

Institutions and commercial frauds in water industry: a view of the metropolitan region of São Paulo

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Abstract: In water industry, frauds committed by customers to access water without paying affect firm's revenue, contribute to increase physical losses and interfere in the economic order causing harm to society. Ex post transaction costs involve inspection *in loco* if fraud is suspected and legal enforcement in case a fraud is confirmed. However, individuals may react differently to the costs and benefits of complying with contractual and legal standards. We analyzed the 115,695 frauds registered in management system of the concessionaire between January 2010 and June/2016 in the Metropolitan Region of São Paulo. The results indicated that the inspections did not have an important influence on frauds quantity. Frauds were much more numerous in residential category of use in poorest areas with low level of formal education. It is concluded that typical fraudster in this category is at the border of crime. Therefore, he needs an 'incentive' to choose not commit fraud. In this case we propose two interrelated paths: to impose a more educational than punitive character on the inspections and to institute a type of multilateral exchange (Coase, 1960). On the other hand, in commercial category of use frauds were much more numerous in areas with high and very high socioeconomic level. This result is supported by Becker (1968; 1974), whose argument incorporates the illegal rational behavior and brings to the scene Hirschmann's argument (1977), that it is up to society and firms to make effective repressive political structures in adherence to civilized self-interest (Hirschmann (1977)). Due to differences in governance within the firm and in legal and social environment, the validity of the results is limited to the MRSP.

Keywords: commercial frauds; water sector; institutions; monitoring, legal enforcement.

1. Introduction

According to Siffert Filho (1996), inspection systems include punishments, which act as 'incentives' for standard norms to be respected. The effectiveness of such a system depends on its ability to minimize breach of the rules laid down in the contract. Therefore, an optimal inspection system should compare its costs to the cost of fraud and contractual breaches that it usually reduces.

According to Demsetz (1964), the value negotiated between the parties crucially depends on the rights of action over physical goods (property rights), and how these rights are enforced (legal enforcement). However, there are situations where the cost of 'policing' the effects of third-party actions can be very high, creating additional complications. The cost of monitoring and policing potential frauds in water industry fits into this problem.

According to North (1990), institutions impose restrictions on human interaction through formal and informal norms. Sociology also recognizes the importance of norms. The theory of social action (Coleman, 1986; 1990) works with two main currents: in the first one norm is defined as a property of a social system governing the behavior of individuals; the other one is aligned with neoclassical theory, where utility maximization is the principle of every individual action, and in this context the concept of norm is unnecessary.

In water industry, frauds committed by users to access water without paying for it result in commercial losses for the company, contribute to increase the level of physical losses and bring harm to competitiveness and economic order. Frauds include clandestine connections, manipulations of the hydrometer, tampering with other illicit practices, and constitute a crime. In this context, investigating if internal and external institutions have influence on frauds is relevant to seek strategies to improve the effectiveness of contract ex post monitoring, and additionally contribute to reducing the harm to society. Internal institutions are represented by the inspections of the concessionaire. External institutions are represented by the law enforcement. On the other hand, the influence that internal and external control mechanisms exert on the fraud decision is related to the socio-economic profile of the fraudster and to the way in which he fits the system of legal and social norms (Coleman, 1990).

Our aim is to verify the effects that the firm's monitoring mechanisms, the application of legal enforcement and the socio-economic condition exert on commercial

fraud in water industry in the Metropolitan Region of São Paulo. Thus, it is fair to assert that the work lies on the threshold between established norm, legality, and factual reality.

2. Institutions

Commons (1931) defines institutions as 'collective action in the control, liberation and expansion of individual action'. For Nelson & Sampat (2001), institutions are 'social technologies that shape and support rational behavior'. According to Eggertsson (1990), institutions are social and political rules. Hodgson (2006) defines institutions as 'objective structures, exogenous to the individual and simultaneously subjective shoots that emerge from within the human head.' We define institutions as social structures created with the purpose of shaping individual action to promote collective action.

Institutions are composed of formal rules, social rules, and executive characteristics of both. In theory, they should reduce the conflict inherent in human interactions, reducing uncertainty and increasing the degree of security of the decision taken (North, 1990; Nelson & Sampat, 2001). If they are effective they can exclude very costly actions and encourage potentially productive actions for all (Nelson & Sampat, 2001).

Institutions affect both performance and economic growth, determine the cost of various feasible actions, as well as the distribution of wealth (Eggertsson, 1990; Greif, 1993). Laws restrict free action and define the costs and benefits that will be obtained from actions arising from them that are reciprocally extended to the actions of others (Buchanan 1971, North 1990, Greif 1993).

Institution-building requires enforcement mechanisms, which are essential to reduce uncertainty about legal rights and ensure social stability (North, 1990). While formal institutions have a legal apparatus and coercive power, informal norms are self-governing, using strategies available to participants in their economic interaction (Axelrod, 1984; Dixit, 2009).

Organizations such as government and firms produce and enforce formal rules to solve collective action problems through sanctions applied by a third party, while informal norms emerge from networks and are reinforced through ongoing social relations. To the extent that formal norms are in line with the preferences and interests of organizational actors, informal processes and social control greatly reduce costs of

monitoring, which reduces transaction costs and leverages economic and organizational performance (Nee, 1998).

Companies, as economic agents, have their performance limited by the norms of the economic environment in which they operate, and also create their own norms to govern their interaction with their clients / users. According to Ropaul (2010), the firms also have an important role in the design of the legal norms created by the government.

2.1. Property rights, transaction costs and legal enforcement

Economic governance is the functioning structure of legal and social institutions that support economic transactions through institutions of property rights, contracts and taking collective action to provide physical and organizational infrastructure. It is required: (i) to secure property rights by encouraging individuals to save and invest; (ii) to ensure enforcement of contracts in order to curb opportunism and promote mutual gains; and (iii) to promote collective action, in order to provide public goods and control "public evils", without which many private economic activities would not be feasible (Dixit, 2009).

With respect to natural resources, Ostrom (1990) discusses the problems related to two distinct modes of governance: control centrally by governments on the one hand, and privatization of another, and then proposes a model of governance based on collective action, which differs in terms of informational asymmetry, magnitude of transaction costs and effectiveness of the sanctions system.

According to Barzel (1989), the term 'property rights' carries two distinct meanings in economic literature: economic meaning, which is an individual's ability to enjoy property, and legal meaning, which is the right assigned by the state to a person. In this sense, economic rights are the end, what people ultimately seek, and legal rights are the means.

The concept of property rights is strictly related to the concept of transaction costs. Direct transaction costs refer to the resources allocated by the firm to establish governance structures to protect its assets against theft and fraud. Indirect transaction costs represent institutions designed to curb illicit acts, structured and maintained with resources from all over society. In this way, the economic meaning of property rights coincides with the theoretical concept of asset. According to the theory of property rights, the pricing of an asset demands an assessment of the transaction costs directly

and indirectly involved in its protection (Demsetz, 1964 and Barzel, 1989). However, there are situations where the cost of policing the effects of actions is so high that it causes additional complications (Demsetz, 1964).

In the Walrasian model, from which the theory of prices derives, the cost of the information is zero, the property rights are well defined and guaranteed without cost, and the firms do not matter, therefore, individuals can do what the firms do to the same cost. There is neither theft nor uncertainty between the parties about the characteristics or price of the goods. Ownership *per se* does not matter, which means that the production function, which describes how inputs relate to outputs, does not specify which capital inputs will be from the firm. The paradox is that production function demands organization and monitoring, factors related to property (Barzel, 1989).

In this context, economic rights of the individuals to their assets are not constant, but a function: (i) of their own efforts to protect them from attempts at capture by others; (ii) formal and informal non-governmental protection; and (iii) government protection primarily carried out by police and justice institutions. A case of great importance for understanding the circumstances under which property can be secured arises when only one of the two parties involved in negotiation can affect the flow of revenue. Accountability of the individual who affected the flow ensures that the property becomes protected. Thus, enforcement that accompanies property rights plays a relevant role in the ability of prices to measure the benefits obtained from trading. In the case of public or common goods, prices, reflecting private benefits, fail to measure the extent of the derived social benefit (Demsetz, 1964; Barzel, 1989).

According to Demsetz (1964), the development of property rights was accompanied by the development of legal enforcement, which represents the set of institutions created to protect and enforce the former. Thus, the level of protection of property rights is associated with the level of efficiency and effectiveness of legal enforcement institutions.

Property rights internalize externalities when internalization gains become larger than the associated costs. These adjustments have emerged in Western societies largely as a result of gradual changes in previous social customs and common law. In a society that values the constant pursuit of efficiency, its long-term viability will depend on how these adjustments change behavior to accommodate the externalities associated with major changes in technology or market values (Demsetz, 1964).

Coase (1960) proposes that the maximization of economic well-being would be achieved by comparing the total social product produced by the various available social arrangements in terms of net benefits of transaction costs, that is, by establishing negotiation scenarios. Thus, the Coasean solution refers to the consideration of which types of institutions could reduce the costs of defining and enforcing formal and informal property rights.

Of course, it is necessary to save in terms of cost of enforcement, so we do not always want to ensure full control of the buyer. But apart from this, it is essential to note that the power of evaluation of the institution of ownership is most effective when the good is private (Barzel, 1989).

When the institutions in charge of enforcing the law are weak, a positive shock on the value of natural resources may increase the demand for private protection and opportunities for extortion, favoring the emergence of mafia-type organizations specializing in such activities (Buonanno, Durante & Prarolo, 2012).

Both the normative and positive approaches tend to take legal enforcement as given, and therefore they have not included systematic cost analysis of enforcement for different types of laws. The company (or an individual) buys an amount of enforcement that it considers appropriate to certain legal code. More will be bought if the code serves a higher value goal, for example, protection against murder, or if the cost of increasing enforcement is less expensive. The level of enforcement will depend on the variety of factors in addition to the effort (for example, the amount of resources) that a society is prepared to devote to enforcement as a function of the amount of enforcement that is obtained (Becker & Stigler, 1974).

As the criminals' gains increase, enforcement quality would tend to decline. In addition, the quality of enforcement depends on the temporal pattern of violations. It is difficult to bribe or intimidate enforcers who would be involved in a non-repetitive breach. The transaction costs to determine if the other party is trustworthy are substantial and become manageable for both criminals and enforcers. This expectation of mutually profitable contracts between repetitive criminals and enforcers helps explaining the development of organized crime. In addition, arrangements with judges or the police that would not be feasible for the members would be feasible for the organization (Becker & Stigler, 1974).

2.2. Property rights and water

In capitalist societies the exploitation of raw water has been increasingly regulated, and the supply of treated water to the population is made through institutional arrangements involving the public and private sectors, which produce three models of supply, that differ in terms of control of property rights: state, market, and community. The debate about environmental market in the water sector is centered on two divergent views, underlined by relevant conceptual issues related to human, social, economic, public and private rights (Bakker, 2007).

Tabel 1. Property rights in water sector's debate

	Common good	Commodity
Definition	Public good	Economic good
Pricing	Free	<i>Full-cost pricing</i>
Regulation	Centralized control	Market based
Goals	Social equality	Water efficiency and safety
Management	Community	Market

Source: Based on Bakker, K., 2007

Knox & Meinzen-Dick (1999) argue that water management has important environmental and economic externalities both inside and outside the country, and legitimate issues have been raised around property rights over these resources.

Mènard & Saussier (2000), using TCE approach, concluded that among the diversity of contractual arrangements observed in France, the concession is the form of governance that presents a better economic performance.

According to Randall (1981), the value of water can be defined in terms of resource costs to provide water, opportunity cost and social cost. The economic notion of market failures suggests that inefficiency results from externalities, common property resources, public goods, and natural monopoly.

According to Rogers et al (2002), promoting efficiency and sustainability in the water sector through price is simple conceptually but politically difficult, and tariffs do not cover the total cost of supply, which generates large inefficiencies.

In recent years there has been a growing participation of the private sector with government moving from the role of provider to regulator of services. Private sector participation can range from total privatization (ownership and management), investor ownership, and concession. Tariffs can be structured in a number of ways, and each one

will address a specific goal. There is no 'best' tariff structure, but it is possible to design it in order to achieve the objectives of a given community.

3. Social action

The concept of the norm is important to describe how societies function, especially in the case of traditionally stable societies, because they give the meaning of 'duty' or 'behavior according to accepted norms', because stability or slow change of norms constitute an important component of the stability of societal self-governance mechanisms (Coleman, 1990).

3.1 Social action theory (Coleman, 1990)

The explicit definition of the norm is important because it derives from the concept of rights. The relevant right to the definition of a norm is a socially defined right that can exist even in the absence of a legally defined right or as opposed to a legally defined right, as in the case of a rule that conflicts with the law. A norm exists only when others assume the right to affect the direction of action that an individual will take. Moreover, it can be incorporated into a social system in a more fundamental way: a norm is said to be internalized when the individual who takes action self-censors or looks at the social reward for its adhering behavior. The existence of norms presupposes the need for corresponding sanctions.

Other factors related to the two fundamental conditions for the emergence of effective norms are the specification of who will sustain the norm, and determine the strength and prevalence of sanctions, recognizing that its application may entail costs for the sanctioner. Another point is to determine the types of sanctions that will be applied, whether those, that reach reputation, or those that impose physical or material damages.

When an action has external consequences on actors who have no control over it we say that it generates externalities, which can be positive or negative depending on whether they generate benefits or harm. If an action produces negative externalities, the problem is how and how much to limit it. If on the other hand it produces positive externalities, the problem is how and how much to encourage it.

When an action generates externalities for other individuals, a possible solution would be Coase's proposal (The Problem of Social Cost, 1960): the negotiation of control rights, in which actors who do not have control of the action must buy control rights from those that holds them, and the only limitation to the action of the former would be their interest and resources to do so. In this case, in the absence of transaction costs the result would be a good social one. In the case of a public good, each actor who is benefited by the actions of others would negotiate rights to control their own action for partial control rights over the actions of the others. For example, each inhabitant of a city should agree to build a public park and contribute at a fraction of the cost. This constitutes a multilateral exchange in which each individual renounces the right not to contribute in exchange for others to use the same right.

Thus, the genesis of a norm is based on externalities of an action that can not be overcome by simple transactions that would put the control of the action in the hands of those who experience externalities.

Etiquette rules induce the actor to focus on the interests of those who interact with him, and at the same time create a positive externality (status) for the members of the group by their differentiation from those who do not belong to the group. But to promote status for group members the norm should impose sufficient difficulties upon entering a third party into the group.

With respect to the way in which sanctions are applied in society, there is evidence that influential people are not only less likely to suffer sanctions but also less likely to obey norms than less influential people. With respect to take position opposed to norms, there is evidence that this behavior is more recurrent among those who are at the top of the social pyramid in relation to those who are at the bottom.

3.2 Economic outcomes and social structure (Granovetter, 1985; 1992; 2005)

A classic problem in social theory is to understand how behavior and institutions are affected by social relations. The oversocialized conception of human being states that socialization makes people very sensitive to third-party opinions and obedient to what dictate systems of norms and values, so obedience is not perceived as a burden. This exaggerated level of incorporation into the environment is known as embeddedness. In this context it is common to attribute different styles of decision

making to members of different social classes as a result of the class culture or its experience in the educational system.

Classical and neoclassical economics, in contrast, operate with an atomized and undersocialized conception of human action, continuing the utilitarian tradition associated with the premise of self-interest, and theoretical arguments disallow by hypothesis any impact of social structure and social relations on production, distribution or consumption. This solution envisions an idealized market, where information is perfect, and therefore, repressive political structures have no function, which makes force and fraud useless, since competition determines the terms of the business so that individual agents can not manipulate, because if agents do find complex relationships characterized by mistrust or malfeasance, they can simply look for other agents who wish to negotiate in terms of the market.

In the real world actors do not behave or decide as atoms out of the social context nor adhere with total subordination to a script written for them by the social categories to which they belong. On the contrary, their attempts to take propositional actions are involved in the present (ongoing) system of social relations.

Under new institutional economics view, social institutions and arrangements are previously thought to be the result of legal, historical, political and social forces function as efficient solutions to certain economic problems, since they make prevarication very costly. However, it is emphasized that the arrangement does not produce trust, but a functional substitute for it. The main arrangements are the contracts.

What has eroded trust in recent years has been the increase in attention on micro-level to imperfect competition markets, characterized by a small number of participants with sunk costs and specific investments in human capital.

According to Hirschmann (1977), the pursuit of self-interest is not typically an uncontrollable passion, but a civilized activity. The broad acceptance of this idea implicitly is an example of how under and oversocialized conceptions complement each other: atomized actors in competitive markets internalize normative norm standards to ensure order for the transactions. In part this premise persisted because in a self-regulated market the competitive forces could suppress force and fraud.

Other economists have recognized that assuming some level of trust is necessary to operate, since institutional arrangements alone can not prevent force or fraud. But the source of that trust remains to be explained. It is known, however, that individuals prefer to negotiate with those with a good reputation; strength and fraud are more

effective if pursued by teams, and the structure of these teams requires some level of internal trust.

3.3 The economic approach of crime

Becker (1974) asserts that the cost of fraud can be measured in terms of the company's resources dedicated to its detection, plus the cost of using public institutions related to the punishment of the offender, plus the loss of revenue of the company. In the case of commercial fraud in water sector, cost measurement is more complex, since they have an impact on physical losses, which are related to investments and to maintenance expenses, and beyond that, increasing physical losses reduces the volume of raw water available to the population, and this increases the need for raw water abstraction and generates negative externalities.

Regarding the decision to commit or not to commit an irregular act, two factors have an important influence: (i) the perceived amount of supervision, which is directly related to the probability of being caught; and (ii) in being caught, the perceived probability of being punished associated with the type and severity of punishment. Actions are limited by income, time, imperfect memory, computing capacity and other limited resources, as well as the economic available opportunities. Despite the assumption that behavior is rational, 'rationality' does not mean materialism, because it recognizes that many people are constrained by ethical considerations, and do not commit crimes even if they are profitable and there is no danger of detection (Jorge, 2012).

The amount of crime is determined not only by the rationality and preferences of criminals but also by the economic and social environment created by public policies, including policing and punishment for different crimes and employment opportunities, school and training programs. Clearly, the type and amount of legal jobs available, as well as law, order and enforcement integrate the economic approach to crime.

Ehrlich (1973) incorporates the incentive both to practice lawful and illicit actions. His thesis is that in violating the law the individual runs the risk of reducing his wealth and well-being, as he is subject to pay a penalty in pecuniary terms or loss of freedom, which will have to be deducted from the benefits earned. An alternative would be to engage in licit activities, which may also be subject to specific risks. The net gain

in both activities is subject to uncertainty. In this model, offenders are free to combine legitimate and illegitimate activities.

Akerlof and Yellen (2000, apud Rodrigues, 2005) emphasized the importance of the community for judicial system functioning, since the condemnation of criminals depends on the collaboration of witnesses, in a more indirect approach to the relationship between poverty and crime through the notions of "fiefs" or territories that are not under the power of the state. In these models, the supply of crime is largely related to the control of territories by gangs that replace the police power and justice. Thus, in the case of those communities, the rights dimension prevails over the issue of income and over the cost and benefit view emphasized by Becker and Ehrlich models. In this case the sociological factor is preponderant on individual choices.

Akerlof and Kranton (2000), on the other hand, emphasize the influence of the community on individual choices related with identity gains and losses involved in choosing between to adapt to the dominant culture or not.

According to Rodrigues (2005), anthropological studies in favelas in Rio de Janeiro have shown that due to lack of citizenship (or "poverty of rights"), the performance of justice and security is ineffective in poor communities. In these areas criminal groups find loopholes to "replace" certain functions of the state.

According to Wang & Wheeler (2005), given the dominance of enforcement and control methods in the US and Canada, the literature has focused on the determinants of compliance with legal standards. In this context, the law enforcement agent (the regulator) attempts to identify and penalize the non-compliant. To induce greater compliance, the legislator can increase the penalty or reinforce monitoring and enforcement.

According to Becker & Stigler (1974), types of crime that are not directly associated with victims in general do not receive attention by society. In addition, the incentive structure for honesty involved in the remuneration of enforcers, which can often be much smaller than the criminals' earnings, may lead to a decline in the quality of enforcement.

3.4 The institute of crime

The crime understood as a criminal type is a generic institute of the state that only indicates that the Penal Codes provide for the prohibition of actions and penalties corresponding to their practices (Almeida, 2015).

According to the theory of social labeling, a deviation is thus labeled not by its intrinsic characteristics, but because this condition is conferred upon it by society. Thus, a deviant act is categorized because it was defined as such by a social norm. This approach subdivides the deviation act into primary deviation - which is the practice of the act itself - and secondary deviation, which is the alteration of individual identity as well as his relations with the social body as a result of the deviant act. This change in identity is due to the stigmatizing and degrading effects of the process and to the penalty (Shimizu, 2011 *apud* Franco and Belloque, 2007).

The theory of social labeling has given rise to other critical theories, which have brought to the criminological thought an inversion as far as its fundamental questions are concerned. Thus, the classic question: "Why do individuals commit crimes?" Has given rise to the question: "Why are some behaviors criminalized while others, although socially harmful, are not?" And even more: "why are some people less vulnerable?" (Shimizu, 2011 *apud* Franco and Belloque, 2007).

Welzel (1997) supports a moral approach to the material definition of crime, namely, that the crime corresponds to a violation of elementary ethical-social duties of community life. In this case Criminal Law aims to protect certain vital assets of the community, including property, imposing legal consequences on their injury, thus ensuring the validity of positive moral values.

4. Contract and Transaction Costs Economics

Contracts are fundamental institutions for social and economic life since they represent legally enforceable agreements (Lumineau, 2014). The classic contractual law that began in the eighteenth century and reached its apogee in the nineteenth century presented two crucial attributes, which have great influence on contractual thinking that succeeded it: (i) its conception as a set of few simple, abstract and universal rules and principles, which made them independent of their specific institutional, moral, and economic contexts; (ii) its conception as a canonical, general and abstract formula of various social relations. Thus, relationships that were previously seen in terms of status, trust, and economic dependence (non-promissory contractual elements) have been

reinterpreted. Weber describes that phenomenon as "process of orientation to the market of modern society" (Macedo Jr., 2006).

According to Posner (2000), the rules of contract law, on which we have influence only when a dispute occurs, are unlikely to have an impact on people's behavior.

In Transaction Cost Economics contracts are regarded as governance structures and designed to minimize transaction costs under the behavioral premise of self-interest with malice or fraud, which may involve subtle forms of fraud (Williamson, 1991). If negotiation costs are negligible and users can freely negotiate, justice could allocate the right to either party without affecting the efficiency of the outcome. The only effect of the court decision would be on the distribution of costs and benefits between the parties (Coase, 1960).

The nature of the transaction is a fundamental element that has to be considered in the institutional matrix under which the transactions will be negotiated and executed. However, it does not clearly identify the critical dimensions of the contract or the purposes of governance. A contractual relationship is not conceived without stabilizing institutions, social rules, values, economics and language. Therefore, there is no contract outside the social context that gives it meaning (Macneil, 1987).

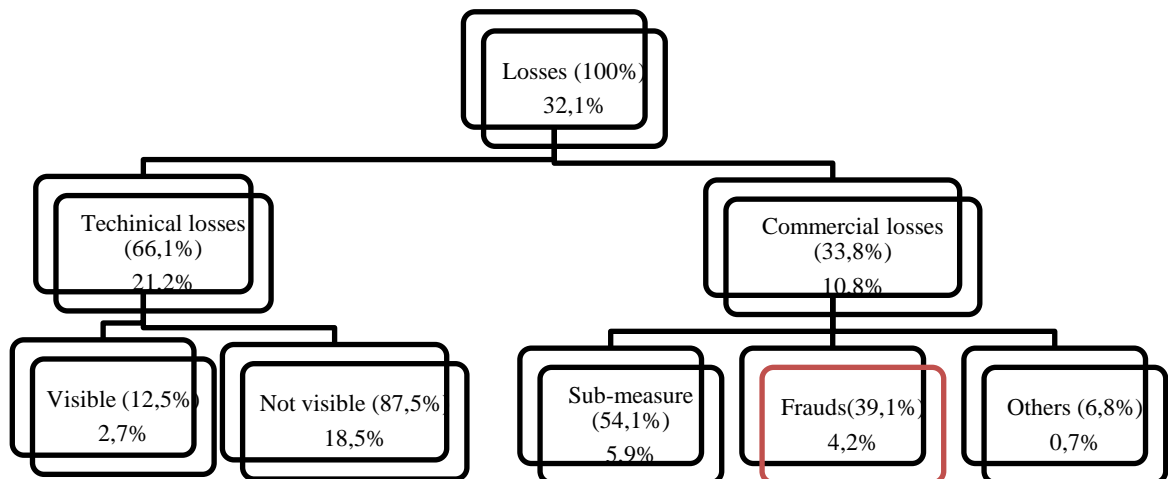
5. Monitoring illegal practices of customers in the MRSP

In sectors such as electricity and water, whose services are diffuse, managers need to formulate strategies to create shortcuts between the company and the fraudsters. In electrical sector illicit acts of the customers have been investigated in depth for some time. According to Araújo (2007), factors that influence fraud behavior are:

- Little supervision, often due to the difficulty of access to the area;
- Impunity of lack of legal support to punish;
- Easy to tamper with the meter;
- Lack of incentive to report frauds, or lack of mechanisms to capture them;
- Lack of technological innovations aimed at improving the surveillance system;
- Lack of alternatives to change the billing system or the available alternatives have a prohibitive cost;
- Bad financial situation of the user (pontual ou transitória);
- Situation of high vulnerability or chronic poverty of the user;

An estimate of the impact of irregular customer practices on water losses in terms of total billed volume of the utility in question is presented below.

Illustration 1. Estimated impact of frauds in terms of unbilled volume



Source: Public hearing Arsesp – February/2013.

Rudd (2000) also cites the absence of structural and perennial programs aimed at strengthening the relationship with communities. He also adds ethical factors, since most clients do not perceive this practice as immoral.

According to Araújo (2007), a major concern of the Brazilian electricity regulatory agencies is to provide interaction between agents of the electricity distribution sector and police authorities, the Public Ministry and the Judiciary to strengthen the fight against fraud in consumption and deviation of energy.

In this study suspicions of fraud are raised mainly through individual consumer control. Employees working in this area add other factors that influence irregular practices, namely:

- Malice in using of regulatory agency rules or Code of Consumer Protection rules;
- Lack of financial incentive for the employers dedicated to fraud detection, whose salary is identical to the employers of general operational services;
- Lack of external skilled labor in detecting fraud in water sector;

- Police Districts do not have interest to register this type of occurrence because it competes with other types of crimes;
- Corruption in the Police institution;
- Involvement of company employees or outsourcers who create a skilled labor supply Market to perform certain more complex types of irregularities, and therefore more difficult to detect them.

When there is a significant reduction of the average consumption, a specific area of commercial department issues a service order so that the property is inspected *in loco*, in order to confirm or not the occurrence of fraud, since the decrease in consumption may also be due to operational factors. Suspicions of irregularity may also entry through complaint channel, whereby any citizen can make a complaint, and through operational services report. The concessionaire has 70 (seventy) hunting fraud teams to cover all MRSP region.

When a fraud is confirmed, the offender can be criminally indicted. Fraud is qualified theft whose punishment varies from 2 to 8 years of imprisonment, but application of legal enforcement depends on the police's notification by the concessionaire, which has to decide between to notify the police and reduce the number of inspections, or to waive enforcement and increase the number of inspections. So, in practice the number of occurrence bulletins for confirmed frauds is small. From year 2012 to 2016 the control over fraud was reinforced by two contracts. In this period 440 occurrence bulletins were opened at the Police.

According to Reis (2006, *apud* Santos, 2011), there is no simple division between fraudster and non-fraudster. In addition, it is unfeasible to inspect all consumers *in loco*, because that would demand an expressive increase in infrastructure, with expressive costs increase, without bringing significant improvements to the final outcome. So, it is crucial to improve the selection strategy for inspecting residential and commercial units. Fraud detection rate on total amount of inspections varies between 5% and 10%.

5.1 Frauds investigation process

The assumptions for investigating fraud suspicion are based on the following tripod: (i) in approaching the potential fraudster the long-term business vision should prevail over the punitive view; (ii) the characterization of a fraud must be based on

conclusive and definitive evidence to avoid the possibility of accidental damage or arising from related services of the concessionaire itself; (iii) analysis of the relationship between the cost of regularization in face of the benefit arising from the eventual collection of consumption difference in case that customers registered in favela and social tariff and (iv) application of contractual penalties for customers with differentiated tariffs, such as firm demand contracts and welfare entities.

Actions aimed at confirming irregular situations should be based on the following elements and restrictions:

- Reports of occurrences prepared through inspections *in loco*;
- Analysis indicating low consumption, outside parameters considered normal;
- Information received through the registration of various complaints;
- Verification of previous irregularities in the same property;
- Evaluation of the consumption potential of the water connection by analyzing the cost x benefit of the performance according to initial premises;
- Priorization of recurrent calls for irregularities;
- When it is not possible to identify a person in charge of the property, the estimation of the stolen volume must be analyzed by higher authority;
- Checking the need for repairs to the water connection;
- Preparation of dossier;
- Customer service triggered by suspected fraud;

The types of occurrences that may be characterized as fraud are:

- Inverted hydrometer;
- Hydrometer manipulated;
- Hydrometer locked;
- Perforated hydrometer;
- By-pass;
- Clandestine connection of water or sewage;
- Direct connection;
- Use of sewage by water from alternative sources without registration or supply

by truck.

Once fraud is confirmed, its nature, extent and severity are assessed, with a focus on commercial understanding with the client. The following measures are applicable but not mandatory:

- Suspension of water supply;
- Application of safety device in the hydrometer;
- Photograph the fraud and keep the evidence for five years;
- Irregularity Notice and ‘accordance to’ from customer;
- Police Occurrence Bulletin;
- Exclusion of the water connection.

Finally, the commercial staff estimates the unpaid consumption for valuation and retroactive billing. In that case the main point concerns the change in the period to retroact, from 60 to only 12 months by determination of the regulatory agency. This norm change potentially increases the risk of loss to the concessionaire unless its ability to detect fraud be increased.

In 2011 the Board of Directors implemented a program to combat fraud in order to standardize systems and resources to identify and disseminate fraudulent agents, individuals who ‘sell’ the service to execute fraud for users. In this program, the contract for the provision of fraud investigation services plays a relevant role. With the water crisis occurred in 2014/2015, the inquiries gained direct support from the government of the State of São Paulo and the concessionaire began to work jointly with the Secretariat of Public Security.

6. Methodology

According to Souza & Torres (2003), a region can be considered as the spatial materialization of socioeconomic organization diversities of the societies. Therefore, a spatial analysis of the territory where the studied phenomenon occurs is applicable. In addition, we used descriptive, inferential and time series analysis. Data about confirmed frauds have been provided by the concessionaire.

The study encompasses 29 municipalities of the MRSP operated by the concessionaire that add up to five million water connections that cover residential,

commercial, industrial and mixed categories of use. The municipalities segregated by geographical location are following:

- North: Caieiras, Cajamar, Francisco Morato, Franco da Rocha e Mairiporã.
- East: Arujá, Biritiba-Mirim, Ferraz de Vasconcelos, Itaquaquecetuba, Poá, Salesópolis e Suzano.
- Southeast: Diadema, Ribeirão Pires e Rio Grande da Serra.
- Southwest: Cotia, Embu, Embu-Guaçu, Itapecerica da Serra, Juquitiba, Taboão da Serra e Vargem Grande Paulista.
- West: Barueri, Carapicuíba, Itapevi, Jandira, Osasco, Pirapora do Bom Jesus e Santana de Parnaíba.

The analysis covers the period from January 2010 to June 2016. The sample includes all the frauds confirmed in this period registered in the managerial system of the concessionaire, which adds up to 115,695. The database consists of an excel file, in which each line corresponds to IGR (Individual General Registry) number, which is the customer identification number. The attributes (columns) related to IGRs (lines) are:

- Date: date the fraud was confirmed.
- Commercial service: encompasses a group of IGRs; can encompass more than one district.
- Business unit: encompasses a group of comercial services;
- City: city where the fraud was confirmed.
- Type of connection: type of service provided by concessionaire. There are 3 types: only water connection, water and sewage connection and only sewage connection;
- Use category: it is the purpose of using and can be residential, commercial, industrial, mixed, welfare or public.
- Economy: property or subdivision of property, with own numeration, characterized as an autonomous unit of consumption, of any category, served by own branch or shared with other economies.
- Average: average consumption in cubic meters of the last 60 months retroactively from the date of fraud confirmation.

- Activity branch: type of activity carried out by the IGR in which fraud was confirmed, for commercial and industrial use categories. For residential category it indicates the type of housing, for example: CDHU, favela, single family residence, horizontal condominium, etc.)
- Tariff: tariff classification for the service and it can be normal or popular;
- Address: address where fraud was confirmed;
- District: district where fraud was confirmed.

Total of inspections on water connections (IGRs) as well as total active connections per month were obtained through the management information system of the concessionaire. In addition, Audit Superintendency provided a file containing the bulletin occurrences registered at the Police for the period.

Following data were obtained from public sources and further tested as explanatory variables in the inferential analysis. It is important to note that educational data are only available for the city of São Paulo.

- Latitude and longitude coordinates of detected fraud addresses (Google Maps Geocoding 2017 API);
- Proportion of people aged 10 years or more by level of education per district (INFOCITY 2017). Levels of schooling considered are:
 - Literate;
 - Incomplete elementary school;
 - Complete elementary school or incomplete high school;
 - Complete high school or incomplete higher education;
 - Complete higher education.
- Proportion of people per level of PSVI (São Paulo Social Vulnerability Index) by district (SEADE Foundation 2017). The levels of PSVI are:
 - Very very low or not vulnerable;
 - Very low vulnerability;
 - Low vulnerability;
 - Medium vulnerability;
 - High vulnerability (urban areas);
 - Very high vulnerability (urban agglomerations);

- High vulnerability (rural areas).

According to Laville (1999), the human disciplines may difficult the complete understanding of a problem. The real should be approached in its totality as a system of related factors, but social phenomena have two dimensions: one is objective and the other one is subjective. In this study the frauds detected represent the objective dimension. In this dimension we describe the quantities related to several managerial variables, spatial location and evolution in time. The subjective dimension encompasses the fraudsters and the monitoring institutions (inspections), the legal enforcement (Police Bulletin occurrence) and the environment / location where the fraudster lives.

6.1 Georeference analysis

Based on the addresses of users who had fraud detected, latitude and longitude were collected using API *Google Maps Geocoding* (2017), and maps are presented in Appendix B. This interface requires the use of Python language programming to make Google Maps query requests via web. Approximately 60% of the fraud addresses were captured, which represents a good result, sufficient to to produce the maps.

6.2 Time series analysis

A scenario of interest is to visualize the behavior of the quantity of frauds over time, and if possible to compare it to the behavior of a particular variable over the same period of time, in order to verify a possible influence of the second over the first one. In general, a time series can be generically decomposed in terms of trend, cycle, seasonality, and random component (Armstrong, 2000).

6.3 Inferential analysis (Manski, 1995)

Why do social scientists often provide conflicting perspectives on issues of public interest? The heart of the problem is the inherent difficulty of studying human behavior. The conclusions that can be drawn from any analysis are determined by the assumptions made and the data brought in, but the range of plausible premises on the behavior is broad and the available data are limited to observations that can be made without undue

intrusion. Researchers combine limited data with different assumptions and often reach logically different and valid conclusions (Manski, 1995).

For the variables selection the backward, stepwise and AIC methods were used. The final model was chosen through the backward method combined with the interpretation of the model parameters (Alencar, Farias & Figueiredo, 2017).

In order to model the number of frauds by district in São Paulo, generalized linear models with negative binomial distribution were adjusted for the counting data of the variable "amount of fraud by district", distribution chosen due to overdispersed counting data. The number of frauds was relativized by the population for each district by the offset function, in order to avoid spurious correlations of larger populations and larger occurrences of fraud. The models were adjusted without interaction and with logarithmic link function. Moreover, since the offset was considered in all models, the average rate mentioned in the models refers to the ratio between the quantity of frauds and the population divided by a thousand (Alencar, Farias & Figueiredo, 2017).

7. Results

Descriptive analysis is presented in APPENDIX A. In APPENDIX B we present the maps, the relevant ones to the georeference analysis. In APPENDIX C the Graphics referring to the time series are presented.

7.1 *Descriptive analysis*

Initially, the distribution of frauds quantity was analyzed in relation to the groupings considered in the study, according to the geographical area (Commercial service, business unit, district and municipality) and according to the characteristics of the IGR, category of use, economies, average consumption, type of industry and tariff).

Through accounting by IGR (Table A.1), we verified that most of the fraudsters were not repeat offenders in the period - more than 90% of the identified fraudsters committed only one fraud, approximately 7.6% of the fraudsters committed two frauds and 1,5% of the fraudsters have reached the third fraud.

Of the 101,279 IGRs with fraud confirmed in the period, 26 (TABLE A.2) committed at least 10 frauds, all of them in residential category of use, as following: 24 single family residences, a horizontal condominium and a tenement. Of these, 22 pay

normal tariff and 4 pay the popular tariff. Legal enforcement was applied only to one IGR, located in Itaquera.

The quantity of recidivists was adhered to the quantity of frauds in their respective districts and counties. After São Paulo, Francisco Morato, Itaquaquecetuba and Franco da Rocha were the municipalities with the most recurrences occurred (TABLE A.3).

North business unit presented the largest quantity of IGRs with recurrences (TABLE A.4), with 71% of the total. The IGR with the highest observed amount of recidivism counted 31 frauds and is located in the municipality of Francisco Morato. Commercial services Freguesia do Ó, Vila Nova Cachoeirinha, Jaçanã, Arthur Alvim and Itaquaquecetuba also registered cases of more than one fraud for the same IGR (TABLE A.5).

Among the 64 commercial services attending the MRSP, Pirituba recorded 5,793 frauds, followed by São Miguel (5,194), Itaim Paulista (4,849), Itaquaquecetuba (4,770) and Santana (4,765). Together those units represent 21.9% of the occurrences (TABLE A.6).

From 135 districts where frauds were detected (TABLE A.7), Itaquaquecetuba obtained the largest quantity of residential frauds (4,515), followed by Brasilândia (4,248) and Osasco (3,482). When relativized by the district population, Cajamar presented 61.1 frauds per thousand inhabitant, a quantity much higher than the second and third placed - district of São Miguel, with 25.3 and Socorro, with 23 frauds per thousand inhabitant.

East and North business units accounted for more than half of frauds detected (TABLE A.8).

The city of São Paulo had the highest incidence of residential frauds, totaling 78,362 in the period. This amount is due mainly to the size of the population, which totalizes more than 11 million inhabitant according to the 2010 census (TABLE A.9), however, when frauds are relativized by the population, the proportion of fraudsters in residences is lower than that of other smaller municipalities, as is the case of Pirapora do Bom Jesus, with 22.6 frauds per thousand inhabitants. Francisco Morato also appears as one of the densest in relation to quantity of frauds, reaching 16.8 frauds per thousand inhabitant.

Results indicated that 86% of the frauds occurred in residential category (TABLE A.10). This percentage is attached to the percentage of water connections in this category. The branches of activity with the largest amount of observations - Residential

single family and horizontal residential condominiums (TABLE A.11) – represents 84% of the records and are subtypes of this category.

In regarding to the tariff (TABLE A.12), frauds are distributed in two types: normal RC (96%) and popular and favela (4%). As is the case in relation to frauds proportionality with respect to the category of use, quantities are adherent to the respective proportions. The same occurred per type of connection (TABLE A.13), most of which were water and sewage (78%), and more than 80% in places with only one economy.

In commercial category, 10,487 frauds were confirmed in the analyzed period. Center business unit was the one with the largest quantity of frauds in commercial category, followed by East business unit. West business unit presented the lowest amount of frauds in this category (TABLE A.14).

In terms of Commercial service in the city of São Paulo (TABLE A.15), the highest number of frauds was reported by Sé, with 1193 occurrences, which represent 11% of the total. The attendance of the Gardens commercial service, which covers the prime area of the city of São Paulo, reported 457 occurrences.

The municipalities that presented the highest quantity of frauds in the commercial category, after São Paulo, were São Bernardo do Campo and Osasco. The districts with the largest quantity of frauds in this category of use were São Miguel, Penha and Santo Amaro (TABLE A.16). When relativized by the population, however, the districts of Sé and Brás occupy the top positions, with 8.20 and 5.81 frauds for 1,000 inhabitants, while São Bernardo do Campo presents only 0.57 (TABLE A.17).

In relative terms the districts that presented higher quantity of frauds in commercial category than in residential category of use were Sé and República. In general, it was observed at most in central districts with a high socioeconomic level population (TABLE A.18).

In industrial category of use the business unit that presented the highest quantity of frauds East business unit, followed by Center business unit (TABLE A.19). The commercial attendances that presented the largest amount of occurrences were Sé, Penha, São Miguel and Santo Amaro (TABLE A.20).

7.1.1 Legal enforcement: bulletin occurrence

The two contracts that supported the fight against fraud through an agreement with the Secretariat of Public Security ran from May 2012 to July 2013 and October 2013 to March 2016. During this period 440 bulletins were registered, 285 fraudsters have been indicted and 142 have been arrested.

The municipalities with the largest quantity of occurrence bulletins were Osasco (37), Itaquaquecetuba (32) and Barueri (16), and districts from São Paulo municipality with the highest number of occurrences were República (19) and Pirituba (18), according to TABLE A.21. Business units that presented the highest number of occurrence bulletins in the period were North, West and Center (TABLE A.22).

Despite the fact that quantity of frauds in residential use category is much larger than in the other categories, occurrence bulletins were mostly registered (85%) in commercial and industrial categories, because in those categories the volumes subtracted are much higher than in residential category of use (TABLE A.23).

In addition, in APPENDIX A Graphics A.1.a to A.7 relate the amount of frauds by district and the proportion of inhabitant at different levels of vulnerability in the city of São Paulo, according to PSVI.

7.2 *Georeference analysis*

From the 115.565 frauds detected, the coordinates of approximately 60% of the addresses have been retrieved. Addresses not found in the Google Maps database may not be cataloged or may differ in their descriptions in the API base.

On the maps per municipality (B1 to B5), all the coordinates retrieved through the API have been counted. In its turn, on the maps by district (B6 a B8), only the coordinates related to the frauds occurred between June 2014 and May 2015 have been counted because that was the last period whose coordinates have been obtained.

Maps indicate that municipalities with the highest absolute number of frauds do not correspond to the municipalities which present the highest relative number of frauds in proportion to their population.

Maps suggest the presence of geographic influence on the frequency of fraud occurrences. Regions in the same municipality show very different patterns. That is the case of West and North regions in the city of São Paulo (B5).

It is also possible to visualize on map B4 the frauds of the municipalities of Francisco Morato and Franco da Rocha, which present high density of occurrences in relation to their population, as already mentioned previously.

7.3 *Time series*

The lowest point was registered between the end of the year 2013 and the beginning of 2014, and the highest point was registered in the year of 2016. It was not possible to identify trends or seasonalities in the general series, as can be observed in Graphic 1.

Regarding the water crisis, which took place in 2014/2015 biennium in the state of São Paulo, Graph 1 shows a slight growth trend in frauds quantity after the beginning of 2014, but it is not possible to assert that it was due the event in question.

According to Graph 2, except for a slight increase in the number of frauds detected, which follows the increase of inspections in March 2010, it is not possible to assert that the number of frauds detected is influenced by the number of inspections.

The behavior of the time series according to the size of the business units does not show any trend or seasonality either, as can be seen in Graphics 3 to 5. The same peaks and slopes are observed in most categories of use, according to Graph 6, with no evidence of influence of some of the variables on the behavior of the series, which presents apparently random variatons.

As can be observed in Graph 7, due to the low number of connections in sewage-only type of connection, its behavior is much different of the other categories of connection.

According to Graph 8, no moviments were observed to justify the increases of valleys in the general series. That can be also observed in the stratification by range of the average consumption, in Graph 9.

7.4 *Inferential analisys*

Following models have been tested.

MODEL 1. Theoretic model with following explanatory variables: low vulnerability (Very very low, very low and low vulnerability grouped), quantity of inspections and quantity of connections.

Y_i := frauds quantity in district i, period from january 2010 to june 2016

$i = 1,2,3 \dots 93$ (district index)

$Y_i \sim \text{Negative Binomial}(\mu_i, \varphi)$,

On what,

μ_i := distribution parameter of Y – medium rate

φ := distribution parameter of Y - form

$\log(\mu_i) = \beta_0 + X_{i1}\beta_1 + X_{i2}\beta_2 + X_{i3}\beta_3$

Being,

β_0 := reference constant;

β_1 := average variation of the log of frauds quantity per district when a unit is added on variable X_{i1} (proportion of inhabitant with low vulnerability in the district i), keeping the other variables fixed, with X_{i1} varying from 0 to 100. The variable X_{i1} represents the grouping of 3 PSVI categories: very very low (or absence of vulnerability), very low vulnerability and low vulnerability.

β_2 := average variation of the log of frauds quantity per district when a unit in the variable X_{i2} is added (quantity of connections inspectioned divided by the population in district i), keeping the remaining variables fixed, with X_{i2} ranging from 0 to 1.5.

β_3 := average variation of the log of frauds quantity per district when a unit in the variable X_{i3} is added (quantity of connections inspectioned divided by the population in district i), keeping the remaining variables fixed, with X_{i3} ranging from 1,6 to 155,8.

From this model, we verified that variables X_{i2} (connected IGRs) and X_{i3} (fiscalized IGRs) were not significant at the significance level of 5%. See below the summary of the model:

Table 2. Summary of model 1

Effect	Estimate	Standard Error	p-value
Intercept	2,580	0,201	<0,001
Low vulnerability	-0,012	0,003	<0,001
Inspections	-0,204	0,306	0,504
Water connections	0,004	0,004	0,272

Since for both variables the p-value was greater than the level of significance, they were removed one by one from the model.

These two variables were not included in the adjusted final models because they did not present a significant explanation for the response variable of interest. The other ones, described in the first section of this study, presented similar behavior to quantity of inspections and quantity of water connections, not showing any change in the detected frauds series behavior when changing categories within each variable. Given these reasons, these categorical variables did not compose the models.

Removing non-significant variables from the model, we obtained a coefficient of 0.99, indicating a decrease of 1% in the average rate of occurrence of frauds when the proportion of inhabitant with very very low (absence of vulnerability), very low or low vulnerability is increased by 1%.

In addition to this model considering the IPVS, we adjusted models with the variables of schooling as shown below:

MODEL 2. Theoretical model with explanatory variable: Without education and incomplete elementary schooling.

Y_i := frauds quantity in district i , in the period from January 2010 to June 2016

$i = 1,2,3 \dots 93$ (district index)

$Y_i \sim \text{Negative Binomial}(\mu_i, \varphi)$,

On what,

μ_i := distribution parameter of Y – average rate

φ := distribution parameter of Y - form

$$\log(\mu_i) = \beta_0 + X_{i1}\beta_1$$

Being,

β_0 := constant reference;

β_1 := average variation of the log of frauds quantity per district when a unit is added in the variable X_{i1} (proportion of inhabitant without instruction and elementary education incomplete in district i), with X_{i1} varying from 0 to 100.

From this model (Model C.2), we verified that the intercept was not significant at level of 5%, and for this reason it was removed from the final model. The summary of the model can be verified as follows:

Table 3. Summary of model 2

Effect	Estimativa	Erro Padrão	Valor-p
Intercept	0,413	0,213	0,053
Without instruction and incomplet elementar school	0,039	0,005	<0,001

Other models have been tested and the final model will be presented in the next section.

MODEL 3. Final theoretical model

Y_i := frauds quantity in district i, period from january 2010 to june 2016

$Y_i \sim \text{Negative Binomial}(\mu_i, \varphi)$,

On what,

$i = 1, 2, 3 \dots 93$ (district index)

μ_i := average rate of frauds in district i

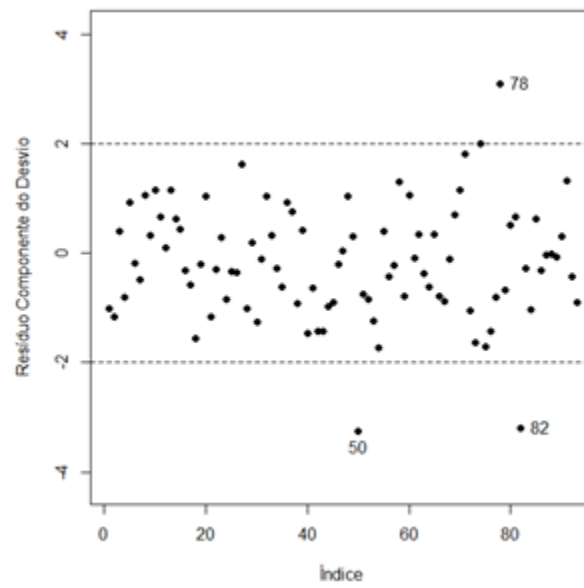
φ := Y shape distribution parameter

$\log(\mu_i) = X_i \beta_1$

Being,

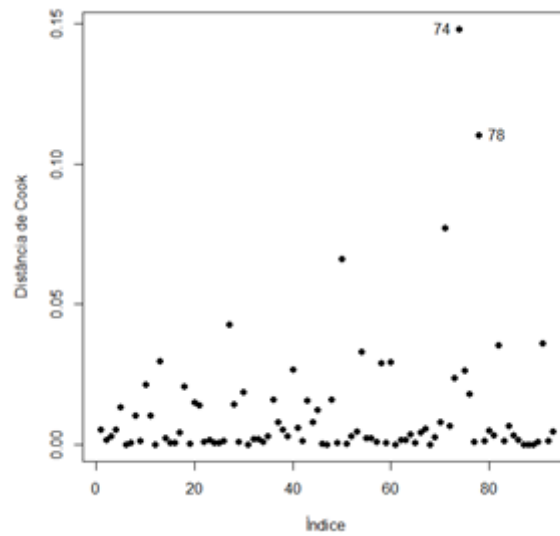
β_1 := average variation of the log of frauds quantity per district when a unit is added in the variable X_i (proportion of inhabitant without instruction or with fundamental incomplete in district i).

The residue analysis indicates that the homoscedasticity assumption is satisfied - the residues are mostly between -2 and 2, according to Graphic 1.

Graphic 1. Residue X Observations

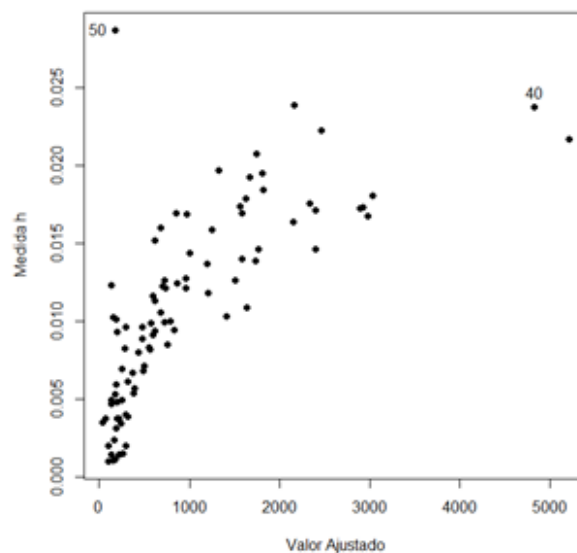
Source: Alencar, Farias & Figueiredo (2017).

Graphic 2 of Cook's distance, which verifies the presence of influential points, shows some more distant observations (74 and 78 - districts of São Miguel and Sé). The removal of these observations did not improve the fit of the model, in this way, they were maintained.

Graphic 2. Cook's distance X Observations

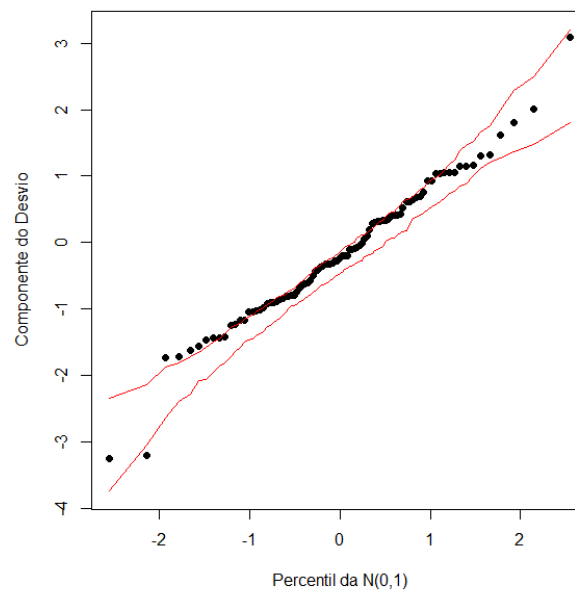
Source: Alencar, Farias & Figueiredo (2017).

Graph 3 (measure h versus adjusted values), shows one point above the others (50 - district of Marsilac), and two points with higher predicted values (28 and 40 - districts of Grajaú and Jardim Ângela), however they were not identified as leverage points.

Graphic 3. Medida h X adjusted values

Source: Alencar, Farias & Figueiredo (2017).

Finally, most of the points are within the 95% confidence range (Graphic 4), indicating adequacy to the distribution of the response variable chosen.

Graphic 4. Quantil

Source: Alencar, Farias & Figueiredo (2017).

The adjusted final model was composed of a single variable without the intercept, being significant only the proportion of inhabitant without formal education or with incomplete elementary school, as Table 4.

Table 4. Summary of model 3 – theoretical final model

Effect	Estimate	Exponentiated estimate	Confidence interval	Standard Error	p-value
Without instruction to incomplete elementary school	0,051	1,052	(1,048; 1,056)	0,002	<0,001

The estimate obtained has the following interpretation:

- For the formal education variable, it is estimated that the increase of 1% in the proportion of inhabitant without formal instruction and those with incomplete elementary school increases the quantity of frauds within that district in 5.2% in average.

8. Discussion of results

In this part we discuss the results related to objective and subjective dimensions.

8.1 *Recidivism*

In the present study, among several possible explanations, recidivism may signal that the measures taken to fight the wrongful act are not sufficient to inhibit the fraudster either because he is unable to comply with his contractual obligations and in that case he is insensitive to the risk; either because he has the perception that the probability of being caught is low; or because he has the perception that in being caught, the probability of being criminally punished is low and the financial sanction will be lower than the benefit obtained with the illicit.

Checking in detail the 26 IGRs with 10 or more frauds (TABLE A.1), we note that in the districts of Francisco Morato, Brasilândia, Itaquera, São Domingos, Limão and Jardim Ângela, for the same IGR there is more than one fraud registered in the same day, and Jardim Ângela presented 11 records of fraud on the same day and another two on the following day for the same IGR, which does not make sense. We also observed several cases of fraud in the same month. The reasons that led to these inconsistencies are not relevant to this study, but what is important to note is that they evidence a condition assumed in empirical studies that measurement and observation values are only partially known, but this fact does not invalidate the study. Another point is that the amount of these occurrences is irrelevant.

Thus, we conclude that a sample that presents: more than 90% of the IGRs without recurrence; more than 9% with one or two recurrences and less than 1% with three or more recurrences is a valid sample and it adequately represents the phenomenon studied.

8.2 *Profile of fraudsters*

In residential category of use it was observed that in districts and municipalities with the highest incidence of frauds, several streets presented more than 40 of such occurrences. The street with the highest quantity in the whole sample is located in

district of Brasilândia in the city of São Paulo (144 frauds), suggesting that fraudsters in this category of use tend to adopt a behavior aligned to the environment in which they are embedded, or to the group to which they belong.

In addition, the areas covered by East and North business units presented the highest level of frauds in the analysed period. Those areas have the districts with the lowest level of infrastructure compatible with the local population, whose socioeconomic level is also the lowest, in comparison to the other areas of São Paulo.

At popular and favela type of tariff it is necessary to assess the cost of regularizing fraud versus the benefit from retroactive charging. 4% of all frauds detected in the period are from users registered on that type of tariff. This percentage is proportional to the total, which indicates that, even if the benefit obtained does not offset the cost of regularizing the fraud, the inspections remain proportional. Thus, the financial aspect does not prevail when it comes to detecting and punishing fraud.

In commercial category of use the Center business unit presented the largest quantity of frauds. This business unit serves the population with the highest socioeconomic level of the MRSP. It is also remarkable to note that, in terms of percentage, Center business unit had more frauds in commercial category of use than in residential category of use. In industrial category of use Center business unit stood out as well. In second position is the East business unit, which covers the most populous area of the city of São Paulo.

The maps help to identify patterns of frauds occurrence by geographic area, evidencing the influence of the social environment. They also confirm the results of the descriptive analysis, that is, in poorer and more populated regions the incidence of frauds in residential category is much higher than in central regions, with a consolidated infrastructure and individuals with a higher socioeconomic level.

8.3 Socio-economic aspects

The results of inferential analysis confirm the results obtained through the descriptive and georeference analysis. Model 1 indicates that 'typical' fraudster in residential category lives in a region of medium, high or very high vulnerability. In addition, model 2 reinforces the results, indicating that the variable 'without formal education and incomplete elementary school' is significant to explain the higher incidence of frauds in districts that present this condition.

The level of formal instruction was the socioeconomic variable that proved to be significant for modeling the incidence of frauds in the MRSP. However, this result is influenced by the high number of frauds (85%) observed in the residential category. Moreover, as previously commented, in commercial category of use the highest incidence of frauds does not occur in districts with that profile, but in districts with high socioeconomic level. Thus, it is reasonable to conclude that this variable is significant to explain the incidence of fraud in residential category, but it does not explain the occurrence of fraud in commercial and industrial categories.

The occurrence of fraud in commercial and industrial categories finds support on cost-benefit analysis of crime (Becker, 1968; 1974). It is well known that frauds in residential category of use are more numerous, even though the proportion of connections in this category is much higher, but frauds in commercial and industrial categories involve very large volumes of water, greater financial losses and harm to society.

8.4 *Monitoring mechanisms*

Monitoring mechanisms, both internal to the firm, as the inspections *in loco*, as external to the firm, such as the legal enforcement institutions, ultimately represent transaction costs to protect property rights (Demsetz, 1964; Buchanan, 1971; North, 1990). A norm can be seen as a common good and its fulfillment promotes social order. Thus, non-compliance is subject to punishment. The underlying idea is that threat of punishment stops the crime.

However, to involve legal enforcement mechanisms involve costs to the firm. On the other hand, if legal enforcement is not applied, the norm becomes weak and ineffective. In this way, the social order can be 'broken' and uncertainty increases. Ultimately, non-effectiveness of the norm can generate malfeasance.

Time series analysis adhered to the inferential analysis, since both indicate that inspections do not exercise important influence on fraud behavior. Thus, it is not possible to reject the null hypothesis, namely, that internal monitoring mechanisms do not have significant effect on the quantity of frauds detected in the districts of São Paulo and municipalities of the MRSP.

8.5 *Social action*

A point of interest in this study consists in investigating whether individual's decision to defraud is influenced by the environment, community pressure and group etiquette, in one hand, or in the other hand, by the company's performance in application of internal and external monitoring mechanisms. In both cases, however, the norm matters.

The descriptive and georeference analyzes allow us to assert that relationship between the environment, represented by the community, and fraud decision exists.

In the case of commercial category of use, it has been demonstrated that internal and external institutional mechanisms are not sufficient to inhibit fraud. In this way competition is disloyal and the economic environment becomes unstable for both competitors and consumers.

In commercial category of use the illicit confronts the socially defined right, in the form of the law. Thus, for the fraudster of this category, the norm does not matter, either because under his perception he is worth the risk of breaking it, or because he has the means, also illicit, of getting rid of the sanction. This finding corroborates Coleman (1986, 1990), who asserts that influential people are not only less likely to suffer sanctions, but also less likely to obey standards than less influential people.

A sensitive point is the amendment of the rule by the regulatory agency, which reduced the deadline to retroact the collection related to the volumes not billed from 60 to 12 months. In practice, this amendment has contributed to increasing the illicit usefulness.

8 Final comments

In capitalist societies political institutions determine rules by means of formal laws and norms, and institutions of economic governance provide the means to 'enforce' those rules. However, for the latter to achieve their purposes, society will have to bear transaction costs, which can take several levels depending on how formal norms are legitimized by informal or social norms. If informal norms are based on ethical concepts of rights and duties, then the transaction costs demanded by economic governance institutions to support business will be lower, and consequently economic efficiency will be greater.

Unlawful acts, in turn, can basically originate from the absence of conditions of the individual falling within the legal norms or from the individual's perception that there are situations where the transaction costs involved are so high that the risk of committing the wrongdoing worth it, because the probability of being caught is very small, or even if it is taken, the economic benefit will be greater than the cost, from the point of view of the individual, including the potential social cost as reputation loss and rejection by the group. If this occurs, a possible explanation is that some social values are weakened, or they have lost meaning *per se*.

In this context, one challenge would be to draw a line between the individuals who fall into the first category, or those excluded from rights, even the right to conduct their own lives on ethical principles; and those who fall into the second category, that is, those who do not follow ethical principles, but their actions are driven by economic and financial gains.

The first category is associated with the political institutions that define property rights. The solution is complex because it demands an institutional change. The second category is associated with the monitoring of property rights. In this case, a possibility would be increasing the effectiveness of the monitoring mechanisms already used, without, however, burdening the transaction costs already incurred. This study seeks to contribute in this sense.

Both normative and positive approaches tend to take legal enforcement as given. However, it has a relevant role on the ability of prices to measure the private benefits obtained from trading, but this measurement does not capture the extent of social benefit when it comes to public or common goods. With regard to the phenomenon studied, the frauds in water sector, we highlight studies that relate repeated violations in time to organized crime as well as studies that relate higher levels of theft of electricity to countries with low levels of effective accountability.

It is not possible to completely ban illegal activity from society no matter will be the cost, unless society prioritizes this goal to detriment of others. Thus, a more effective enforcement of the law would increase potential gains, on the one hand, and on the other hand, the firm would have to seek mechanisms that would increase the effectiveness of its monitoring, which should have a low incremental cost, and so, they would have to be associated with social norms and values, if these are based on ethical concepts.

When duty has an important significance in the individual life, the mechanisms of self-governance are more stable and thus society becomes more stable as well, which provides a solid basis for economic development. As the norms impose penalties for their non-compliance, it can be concluded that in more stable societies, sanctions are less used, since the norms act as mechanisms of self-governance. However, if the rule is not followed, the sanction will be effective.

The norm derives from a socially defined right. Thus, an irregular action will not only have a punishment legally established as a socially sanctioned penalty, should the individual be held liable. However, influential people are less likely to suffer sanctions, that is, to undergo the process of secondary criminalization.

Institutional economics is associated with the oversocialized view of individual action. In this approach the agent would be 'embarrassed' to negotiate within the norm because prevarication would be costly, and the economic governance mechanisms should guarantee the security of the transactions.

Neoclassical economics is associated with the undersocialized view, in which the individual is driven by self-interest and in that context trust is a presupposition, whose break would take the economic agent to be eliminated from the competitive game. In this context, force and fraud are useless, because for the fraudster, a short-term benefit can turn into a long-term malfunction. However, in imperfect markets with sunk costs, the low level of competition has contributed to erode the level of confidence. Thus, it is fair to conclude that in this environment institutional economics approach is useful.

In addition to the fraudster's rationality, other factors that influence fraud are public policies and the community.

Increase the penalty or monitoring, what would be more effective to reduce frauds? Is it better to capture a smaller quantity of frauds and punish them severely or capture a higher quantity and punish them moderately? Increasing the penalty is difficult and costly as it involves a change in the law. In addition, it is necessary to check if the current rule is being fulfilled, because if it is not, the resources invested to change it will not bring any return. This leaves the way of increasing monitoring, which also means increasing costs.

However, if more fraudsters are caught, the company and state should be able to punish them, otherwise the resources invested in increasing monitoring will not bring a return. Thus, increased monitoring implies also increasing administrative and punitive capacity. It is concluded that it is fundamental to punish the individual, making him

responsible for the wrongful act committed, and the path then would be to increase the efficiency of the available monitoring mechanisms, seeking to 'multiply' the effect of the punishments applied.

With regard to the perception of users of public services about the illegal act, research carried out in the electric sector in Brazil has shown that this practice is not seen as immoral, and in countries with different levels of development, morality and degree of compliance are conditioned by customer's trust in the service provider.

The results indicate that threat of punishment, represented by the inspection of the concessionaire and fraud detection has no significant effect on the fraud decision in the case of frauds committed in residential category. Complainants indicate that fraud in this category is related to the individual's low level of formal education and the influence of the community or group. In this way, we can conclude that embeddedness (Granovetter, 1985) plays an important role.

Therefore, since the inspections were not relevant on decision to defraud or not for residential category, and the fraudster in this category presents low level of formal education, we considered that the inspection as institution could be more effective if it had a educational character rather than punitive for these users, seeking to internalize the value of water and citizenship, since this fraudster behaves in a more socialized way. Thus, the firm should target institutional change in order to change community behavior.

In addition, it can be concluded that typically the fraudster in residential category is on the 'frontier' of crime. This individual can not be included in the social tariff. However, he presents a vulnerable social condition and for that reason he needs an 'incentive' to choose not to defraud. This may explain why the results indicated that the inspection of the concessionaire does not have a significant influence on fraud decision. Thus, we consider that a possible path could be to take advantage of the oversocialized effect, which in this category apparently predominates over the undersocialized behavior, to institute the solution based on the multilateral exchange, in which each individual belonging to the group would renounce 'the right to defraud', in exchange for the other individuals resignation, to benefit the community.

In commercial and industrial categories of use, the results indicate that fraud occurs predominantly in regions with medium, high and very high socioeconomic level. In this case, it is concluded that the fraudster's motivation adheres to Becker's argument (1974), which incorporates unlawful rational behavior and other anti-social actions, in

which the decision is influenced by the probability of being caught and, on being caught, by the probability of being punished. As we do not have an idealized market, in real world is up to society and the companies to make effective the political repressive structures in adherence to civilized self-interest (Hirschmann 1977).

This study focuses on a relevant issue in emerging countries, which is the socioeconomic condition of the individual to prevail, to some extent, on moral factors related to the prospect of being caught and punished. We understand that in water industry, which requires mechanisms that induce collective action to reduce transaction costs, this issue is relevant.

This study sought to characterize empirical association between crimes reported in a given region, namely, the MRSP, and premises from the institutional economics. We understand that, beyond the limits of MRSP, even considering other metropolitan regions of Brazil, the results should be validated by means of a new research, since the monitoring mechanisms of the concessionaires and the system of formal and informal rules may present differences.

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APPENDIX A

TABLE A.1 Amount of frauds: IGR

Amount of frauds	Amount of IGRs	Total of frauds	% de IGRs
1	91.170	91.170	90,019%
2	7.705	15.410	7,608%
3	1.547	4.641	1,527%
4	458	1.832	0,452%
5	193	965	0,191%
6	94	564	0,093%
7	46	322	0,045%
8	29	232	0,029%
9	11	99	0,011%
10	10	100	0,010%
11	6	66	0,006%
12	5	60	0,005%
13	1	13	0,001%
17	1	17	0,001%
21	1	21	0,001%
22	1	22	0,001%
31	1	31	0,001%
Total	101.279	115.565	100,000%

TABLE A2. More than 10 recurrences per IGR and event bulletin at the Police

IGR	Amount of frauds	District	Use category/tariff/activity/ bulletin at the Police
544657101	31	F. Morato	Residential/ popular /single family/N
167708112	22	Brasilândia	Residential/normal/single family/N
180068687	21	V Cachoeirinha	Residential/normal/single family/N
601544200	17	Jardim Ângela	Residential/normal/single family/N
111834708	13	Jaraguá	Residential/normal/ Condominium /N
102051607	12	Mandaqui	Residential/normal/single family/N
155134833	12	Artur Alvim	Residential/normal/single family/N
167707817	12	Brasilândia	Residential/normal/single family/N
224867474	12	Itaquera	Residential/ popular /single family/ S
239210646	12	Jaçanã	Residential/normal/single family/N
155134914	11	Artur Alvim	Residential/normal/single family/N
221885170	11	Cidade Líder	Residential/normal/single family/N
239987845	11	Vila Medeiros	Residential/ popular / tenement /N
423954458	11	Itaquaquecetuba	Residential/normal/single family/N
431178569	11	Itaquaquecetuba	Residential/normal/unifamiliar/N
510313531	11	F. da Rocha	Residential/ popular /single family/N
98792504	10	Tremembé	Residential/normal/single family/N
99296306	10	Santana	Residential/normal/single family/N
115363300	10	São Domingos	Residential/normal/single family/N
115756973	10	São Domingos	Residential/normal/single family/N
167707655	10	Brasilândia	Residential/normal/single family/N
175746923	10	Limão	Residential/normal/single family/N
178096148	10	Brasilândia	Residential/normal/single family/N
228603471	10	Cid. Tiradentes	Residential/normal/single family/N
236922432	10	Vila Medeiros	Residential/normal/single family/N
442709170	10	Brasilândia	Residential/normal/single family/N
Total	330		

TABLE A.3 Frauds bycounty – IGRs with recurrences

County	Amount de frauds	%
Francisco Morato	31	9%
Franco da Rocha	11	3%
Itaquaquecetuba	22	7%
São Paulo	266	81%
Total	330	100%

TABLE A.4 Frauds by business unit – IGRs with recurrences

Business unit	Amount of frauds	%
East	78	24%
North	235	71%
South	17	5%
Total	330	100%

TABLE A.5. Frauds by Commercial service – IGRs reincidentes

Commercial service	Amount de frauds	%
Arthur Alvim	23	7%
Campo Limpo	17	5%
Cidade Tiradentes	21	6%
Francisco Morato	31	9%
Franco da Rocha	11	3%
Freguesia do Ó	44	13%
Guaianazes	12	4%
Itaquaquecetuba	22	7%
Jaçanã	33	10%
Pirituba	53	16%
Santana	20	6%
Vila Nova Cachoeirinha	43	13%
Total	330	100%

TABLE A.6. Frauds by Commercial service - Total

Commercial service	AMOUNT de frauds	%
Americanópolis	2.564	2,2%
Arthur Alvim	3.085	2,7%
Arujá	293	0,3%
Barueri	1.789	1,5%
Biritiba Mirim	180	0,2%
Bragança Paulista	569	0,5%
Butantã	1.756	1,5%
Caieiras	783	0,7%
Cajamar	782	0,7%
Campo Limpo	3.462	3,0%
Capela Do Socorro	3.343	2,9%
Carapicuíba	2.672	2,3%
Cidade Tiradentes	4.344	3,8%
Cotia	1.502	1,3%
Diadema	90	0,1%
Embu	743	0,6%
Embu Guaçu	181	0,2%
Ferraz de Vasconcelos	1.296	1,1%
Francisco Morato	2.703	2,3%
Franco da Rocha	1.511	1,3%
Freguesia do Ó	4.524	3,9%
Grajaú	1.952	1,7%
Guaianazes	2.861	2,5%
Ipiranga	1.788	1,5%
Itaim Paulista	4.849	4,2%
Itapecerica da Serra	567	0,5%
Itapevi	1.700	1,5%
Itaquaquecetuba	4.770	4,1%
Jaçanã	1.666	1,4%
Jandira	932	0,8%
Jardins	803	0,7%
Joanópolis	23	0,0%
Mairiporã	328	0,3%
Moóca	2.053	1,8%
Nazaré Paulista	45	0,0%
Osasco Antonio Agu	1.922	1,7%
Osasco Km 18	2.122	1,8%
Pedra Bela	15	0,0%
Penha	3.587	3,1%
Perus	3.887	3,4%
Pinhalzinho	12	0,0%

"to be continued"

"continuation"

Commercial service	Amount of frauds	%
Piracaia	70	0,1%
Pirajussara	1.250	1,1%
Pirapora Do Bom Jesus	367	0,3%
Pirituba	5.793	5,0%
Poa	992	0,9%
Ribeirão Pires	223	0,2%
Rio Grande Da Serra	80	0,1%
Salesópolis	9	0,0%
Santana	4.756	4,1%
Santana Do Parnaíba	802	0,7%
Santo Amaro	2.592	2,2%
São Bernardo Do Campo	3.135	2,7%
São Mateus	2.679	2,3%
São Miguel	5.194	4,5%
Sé	2.413	2,1%
Socorro	50	0,0%
Suzano	2.672	2,3%
Taboão Da Serra	1.148	1,0%
Vargem	11	0,0%
Vargem Grande Paulista	114	0,1%
Vila Maria	1.800	1,6%
Vila Mariana	887	0,8%
Vila Nova Cachoeirinha	4.474	3,9%
Total	115.565	100%

"conclusion"

TABLE A.7. Residencial frauds per 1000 inhabitant – district level

District	Population	Amount of residential frauds	Frauds/1000 inhab
Cajamar	11.589	708	61,1
São Miguel	92.081	2.334	25,3
Socorro	37.783	869	23,0
Pirapora do Bom Jesus	15.733	355	22,6
Perus	80.187	1.478	18,4
São Domingos	84.843	1.490	17,6
Francisco Morato	154.472	2.597	16,8
Brasilândia	264.918	4.248	16,0
Suzano	155.804	2.426	15,6
Cachoeirinha	143.523	2.131	14,8
Itaquaquecetuba	321.770	4.515	14,0
Vila Medeiros	129.919	1.762	13,6
Barueri	112.726	1.512	13,4
Guaianases	103.996	1.373	13,2
Jaçanã	94.609	1.152	12,2
Cidade Tiradentes	211.501	2.538	12,0
Itaim Paulista	224.074	2.649	11,8
Freguesia do Ó	142.327	1.650	11,6
Tremembé	197.258	2.283	11,6
Anhanguera	65.859	744	11,3
Franco da Rocha	131.604	1.412	10,7
Carapicuíba	230.112	2.425	10,5
Jaraguá	184.818	1.879	10,2
Ferraz de Vasconcelos	120.194	1.181	9,8
Penha	127.820	1.241	9,7
Artur Alvim	105.269	1.002	9,5
Limão	80.229	758	9,4
Casa Verde	85.624	742	8,7
Pedreira	144.317	1.250	8,7
Poá	100.546	854	8,5
Caieiras	86.529	721	8,3
Jaguara	24.895	205	8,2
Vila Jacuí	142.372	1.155	8,1
Pirituba	167.931	1.362	8,1
Vila Curuçá	149.053	1.190	8,0
Cotia	170.513	1.359	8,0
Jandira	108.344	836	7,7
Jardim Helena	135.043	1.004	7,4
Vila Maria	113.463	833	7,3
Lajeado	164.512	1.204	7,3
Itapevi	200.769	1.425	7,1

"to be continued"

"continuation"

District	Population	Amount of residential frauds	Frauds/1000hab
Santana de Parnaíba	108.813	751	6,9
Parque do Carmo	68.258	446	6,5
Itaquera	204.871	1.306	6,4
Vargem Grande Paulista	42.997	274	6,4
Grajaú	360.787	2.267	6,3
Cidade Lider	126.597	787	6,2
Campo Limpo	211.361	1.308	6,2
Biritiba-Mirim	28.575	169	5,9
Cangaíba	136.623	779	5,7
Cidade Kemel	5467	31	5,7
Cidade Dutra	196.360	1.084	5,5
Vila Matilde	104.947	579	5,5
Taboão da Serra	244.528	1.347	5,5
Ermelino Matarazzo	113.615	600	5,3
Sé	23.651	124	5,2
Osasco	666.740	3.482	5,2
Tucuruvi	98.438	500	5,1
Mandaqui	107.580	546	5,1
Pari	17.299	87	5,0
Iguatemi	127.662	634	5,0
Belém	45.057	219	4,9
Mairiporã	63.265	306	4,8
Ponte Rasa	93.894	454	4,8
Vila Guilherme	54.331	261	4,8
Jardim Ângela	295.434	1.392	4,7
Brás	29.265	130	4,4
Raposo Tavares	100.164	418	4,2
Ipiranga	106.865	434	4,1
Cidade Ademar	266.681	1.018	3,8
Parelheiros	131.183	493	3,8
José Bonifácio	124.122	429	3,5
Butantã	54.196	185	3,4
Embu-Guaçu	43.106	146	3,4
Bragança Paulista	146.744	496	3,4
São Bernardo do Campo	736.161	2.484	3,4
Arujá	74.905	251	3,4
Aricanduva	89.622	285	3,2
Jabaquara	223.780	706	3,2
Sacomã	247.851	771	3,1
Carrão	83.281	259	3,1
Vila Prudente	104.242	322	3,1
São Rafael	143.992	442	3,1

"to be continued"

"continuation"

District	Population	Amount of residential frauds	Frauds/1000inhab
Bom Retiro	33.892	104	3,1
Sapopemba	284.524	867	3,0
Cambuci	36.948	112	3,0
Rio Pequeno	118.459	343	2,9
Capão Redondo	268.729	757	2,8
Cursino	109.088	302	2,8
São Mateus	155.140	426	2,7
Santana	118.797	326	2,7
Ribeirão Pires	77.986	193	2,5
Itapecerica da Serra	152.614	367	2,4
Jardim São Luís	267.871	640	2,4
Vila Formosa	94.799	223	2,4
São Lucas	142.347	323	2,3
Nazaré Paulista	16.414	37	2,3
Liberdade	69.092	155	2,2
Embu	240.230	523	2,2
Piracaia	25.116	54	2,2
Jaguareé	49.863	106	2,1
Vila Sônia	108.441	221	2,0
Água Rasa	84.963	162	1,9
Pedra Bela	5.780	11	1,9
Rio Grande da Serra	43.974	75	1,7
Joanópolis	11.768	20	1,7
Campo Grande	100.713	166	1,6
Campo Belo	65.752	105	1,6
Santo Amaro	71.560	105	1,5
Lapa	65.739	88	1,3
Mooca	75.724	97	1,3
Vargem	8.801	11	1,2
Vila Leopoldina	39.485	46	1,2
Tatuapé	91.672	102	1,1
Vila Mariana	130.484	136	1,0
Morumbi	46.957	47	1,0
Santa Cecília	83.717	76	0,9
Itaim Bibi	92.570	81	0,9
Marsilac	8.258	7	0,8
Saúde	130.780	101	0,8
Pinhalzinho	13.105	10	0,8
Alto de Pinheiros	43.117	29	0,7
Perdizes	111.161	72	0,6
Salesópolis	12.479	8	0,6
Bela Vista	69.460	44	0,6

"to be continued"

“continuation”

District	Population	Amount of residential frauds	Frauds/1000inhab
República	56.981	32	0,6
Barra Funda	14.383	8	0,6
Pinheiros	65.364	23	0,4
Vila Andrade	127.015	41	0,3
Pirajussara	244.528	56	0,2
Moema	83.368	18	0,2
Consolação	57.365	7	0,1
Jardim Paulista	88.692	9	0,1
Batatuba	-	3	0,0
Sem informação	-	59	0,0
Total	16.188.304	99.726	813

“conclusion”

TABLE A.8. Frauds per business unit

Business unit	Amount of frauds	%
Center	10.623	9%
East	34.132	30%
North	33.802	29%
West	18.076	16%
South	18.932	16%
Total	115.565	100%

TABLE A.9. Residential frauds per 1000 inhabitant – county level

County	Population	Amount of residential frauds	Frauds/1000 inhab	%
Pirapora Do Bom Jesus	15.733	355	22,6	0,4%
Francisco Morato	154.472	2.589	16,8	2,6%
Itaquaquecetuba	321.770	4.488	13,9	4,5%
Cajamar	64.114	710	11,1	0,7%
Franco Da Rocha	131.604	1.419	10,8	1,4%
Suzano	262.480	2.423	9,2	2,4%
Poá	106.013	904	8,5	0,9%
Caieiras	86.529	720	8,3	0,7%
Itapevi	200.769	1.593	7,9	1,6%
Jandira	108.344	835	7,7	0,8%
Ferraz De Vasconcelos	168.306	1.186	7,0	1,2%
Santana De Parnaíba	108.813	743	6,8	0,7%
Cotia	201.150	1.360	6,8	1,4%
Carapicuíba	369.584	2.423	6,6	2,4%
Barueri	240.749	1.528	6,3	1,5%
Biritiba-Mirim	28.575	169	5,9	0,2%
São Paulo	11.253.503	66.459	5,9	66,6%
Osasco	666.740	3.480	5,2	3,5%
Taboão Da Serra	244.528	982	4,0	1,0%
Mairiporã	80.956	306	3,8	0,3%
Bragança Paulista	146.744	496	3,4	0,5%
Arujá	74.905	253	3,4	0,3%
São Bernardo Do Campo	765.463	2.486	3,2	2,5%
Itapecerica Da Serra	152.614	484	3,2	0,5%
Embu	240.230	618	2,6	0,6%
Vargem Grande Paulista	42.997	103	2,4	0,1%
Embu-Guaçu	62.769	146	2,3	0,1%
Piracaia	25.116	57	2,3	0,1%
Nazaré Paulista	16.414	37	2,3	0,0%
Pedra Bela	5.780	11	1,9	0,0%
Ribeirão Pires	113.068	193	1,7	0,2%
Rio Grande Da Serra	43.974	75	1,7	0,1%
Joanópolis	11.768	20	1,7	0,0%
Vargem	8.801	11	1,2	0,0%
Socorro	36.686	41	1,1	0,0%
Pinhalzinho	13.105	12	0,9	0,0%
Salesópolis	15.635	8	0,5	0,0%
Diadema	386.089	65	0,2	0,1%
TOTAL		99.788		100,0%

TABLE A.10. Frauds per use category

Category	Amount of frauds	%
Commercial	10.487	9%
Industrial	1.476	1%
Mixed	3.731	3%
Public	83	0%
Residential	99.788	86%
Total	115.565	100%

TABLE A.11. Frauds per type of activity

Type of activity	Amount of frauds	%
Residential/ single family	89.242	77,22%
Horizontal Residential condominium	8.297	7,18%
Food services	4.435	3,84%
Miscellaneous repairs	2.435	2,11%
Vehicles repair and gas station	2.059	1,78%
Shanty town	1.535	1,33%
Not identified	1.067	0,92%
Personal services	756	0,65%
Manufacture of food products and beverages	581	0,50%
Assoative activities	550	0,48%
Warehouses and terminals	503	0,44%
Wholesale and retail sale	479	0,41%
Other social and sportiv activities	466	0,40%
Health services	364	0,31%
Accounting, auditing and engineering sevice	352	0,30%
Education	293	0,25%
Tenement	280	0,24%
Construction	229	0,20%
Metal products manufacture except machines and equipments	203	0,18%
Vertical residential condominium	174	0,15%
Commercial coonduminium	152	0,13%
Furniture manufacture and other industries	120	0,10%
Manufacture of articles of clothing and acessories	116	0,10%
Residential Cingapura	84	0,07%
Residential CDHU	69	0,06%
Metallurgy	63	0,05%
Manufacture of wooden articles	57	0,05%

"to be continued"

"continuation"

Type of activity	Amount of frauds	%
Manufacture of non-metallic mineral products	57	0,05%
Collective services provided by public administration	55	0,05%
Manufacture of rubber and plastic articles	48	0,04%
Financial intermediaries, insurers and private pension	47	0,04%
Edition and print services	45	0,04%
Rent and lease	40	0,03%
Residential Cohab	39	0,03%
Textile products manufacture	38	0,03%
Manufacture of machine and equipment	32	0,03%
Consulting	28	0,02%
Recycling	28	0,02%
Manufacture of paper and cellulose	26	0,02%
Manufacture of electric appliance and materials eléctricos	18	0,02%
Manufacture of chemical products	18	0,02%
Mail and telecommunication	12	0,01%
Manufacture of leather articles	12	0,01%
Manufacture of motor vehicles and trailer	12	0,01%
Medical and optical equipments	9	0,01%
Residential and commercial condominiums	8	0,01%
Extraction of non metallic minerals	7	0,01%
Urban cleansing	7	0,01%
Manufacture electronic materials and communication devices	6	0,01%
Abstraction, treatment and distribution of water	3	0,00%
Electricity and gas	3	0,00%
Agricultural	2	0,00%
Manufacture of transportation equipments	2	0,00%
Extraction of coal	1	0,00%
Extraction of metallic minerals	1	0,00%
Total	115565	100,0%

"conclusion"

TABLE A.12. Frauds per tariff

Tariff	Amount of frauds	%
Care entity	8	0%
Customer with contracted demand	3	0%
Public entity	85	0%
Special customers	184	0%
Special customers - well	9	0%
Fire valve	110.712	96%
Favela	4.558	4%
Own building	6	0%
Total	115.565	100%

TABLE A.13. Frauds per type of connection

Type of connection	Amount of frauds	%
Only water	25.961	22,46%
Water and sewage	89.578	77,51%
Only sewage	26	0,02%
Total	115.565	100,00%

TABLE A.14. Commercial frauds comerciais per business unit

Business unit	Amount of frauds	%
Center	2662	25,4%
South	2462	23,5%
East	2129	20,3%
North	1875	17,9%
West	1359	13,0%
Total	10.487	100%

**TABLE A.15. Business services with the largest amounts of commercial frauds –
County of São Paulo**

Commercial service	Amount of frauds	%
Sé	1193	11%
Santo Amaro	947	9%
São Miguel	505	5%
Jardins	457	4%
Penha	430	4%
Santana	401	4%
Mooça	392	4%
Campo Limpo	341	3%
Butantã	312	3%
Capela do Socorro	275	3%
Demais Atendimentos	5234	50%
	10.487	100%

TABLE A.16. Frauds in commercial category per county and district

District	Amount of commercial frauds	%
São Bernardo do Campo	416	4,0%
São Miguel	369	3,5%
Osasco	344	3,3%
Penha	294	2,8%
Santo Amaro	289	2,8%
Itaim Bibi	223	2,1%
República	197	1,9%
Sé	194	1,8%
Vila Medeiros	189	1,8%
Brás	170	1,6%
Itaim Paulista	168	1,6%
Jabaquara	158	1,5%
Taboão da Serra	158	1,5%
Cidade Ademar	153	1,5%
Barueri	148	1,4%
Carapicuíba	148	1,4%
Cidade Tiradentes	143	1,4%
Grajaú	135	1,3%
Freguesia do Ó	132	1,3%
Suzano	129	1,2%
Artur Alvim	123	1,2%
Campo Belo	123	1,2%

“to be continued”

“continuation”

District	Amount of commercial frauds	%
Santa Cecília	122	1,2%
Jardim Ângela	120	1,1%
Santana	120	1,1%
Socorro	120	1,1%
Jardim São Luís	119	1,1%
Vila Maria	117	1,1%
Vila Nova Cachoeirinha	116	1,1%
Campo Grande	115	1,1%
Itaquaquecetuba	115	1,1%
Bom Retiro	113	1,1%
Ipiranga	112	1,1%
Brasilândia	98	0,9%
Campo Limpo	97	0,9%
Tremembé	97	0,9%
Vila Mariana	96	0,9%
Pinheiros	94	0,9%
Cidade Dutra	93	0,9%
Casa Verde	89	0,8%
Belém	87	0,8%
Vila Prudente	87	0,8%
Liberdade	86	0,8%
Butantã	84	0,8%
Jaraguá	83	0,8%
Sapopemba	82	0,8%
Capão Redondo	81	0,8%
Lapa	81	0,8%
Vila Guilherme	80	0,8%
Pedreira	79	0,8%
Pirituba	79	0,8%
Itaquera	76	0,7%
Vila Leopoldina	76	0,7%
Tatuapé	72	0,7%
Guaianases	69	0,7%
Moema	69	0,7%
Cotia	68	0,6%
São Domingos	67	0,6%
Embu	66	0,6%
Jaçanã	65	0,6%
Vila Curuçá	65	0,6%
Limão	64	0,6%
Tucuruvi	63	0,6%

“to be continued”

“continuation”

District	Amount of commercial frauds	%
Vila Matilde	63	0,6%
Pari	62	0,6%
Cursino	61	0,6%
Bela Vista	60	0,6%
Mooca	59	0,6%
Sacomã	59	0,6%
Vila Sonia	59	0,6%
Cangaíba	58	0,6%
São Matheus	58	0,6%
Cambuci	57	0,5%
Franco da Rocha	55	0,5%
Ponte Rasa	55	0,5%
Saúde	55	0,5%
Vila Jacuí	54	0,5%
Perus	52	0,5%
Bragança Paulista	51	0,5%
Carrão	51	0,5%
Raposo Tavares	51	0,5%
Ferraz de Vasconcelos	50	0,5%
Cajamar	49	0,5%
Ermelino Matarazzo	49	0,5%
Itapevi	49	0,5%
Rio Pequeno	48	0,5%
Consolação	47	0,4%
Poá	46	0,4%
Itapecerica da Serra	45	0,4%
Jardim Paulista	45	0,4%
Perdizes	45	0,4%
Mandaqui	43	0,4%
Aricanduva	42	0,4%
Jandira	42	0,4%
Jardim Helena	41	0,4%
Santana de Parnaíba	40	0,4%
São Lucas	40	0,4%
Jaguapé	39	0,4%
Francisco Morato	37	0,4%
Lajeado	34	0,3%
Vila Formosa	34	0,3%
Cidade Líder	33	0,3%
Parque do Carmo	33	0,3%
Jaguará	32	0,3%

“to be continued”

“continuation”

District	Amount of commercial frauds	%
Anhanguera	31	0,3%
Água Rasa	30	0,3%
Caieiras	30	0,3%
Parelheiros	29	0,3%
Barra Funda	28	0,3%
Iguatemi	27	0,3%
Embu Guaçu	26	0,2%
José Bonifácio	26	0,2%
Arujá	23	0,2%
Morumbi	23	0,2%
Ribeirão Pires	22	0,2%
Pirajussara	17	0,2%
Vargem Grande Paulista	15	0,1%
Vila Andrade	15	0,1%
Mairiporã	14	0,1%
São Rafael	13	0,1%
Alto de Pinheiros	10	0,1%
Sem localização	10	0,1%
Piracaia	8	0,1%
Biritiba Mirim	6	0,1%
Nazaré Paulista	6	0,1%
Pirapora do Bom Jesus	5	0,0%
Rio Grande da Serra	4	0,0%
Pedra Bela	2	0,0%
Total	10487	100%

“to be continued”

TABLE A.17. Frauds in commercial category per 1000 inhabitant – County and District

District	Population	Amount of commercial frauds	Frauds/1000inhab
Sé	23.651	194	8,20
Brás	29.265	170	5,81
Cajamar	11.589	49	4,23
Santo Amaro	71.560	289	4,04
São Miguel	92.081	369	4,01
Pari	17.299	62	3,58
República	56.981	197	3,46
Bom Retiro	33.892	113	3,33
Socorro	37.783	120	3,18
Itaim Bibi	92.570	223	2,41
Penha	127.820	294	2,30
Barra Funda	14.383	28	1,95
Belém	45.057	87	1,93
Vila Leopoldina	39.485	76	1,92
Campo Belo	65.752	123	1,87
Butantã	54.196	84	1,55
Cambuci	36.948	57	1,54
Vila Guilherme	54.331	80	1,47
Santa Cecília	83.717	122	1,46
Vila Medeiros	129.919	189	1,45
Pinheiros	65.364	94	1,44
Barueri	112.726	148	1,31
Jaguara	24.895	32	1,29
Liberdade	69.092	86	1,24
Lapa	65.739	81	1,23
Artur Alvim	105.269	123	1,17
Campo Grande	100.713	115	1,14
Ipiranga	106.865	112	1,05
Casa Verde	85.624	89	1,04
Vila Maria	113.463	117	1,03
Santana	118.797	120	1,01
Freguesia do Ó	142.327	135	0,95
Bela Vista	69.460	60	0,86
Vila Prudente	104.242	87	0,83
Suzano	155.804	129	0,83
Moema	83.368	69	0,83
Consolação	57.365	47	0,82
Vila Nova Cachoeirinha	143.523	116	0,81

“to be continued”

“continuation”

District	Population	Amount of commercial frauds	Frauds/1000hab
Limão	80.229	64	0,80
São Domingos	84.843	67	0,79
Tatuapé	91.672	72	0,79
Jaguaré	49.863	39	0,78
Mooca	75.724	59	0,78
Itaim Paulista	224.074	168	0,75
Vila Mariana	130.484	96	0,74
Jabaquara	223.780	158	0,71
Jaçanã	94.609	65	0,69
Cidade Tiradentes	211.501	143	0,68
Guaianases	103.996	69	0,66
Perus	80.187	52	0,65
Taboão da Serra	244.528	158	0,65
Carapicuíba	230.112	148	0,64
Tucuruvi	98.438	63	0,64
Carrão	83.281	51	0,61
Embu-Guaçu	43.106	26	0,60
Vila Matilde	104.947	63	0,60
Ponte Rasa	93.894	55	0,59
Cidade Ademar	266.681	153	0,57
São Bernardo do Campo	736.161	416	0,57
Cursino	109.088	61	0,56
Pedreira	144.317	79	0,55
Vila Sônia	108.441	59	0,54
Osasco	666.740	344	0,52
Raposo Tavares	100.164	51	0,51
Jardim Paulista	88.692	45	0,51
Tremembé	197.258	97	0,49
Morumbi	46.957	23	0,49
Parque do Carmo	68.258	33	0,48
Cidade Dutra	196.360	93	0,47
Anhanguera	65.859	31	0,47
Pirituba	167.931	79	0,47
Aricanduva	89.622	42	0,47
Campo Limpo	211.361	97	0,46
Poá	100.546	46	0,46
Jaraguá	184.818	83	0,45
Jardim São Luís	267.871	119	0,44
Vila Curuçá	149.053	65	0,44
Ermelino Matarazzo	113.615	49	0,43

“to be continued”

"continuation"

District	Population	Amount of commercial frauds	Frauds/1000inhab
Cangaíba	136.623	58	0,42
Saúde	130.780	55	0,42
Franco da Rocha	131.604	55	0,42
Ferraz de Vasconcelos	120.194	50	0,42
Jardim Ângela	295.434	120	0,41
Rio Pequeno	118.459	48	0,41
Perdizes	111.161	45	0,40
Mandaqui	107.580	43	0,40
Cotia	170.513	68	0,40
Jandira	108.344	42	0,39
Vila Jacuí	142.372	54	0,38
Grajaú	360.787	135	0,37
São Mateus	155.140	58	0,37
Itaquera	204.871	76	0,37
Brasilândia	264.918	98	0,37
Santana de Parnaíba	108.813	40	0,37
Nazaré Paulista	16.414	6	0,37
Vila Formosa	94.799	34	0,36
Itaquaquecetuba	321.770	115	0,36
Água Rasa	84.963	30	0,35
Vargem Grande Paulista	42.997	15	0,35
Bragança Paulista	146.744	51	0,35
Caieiras	86.529	30	0,35
Pedra Bela	5.780	2	0,35
Piracaia	25.116	8	0,32
Pirapora do Bom Jesus	15.733	5	0,32
Arujá	74.905	23	0,31
Jardim Helena	135.043	41	0,30
Capão Redondo	268.729	81	0,30
Itapeçerica da Serra	152.614	45	0,29
Sapopemba	284.524	82	0,29
Ribeirão Pires	77.986	22	0,28
São Lucas	142.347	40	0,28
Embu	240.230	66	0,27
Cidade Lider	126.597	33	0,26
Itapevi	200.769	49	0,24
Francisco Morato	154.472	37	0,24
Sacomã	247.851	59	0,24
Alto de Pinheiros	43.117	10	0,23
Mairiporã	63.265	14	0,22

"to be continued"

“continuation”

District	Population	Amount of commercial frauds	Frauds/1000inhab
Parelheiros	131.183	29	0,22
Iguatemi	127.662	27	0,21
Biritiba-Mirim	28.575	6	0,21
José Bonifácio	124.122	26	0,21
Lajeado	164.512	34	0,21
Vila Andrade	127.015	15	0,12
Rio Grande da Serra	43.974	4	0,09
São Rafael	143.992	13	0,09
Pirajussara	244.528	17	0,07
Não localizado	0	10	0
Total	16.128.426	10491	

“conclusion”

TABLE A.18. Districts with a higher proportion of commercial frauds than residential frauds/1000 inhab.

District	Population	Amount of commercial frauds	Commercial frauds /1000inhab	Amount of residential frauds	Residential frauds /1000inhab
Sé	23.651	194	8,2	124	5,2
República	56.981	197	3,5	32	0,6
Santo Amaro	71.560	289	4,0	105	1,5
Itaim Bibi	92.570	223	2,4	81	0,9
Barra Funda	14.383	28	1,9	8	0,6
Brás	29.165	170	5,8	130	4,5
Pinheiros	65.364	94	1,4	23	0,4
Consolação	57.365	47	0,8	7	0,1
Moema	83.368	69	0,8	18	0,2
Santa Cecília	83.717	122	1,5	76	0,9
Jd. Paulista	88.692	45	0,5	9	0,1
Bela Vista	69.460	60	0,9	44	0,6

TABLE A.19. Frauds in industrial category per business unit

Business unit	Amount of frauds	%
Center	323	22%
South	298	20%
East	438	30%
North	259	18%
West	158	11%
Total	10.487	100%

TABLE A.20. Commercial services with the largest amounts of industrial frauds

Commercial service	Amount of frauds	%
Sé	103	7%
Penha	94	6%
São Miguel	90	6%
Santo Amaro	90	6%
Mooca	72	5%
Itaim Paulista	52	4%
Santana	51	3%
Campo Limpo	43	3%
Demais Atendimentos	881	44%
	1.476	100%

TABLE A.21. Police report bulletin per county and district

County / District	Amount of Police Report Bulletin	%
Osasco	37	8,5%
Itaquaquecetuba	32	7,4%
República	19	4,3%
Pirituba	18	4,1%
Barueri	16	3,6%
Santana	12	2,7%
Vila Maria	11	2,5%
Casa Verde	10	2,3%
Rio Pequeno	10	2,3%
Taboão da Serra	10	2,3%
Ipiranga	9	2,0%
Santana de Parnaíba	9	2,0%

"to be continued"

“continuation”

County / District	Amount of Police Report Bulletin	%
Vila Guilherme	9	2,0%
Barra Funda	8	1,8%
Brás	8	1,8%
Vila Nova Cachoeirinha	8	1,8%
Butantã	7	1,6%
Carapicuíba	7	1,6%
Freguesia do Ó	7	1,6%
São Domingos	7	1,6%
Tucuruvi	7	1,6%
Brasilândia	6	1,4%
Liberdade	6	1,4%
Sé	6	1,4%
Itaim Paulista	5	1,1%
Jaçanã	5	1,1%
Jaguapé	5	1,1%
Perdizes	5	1,1%
Vila Mariana	5	1,1%
Pinheiros	5	1,1%
Vila Medeiros	5	1,1%
Cajamar	4	0,9%
Cidade Ademar	4	0,9%
Cidade Dutra	4	0,9%
Itaquera	4	0,9%
Mandaqui	4	0,9%
Morumbi	4	0,9%
Perus	4	0,9%
Santo Amaro	4	0,9%
São Miguel Paulista	4	0,9%
São Bernardo do Campo	4	0,9%
Suzano	4	0,9%
Água Rasa	3	0,7%
Americanópolis	3	0,7%
Bela Vista	3	0,7%
Belém	3	0,7%
Cangaíba	3	0,7%
Cotia	3	0,7%
Itaim Bibi	3	0,7%
Jandira	3	0,7%
Jaraguá	3	0,7%
Lapa	3	0,7%

“to be continued”

“continuation”

County / District	Amount of Police Report Bulletin	%
Mairiporã	3	0,7%
Socorro	3	0,7%
Vila Matilde	3	0,7%
Campo Limpo	2	0,5%
Ferraz de Vasconcelos	2	0,5%
Itapevi	2	0,5%
Parelheiros	2	0,5%
Raposo Tavares	2	0,5%
São Matheus	2	0,5%
Sapopemba	2	0,5%
Saúde	2	0,5%
Vila Jacuí	2	0,5%
Vila Sônia	2	0,5%
Artur Alvim	1	0,2%
Arujá	1	0,2%
Bom Retiro	1	0,2%
Bragança Paulista	1	0,2%
Campo Belo	1	0,2%
Campo Grande	1	0,2%
Carrão	1	0,2%
Cidade Líder	1	0,2%
Consolação	1	0,2%
Ermelino Matarazzo	1	0,2%
Franco da Rocha	1	0,2%
Itapecerica da Serra	1	0,2%
Jaguará	1	0,2%
Jardim Ângela	1	0,2%
Limão	1	0,2%
Mooca	1	0,2%
Penha	1	0,2%
Tatuapé	1	0,2%
Vila Andrade	1	0,2%
Vila Curuçá	1	0,2%
Fila Formosa	1	0,2%
Vila Leopoldina	1	0,2%
Vila Prudente	1	0,2%
Total	440	100%

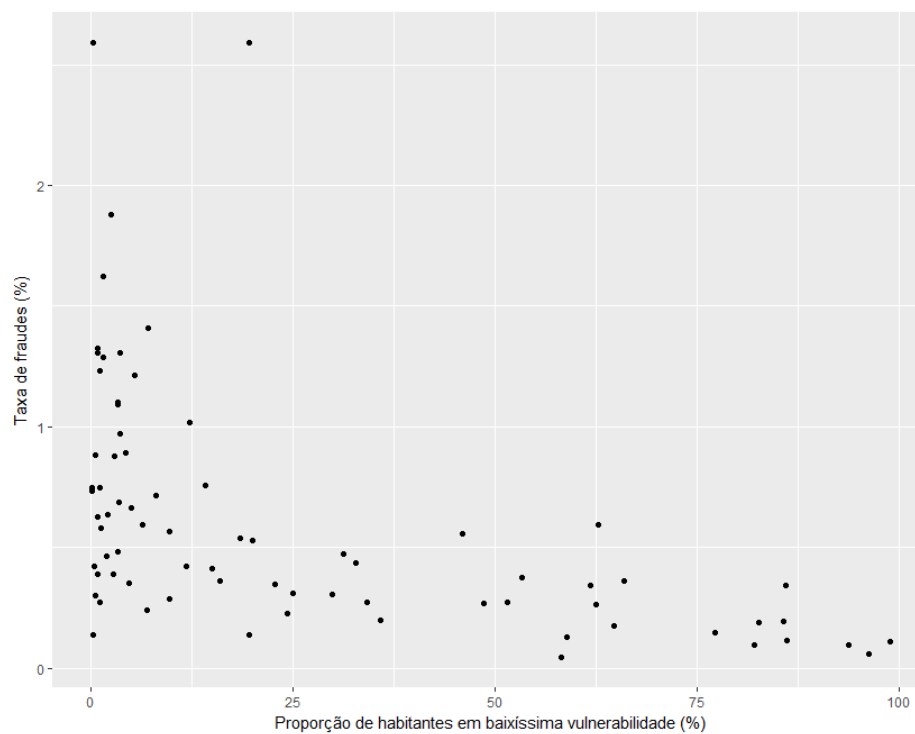
“conclusion”

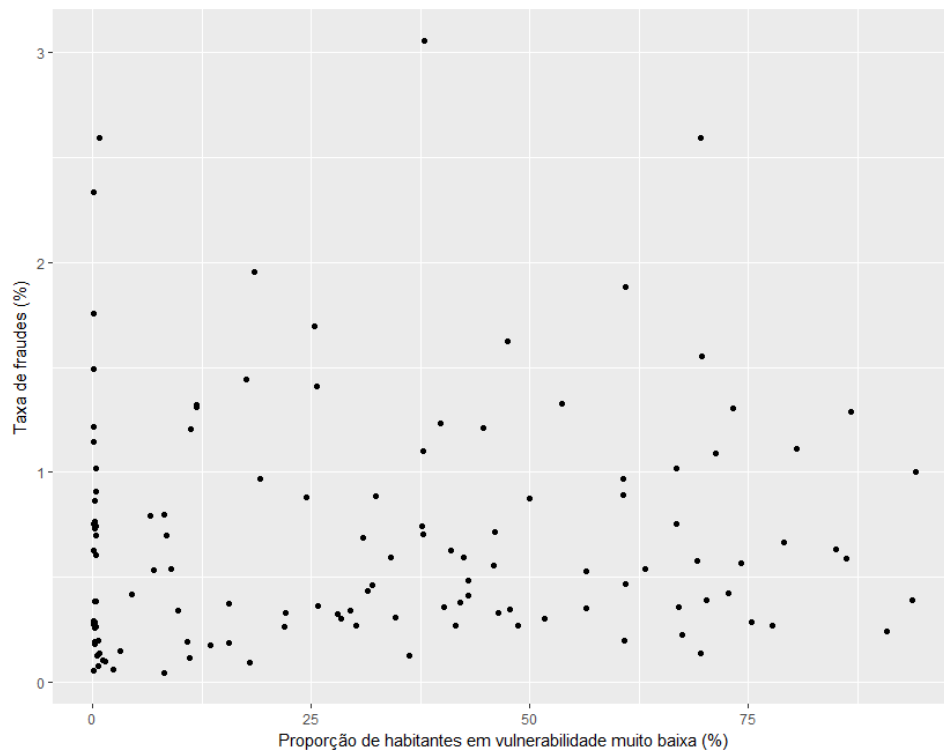
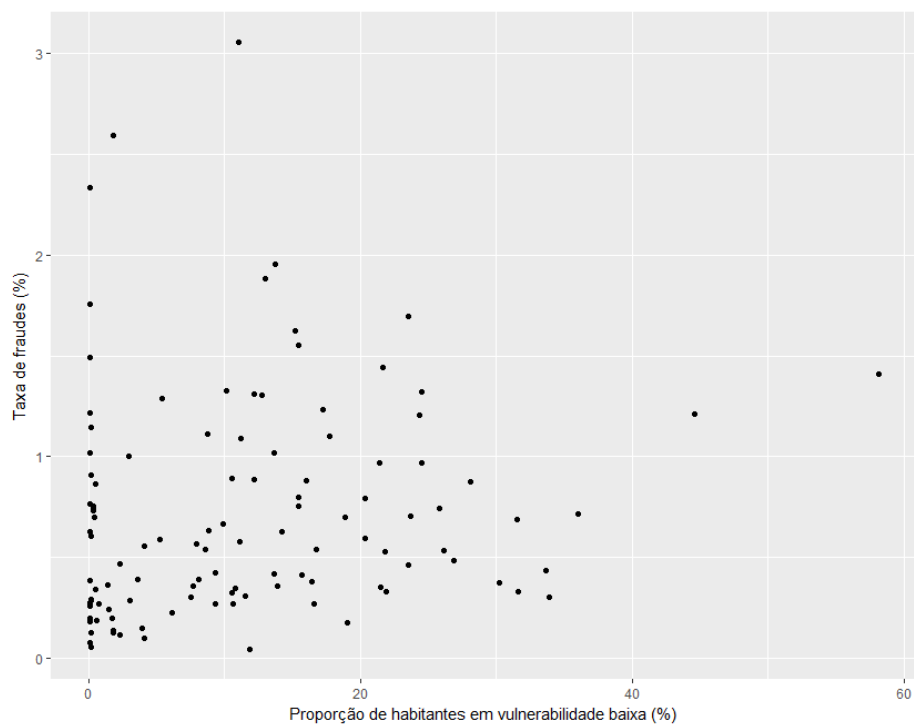
TABLE A.22. Police Bulletin Report per business unit

Business unit	Amount of Police Report Bulletin	%
North	128	29,1%
West	118	26,8%
Center	99	22,5%
East	63	14,3%
South	32	7,3%
Total	440	100,00%

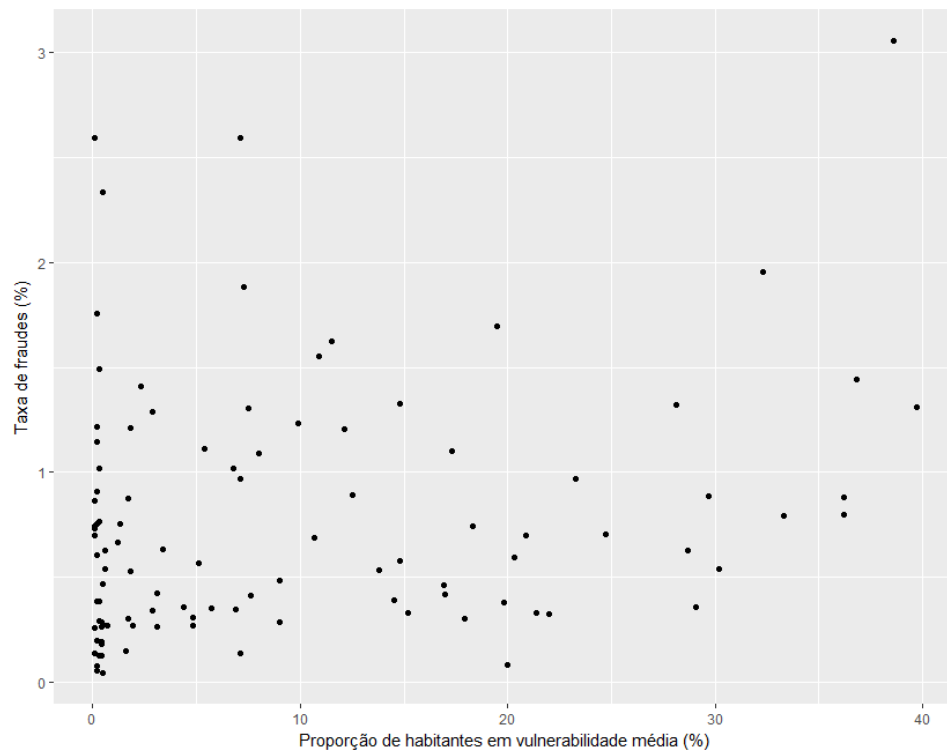
TABLE A.23. Police Report Bulletin per use category

Use category	Commercial/ Industrial	%
Commercial/Industrial	373	85%
Residential/Mixed	67	15%
TOTAL	440	100,00%

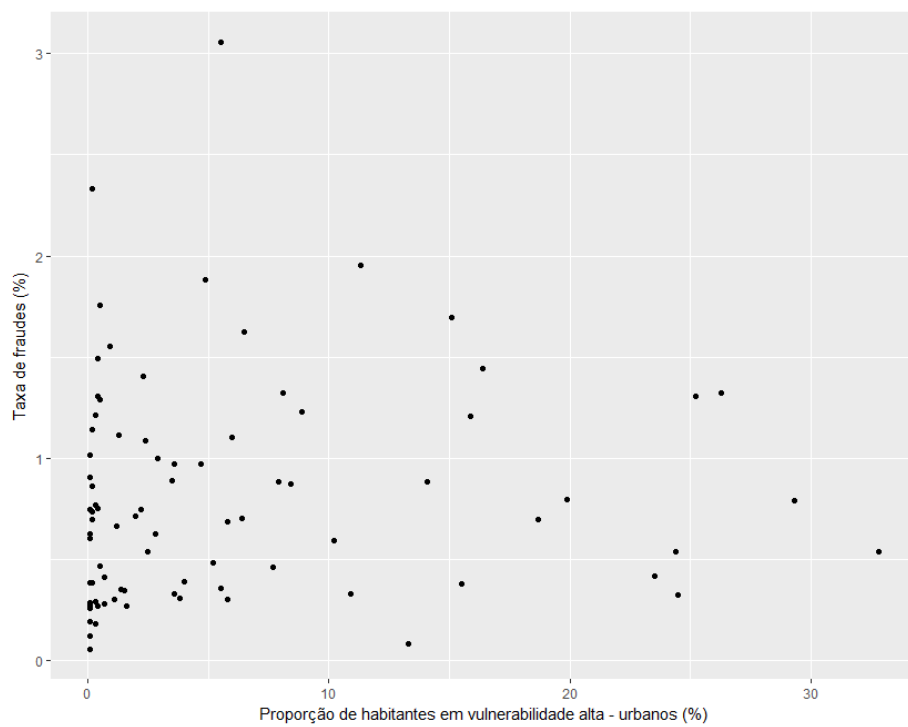
Graphic A.1. Fraud rate per district: proportion of inhabitant in very very low vulnerability

Graphic A.2. Fraud rate per district: proportion of inhabitant in very low vulnerability**Graphic A.3. Fraud rate per district: proportion of inhabitant in low vulnerability**

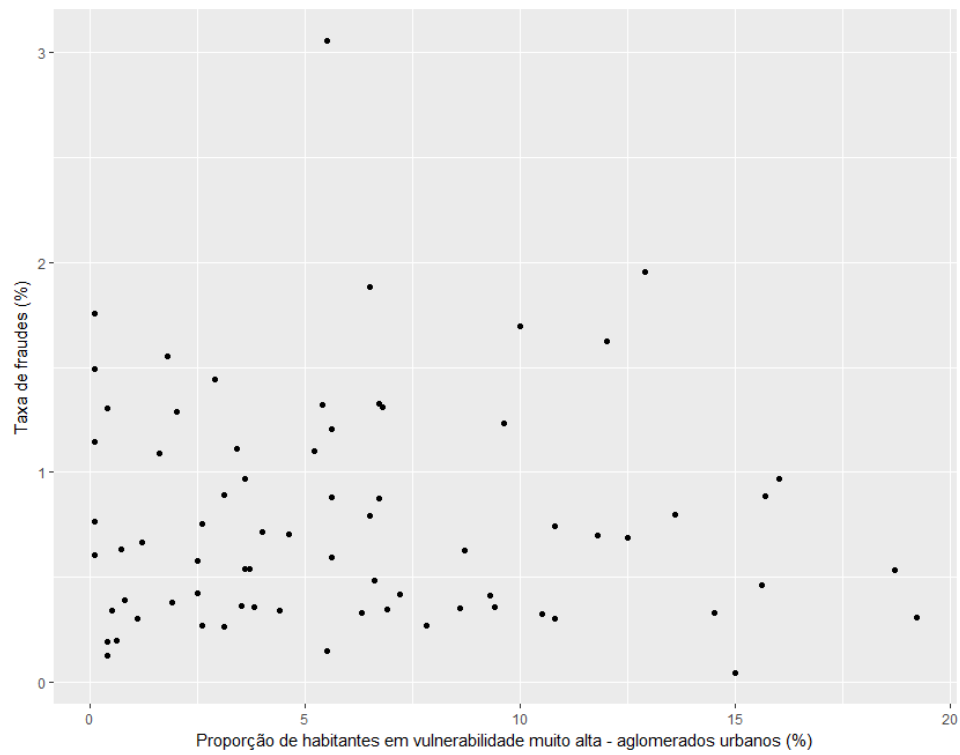
Graphic A.4. Fraud rate per district: proportion of inhabitant in medium vulnerability



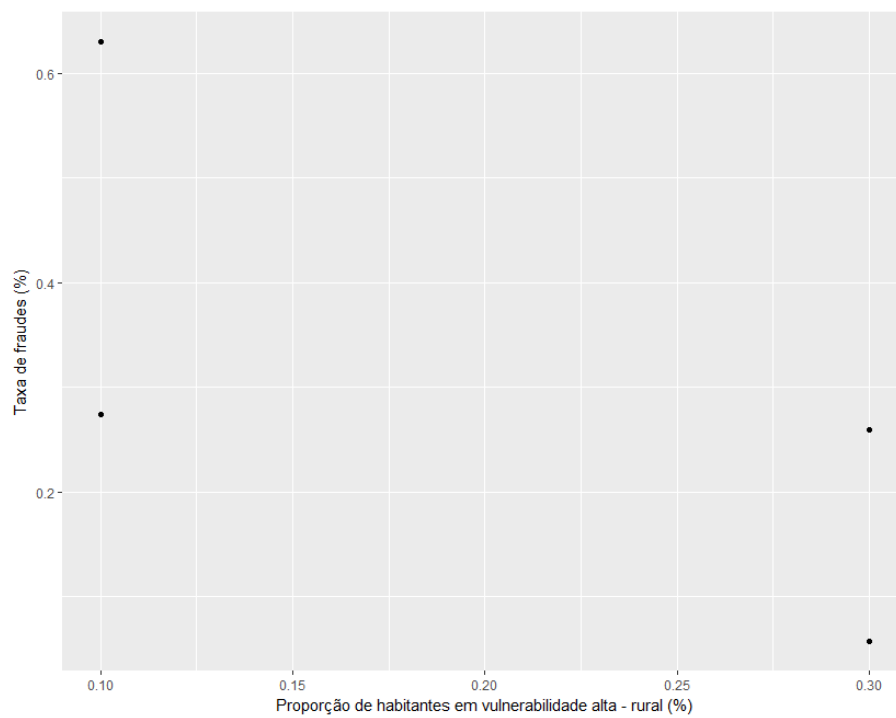
Graphic A.5. Fraud rate per district: proportion of inhabitant in high vulnerability (urban)



Graphic A.6. Fraud rate per district: proportion of inhabitant in very high vulnerability (urban agglomerations)

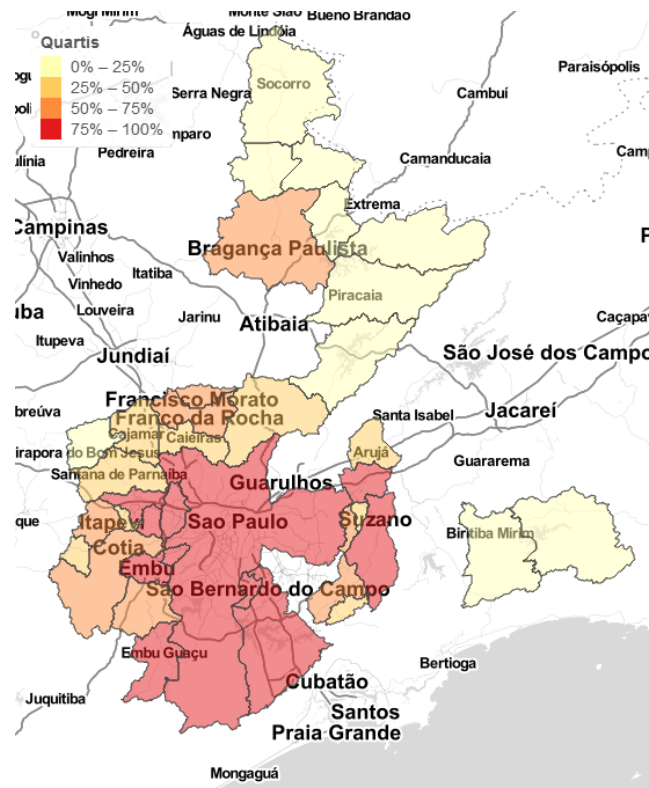


Graphic A.7. Fraud rate per district: proportion of inhabitant in high vulnerability (rural)

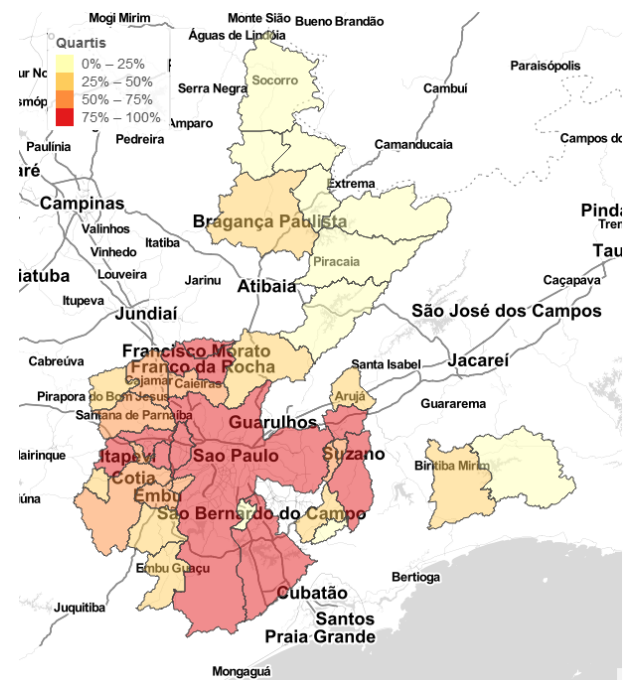


APPENDIX B

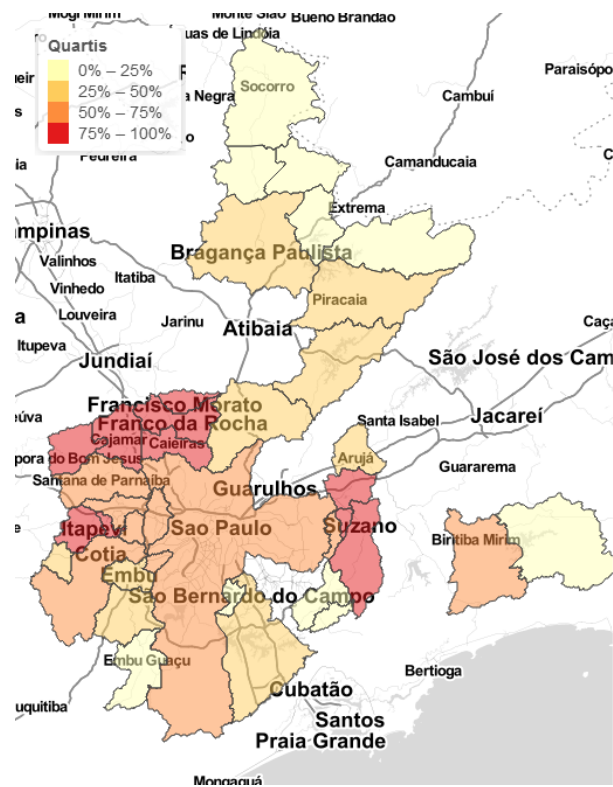
Map B1. Heat map in quartiles of the population: county



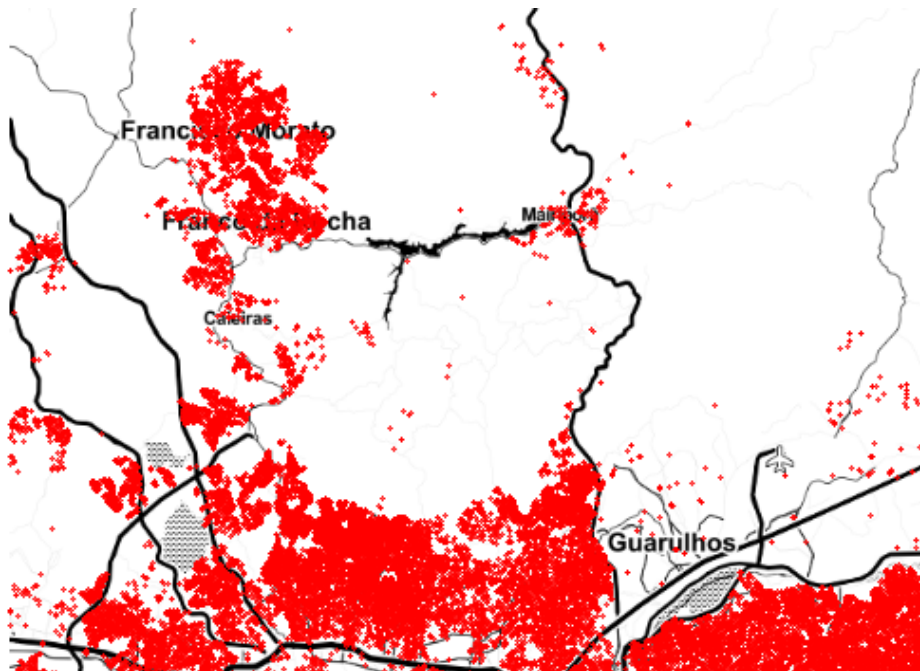
Map B2. Heat map in quartiles of frauds quantity: county



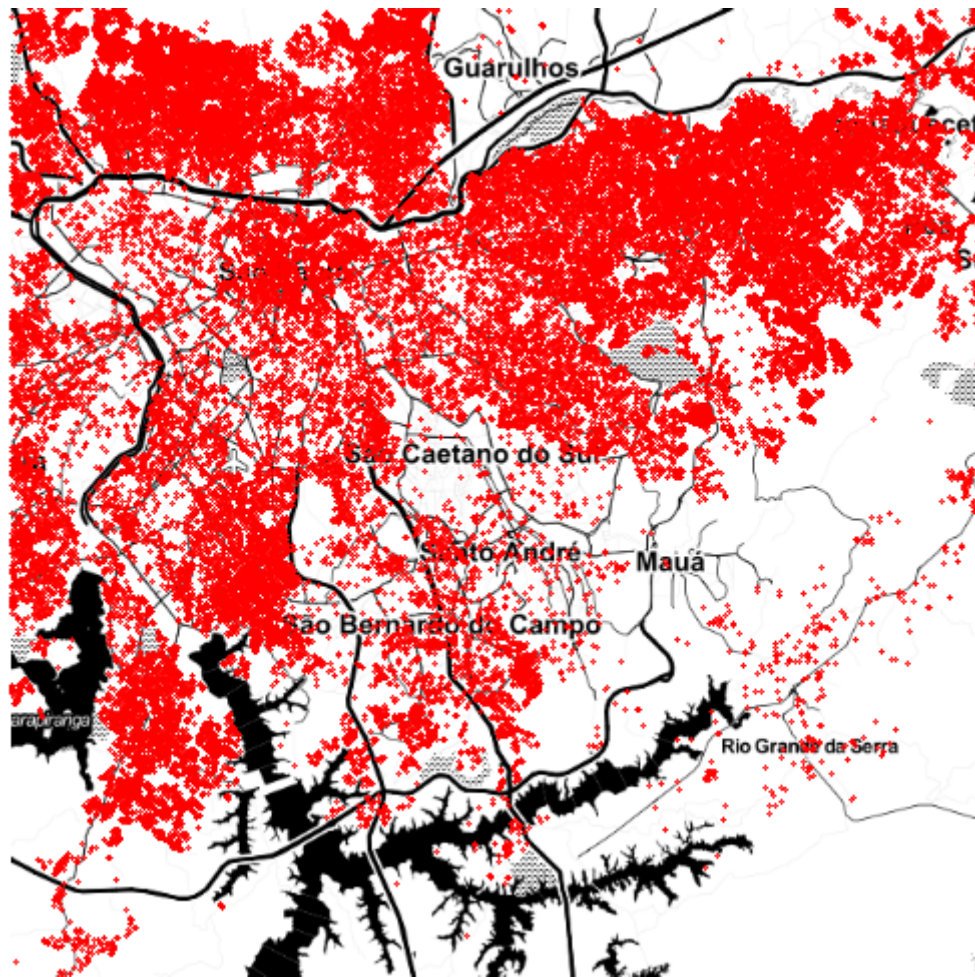
Map B3. Heat map in quartiles of residential frauds per thousand inhabitants: county



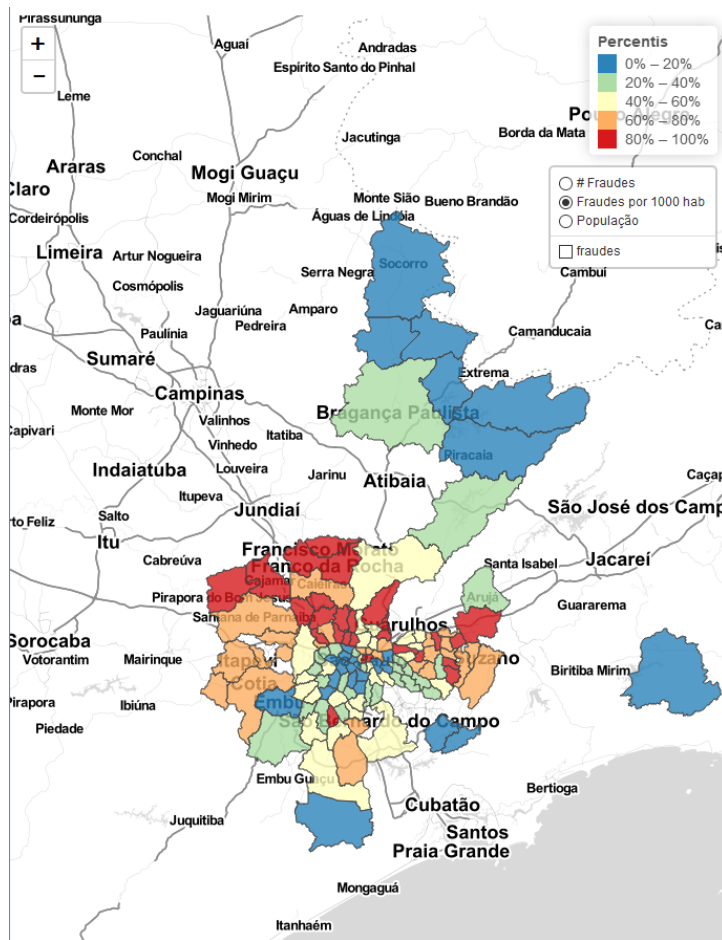
Map B4. Frauds in Francisco Morato and Franco da Rocha in detail



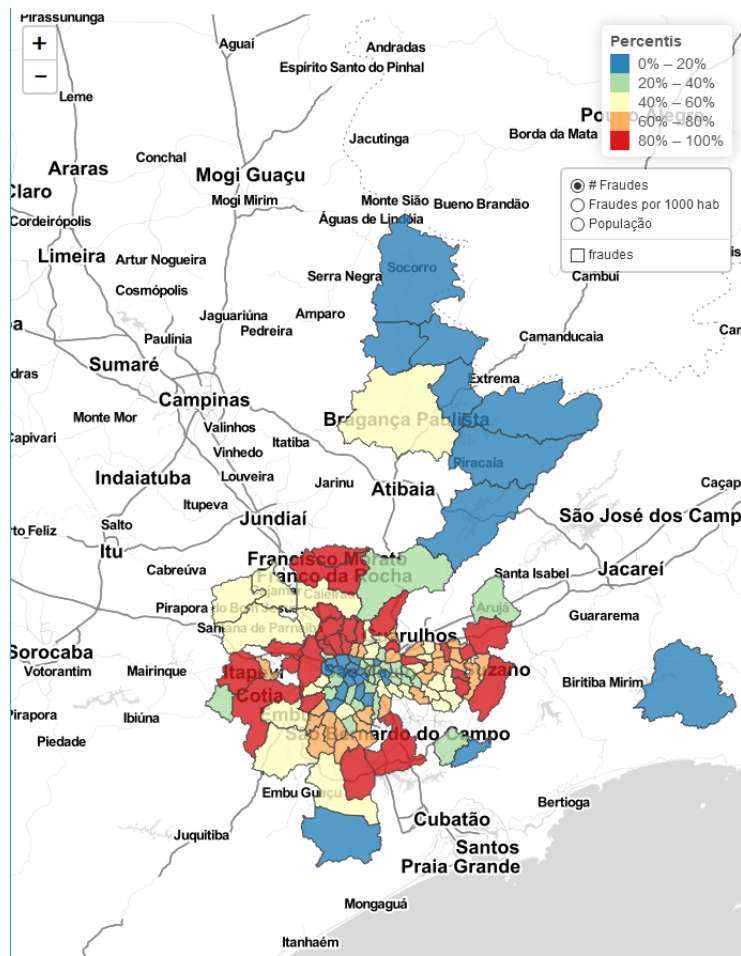
Map B5. Frauds in the municipality of São Paulo in detail

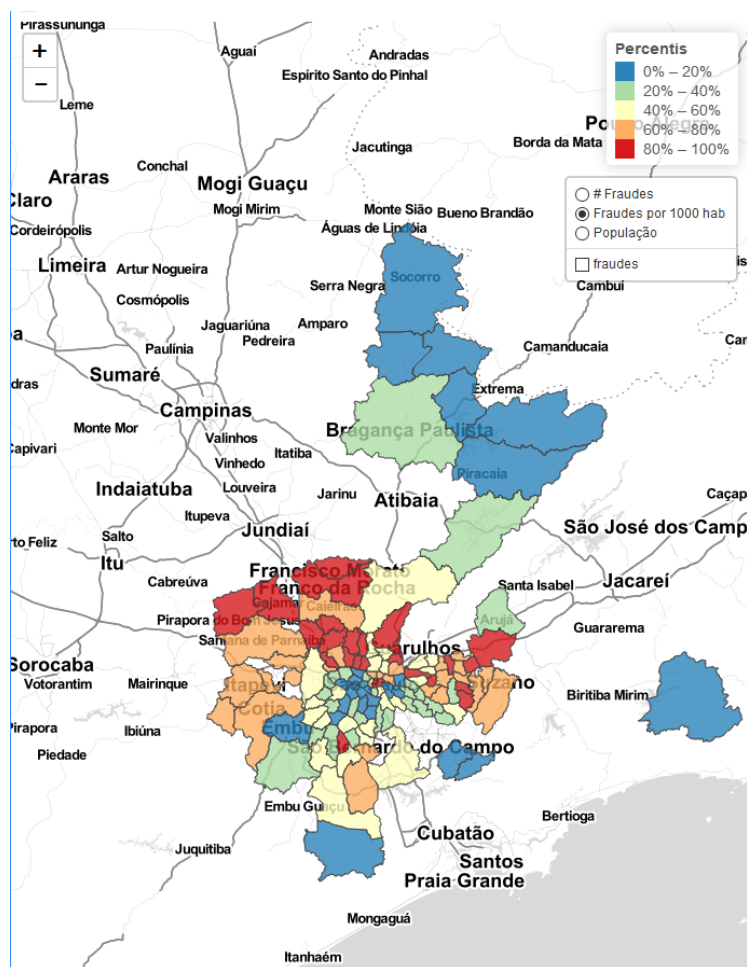


Map B.6 Heat map in quartiles of the population per district



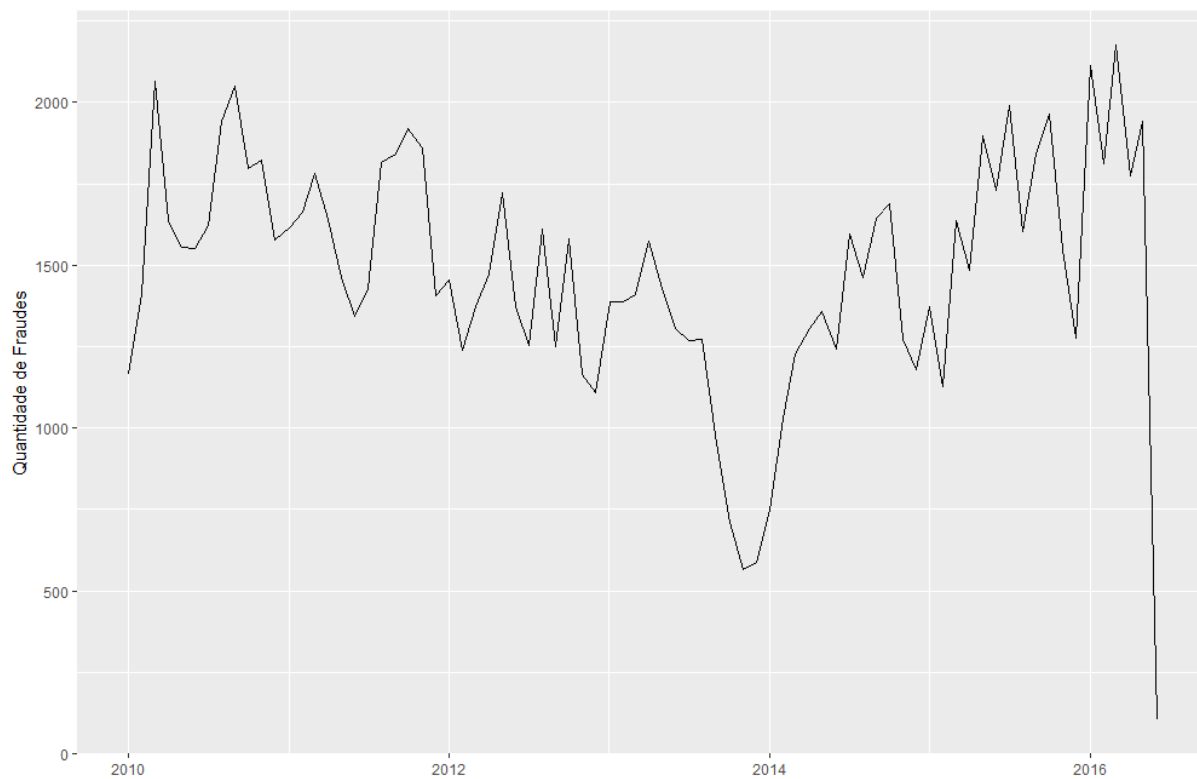
Map B.7 Heat map in quartiles of frauds quantity per district



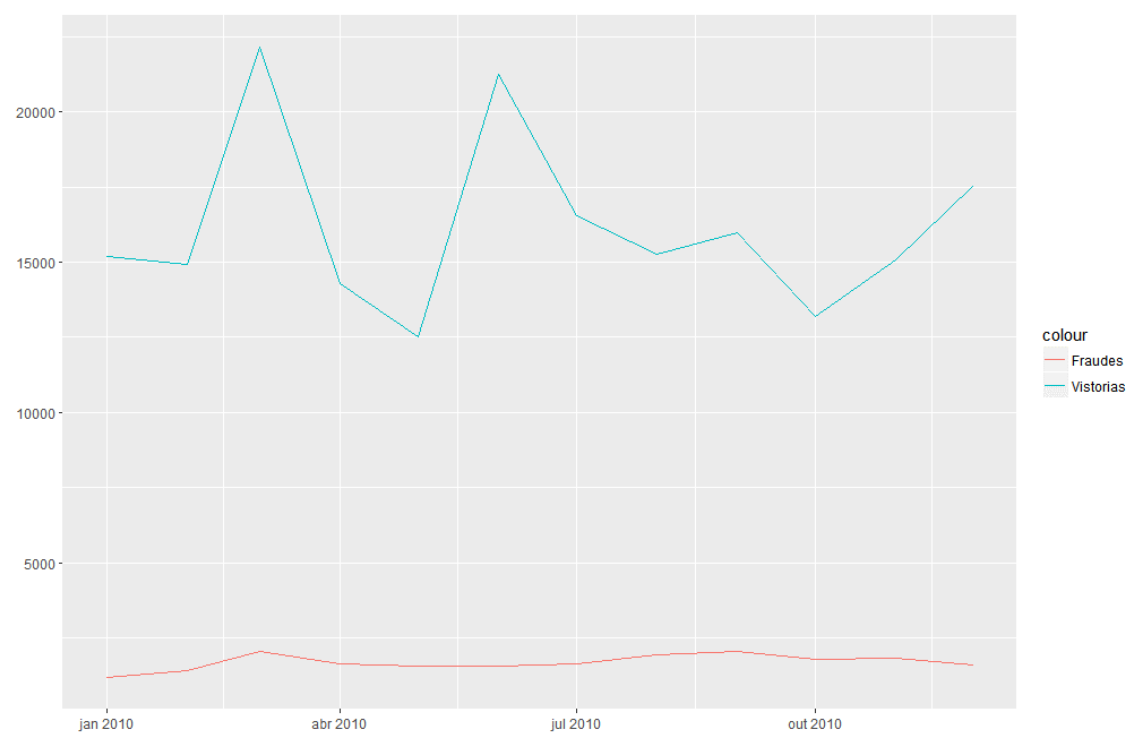
Map B.8 Heat map in quartiles of frauds quantity per thousand inhabitants: district

APPENDIX C

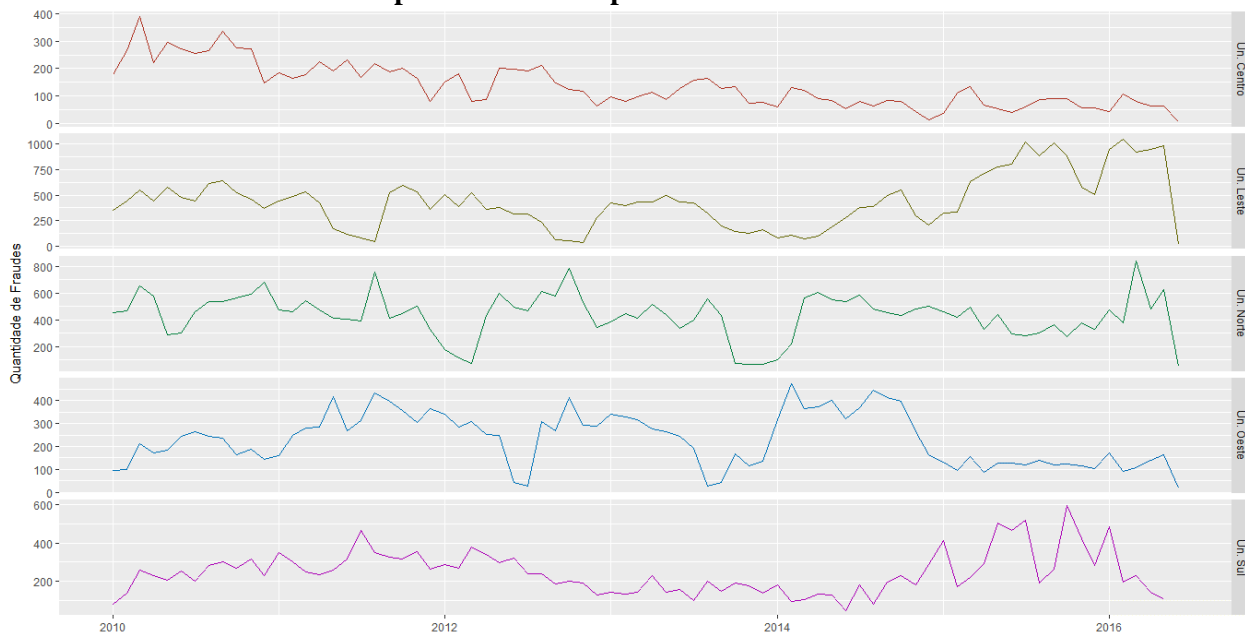
Graphic C.1. Frauds per month



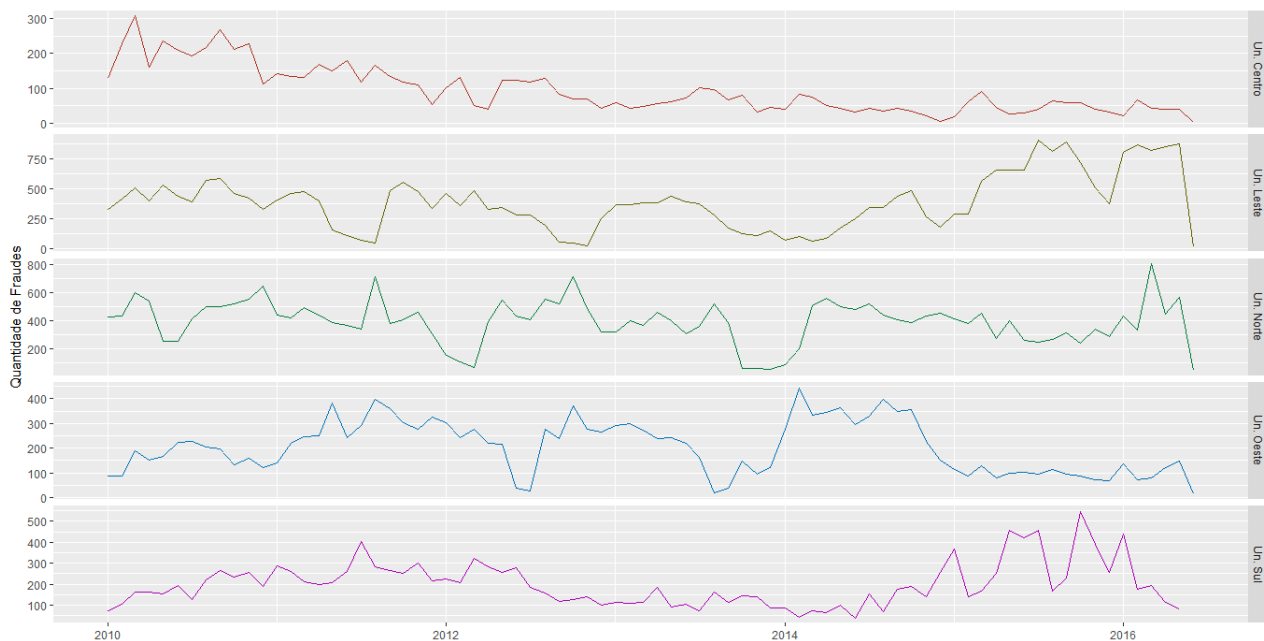
Graphic C.2. Frauds and inspections per month



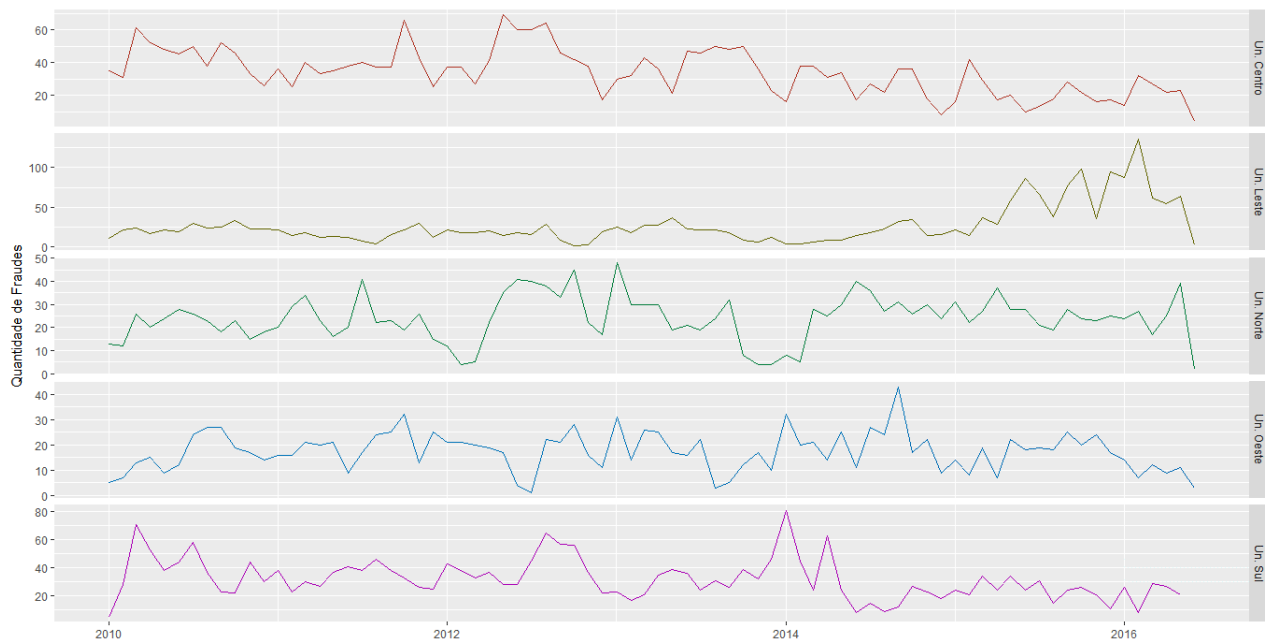
Graphic C.3. Frauds per business units



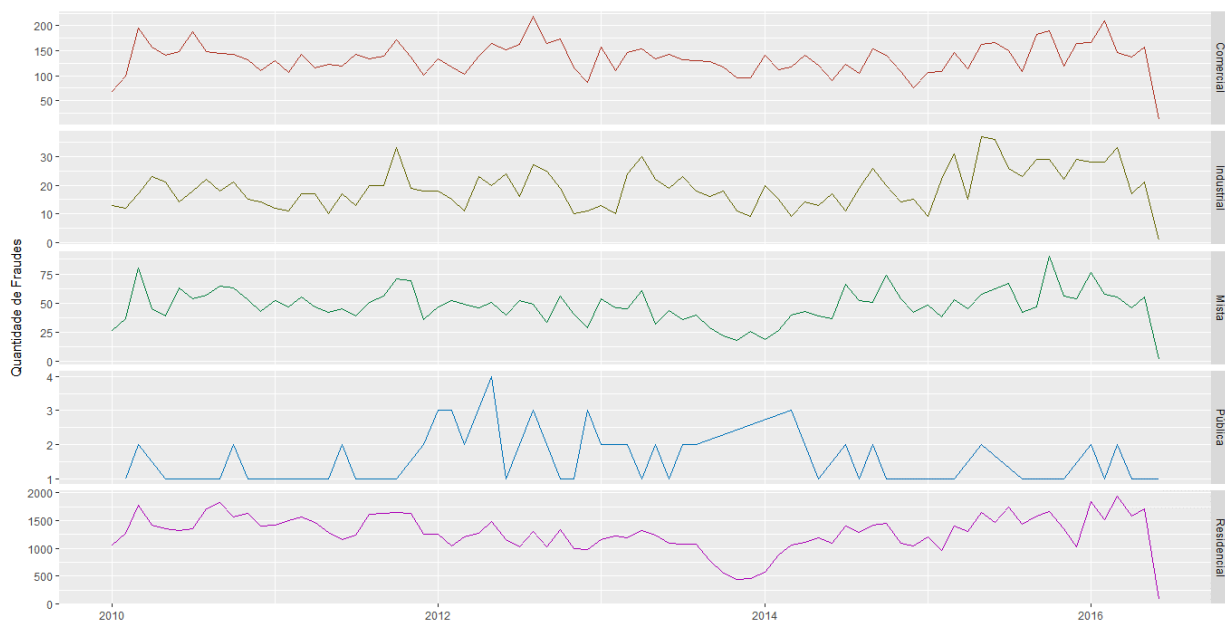
Graphic C.4. Frauds per business unity / month – residential category



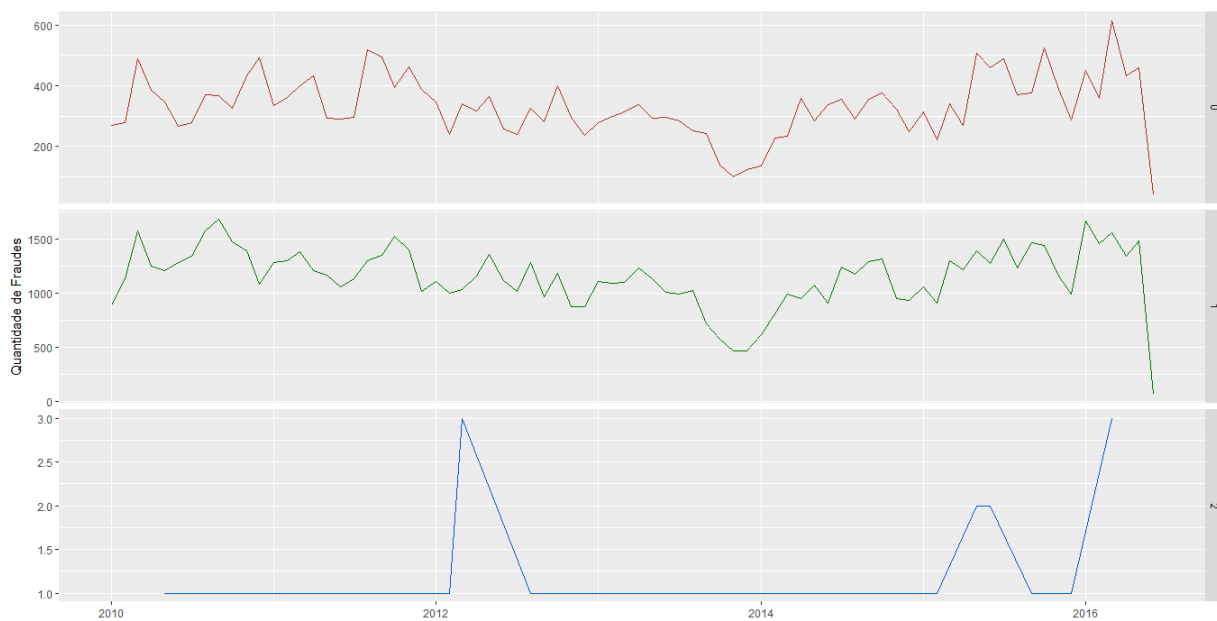
Graphic C.5. Frauds per business unit / month –commercial category



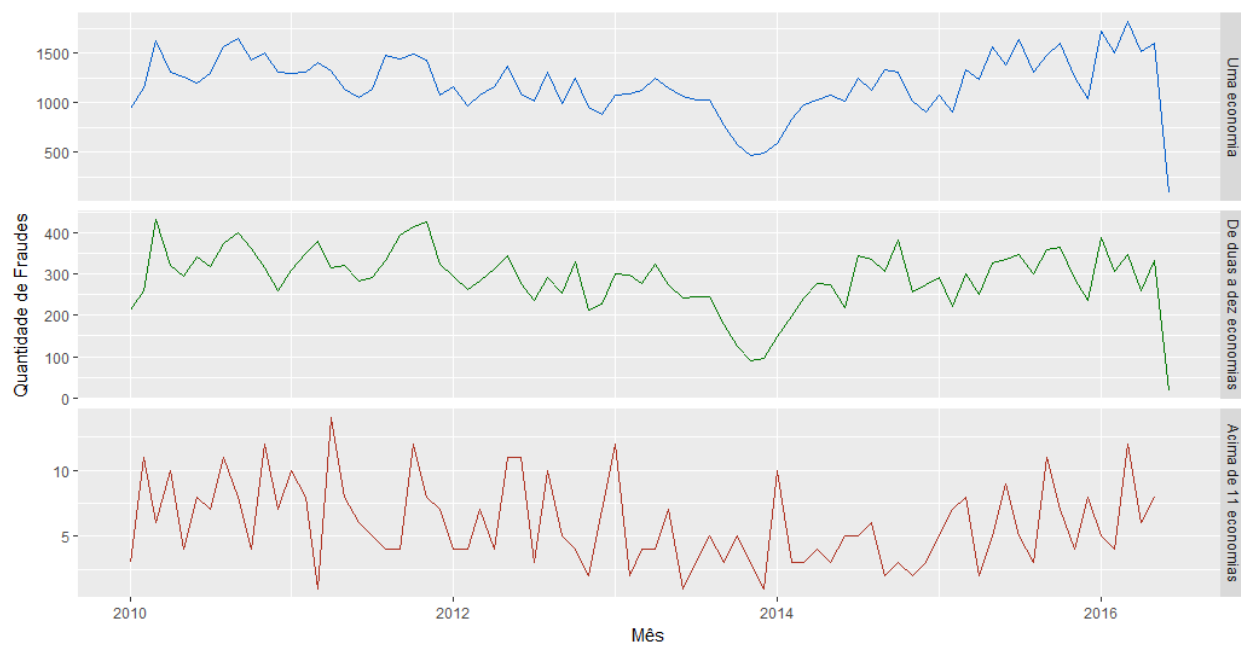
Graphic C.6. Frauds per use category / month



Graphic C.7. Frauds per type of connection



Graphic C.8. Frauds per range of 'economias' (connection subdivision)



Graphic C.9. Frauds per range of medium consumption