FGV PROJETOS

GOVERNMENT PROCUREMENT STRATEGIES IN BRAZIL

AUCTION THEORY AND "BIG DATA"

Nº 18

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SUMMARY

PRESENTATION

In Brazil, the policy of sustained economic growth with less income inequality has emphasized the importance of adopting more efficient public administration practices, both at the federal level as well as in the states and municipalities. In this context, government procurement plays a role in the economy in terms of public spending as well as a policy tool, mobilizing production chains with great potential to spur development.

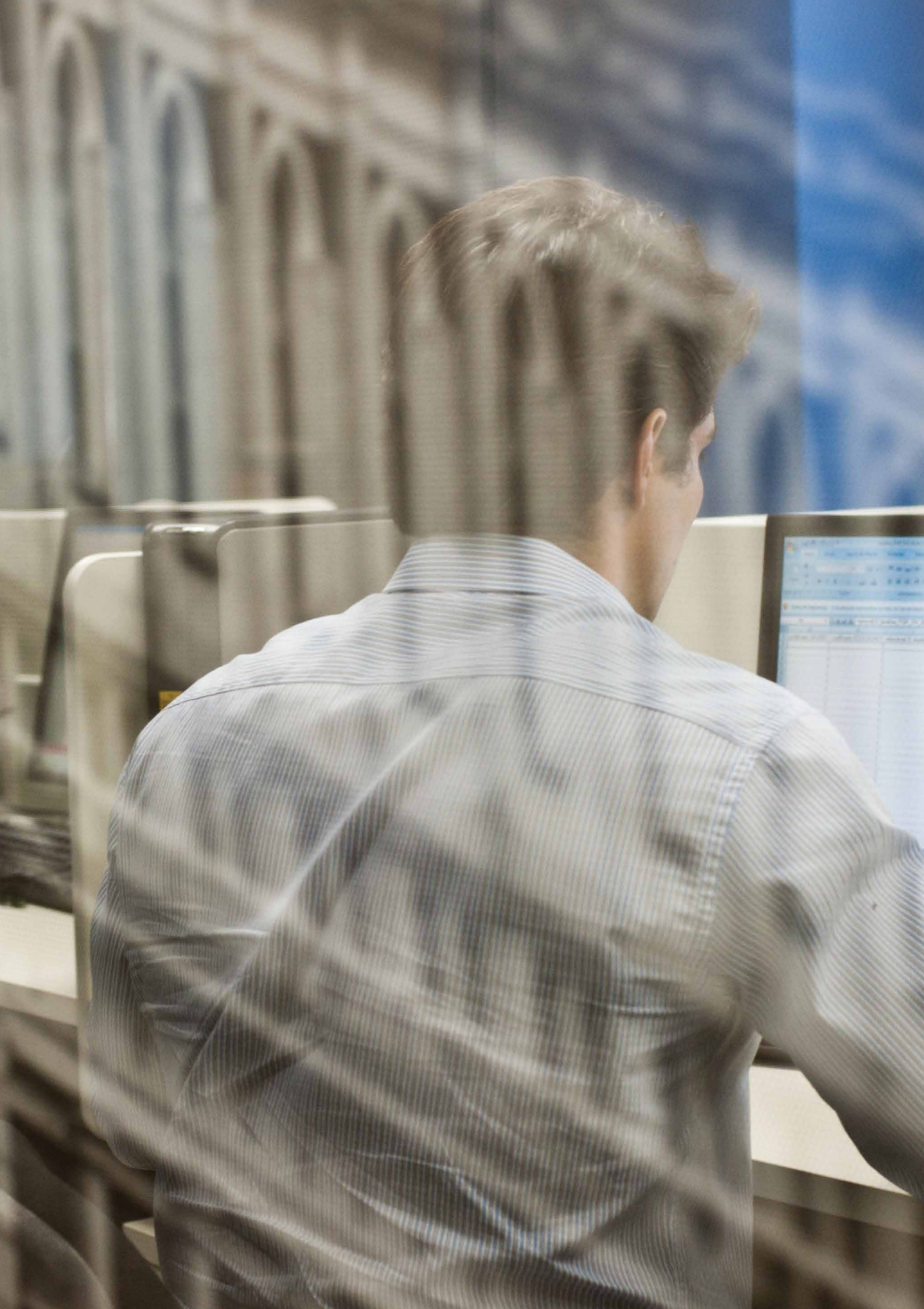
The study of FGV Projetos, coordinated by the economist Fernando Blumenschein, developed a methodological framework based on a series of studies related to the formatting of strategies for government procurement conducted by the National Fund for Education Development (FNDE). This study highlights the potential of applying auction theory with "Big Data" in methodologies that design and implement public procurement processes.

Methodological advances in this field have had two important consequences. First, there is the improvement of efficiency in government spending. This process has led to savings of approximately R$ 866 million for the Brazilian Government in the period 2008-2010, obtained through FNDE systematic application of procurement strategies developed by FGV Foundation. Second, the design of public procurement policies could affect the development of specific productive supply chains at the national level or on spurring regional economic growth.

By publishing this analysis, we reaffirm the commitment of FGV Foundation to the production of public goods and to knowledge sharing. We thus hope to inspire new initiatives, especially at the state and municipal levels, in order to create a solid strategy for government procurement that can contribute to our country and to its socioeconomic development. The Brazilian experience can also serve as a model for other countries seeking greater government transparency and other long-term benefits.

Enjoy!

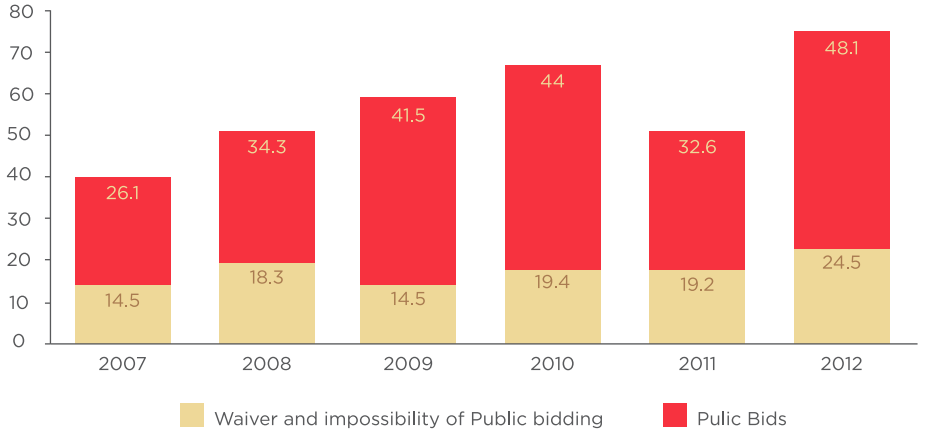
Cesar Cunha Campos
Director | FGV Projetos



1. INTRODUCTION

Government purchases account for a significant portion of the Brazilian economy and have grown considerably over the last few years. According to data from the Ministry of Planning, the volume of federal government purchases rose from R$ 40.6 billion in 2007 to R$ 72.6 billion in 2012, as shown in Chart 1.

Chart 1: Value of federal government purchases (R$ billion)



Source: Ministry of Planning

It is evident that electronic procurement has become the most relevant modality in federal government purchasing. Between 2007 and 2012, the number of acquisitions made through electronic procurement grew 78% in value and 33% in terms of the number of competitive bids. In 2012, acquisitions made via electronic procurement reached R$ 33.6 billion, representing 46% of all government purchases and 91% of competitive bids. It is worth noting, however, that a significant volume of government purchases – R$ 24.5 billion, or 34% of all goods and services acquired – occurred in cases in which competitive bidding was waived.

Concerning goods, the most representative sector for purchases acquired through bidding in 2012 was “Vehicles”, which accounted for 24% of these purchases (R$ 5.5 billion). With respect to services, the most representative group was “General construction services in civil engineering”, which accounted for 29% of these contracts (R$ 7.3 billion).

This panorama of federal government purchases shows both the evolution of its economic relevance and the growth of the modality of purchasing via electronic procurement. Together, these two elements suggest the potential of public procurement as a channel for improving the efficiency of public spending and promoting public policies.

Electronic procurement has become the most relevant modality in federal government purchasing.

In fact, the power of governmental procurement can be used to encourage more efficient public spending through procurement strategies designed to meet this goal. In this sense, the scale of purchases can be raised in different ways. One possible way would be through joint action by different branches of public administration, whereby decisions are made to buy from a central agency, or some purchases are bundled together, leading to larger contracts for the acquisition of goods and services. Alternatively, coordinated action among different agencies can help to harmonize the standards and requirements of products and services that are being bid upon, to help improve these standards and requirements and increase supply, thereby reducing the number of specifications to help achieve economies of scale and reduce the costs of production.

As mentioned above, government purchases can also be an instrument for promoting public policies, whether by fostering the development of specific productive chains at the national level or creating incentives for local economies. With respect to the former, Law 12.349, which went into effect on 15 December 2010, foresaw the possibility of using a margin of preference for products made with Brazilian technology.

Public procurement policies at the regional level, such as decentralized government procurement programs, can have a significant impact on local economic dynamics. However, those who design those policies are presented with a trade-off. On one hand, there is the challenge of identifying and intensifying the comparative advantages that lead to beneficial trade relations with other regions of the country. On the other hand, both concrete evidence and spatial analysis show that there is a close relationship between attractiveness and growth, and that some thresholds, when crossed, promote a great leap forward in the economic importance of that region.

Policymakers must realize that while the economic density of the large cities and regional centers is attractive in terms of the variety of commerce, services and opportunities, a movement toward homogenization of regions produces imbalance and inefficiency by ignoring factors such as comparative advantages and regional complementarity.

It is also clear that creating public policies through government purchasing activity is no easy task, nor is putting together multiple objectives in designing procurement strategies. In this sense, the formatting of a procurement strategy based on a specific methodological framework plays a crucial role in the entire process, since this is the mechanism by which such ends can be implemented and/or adapted.

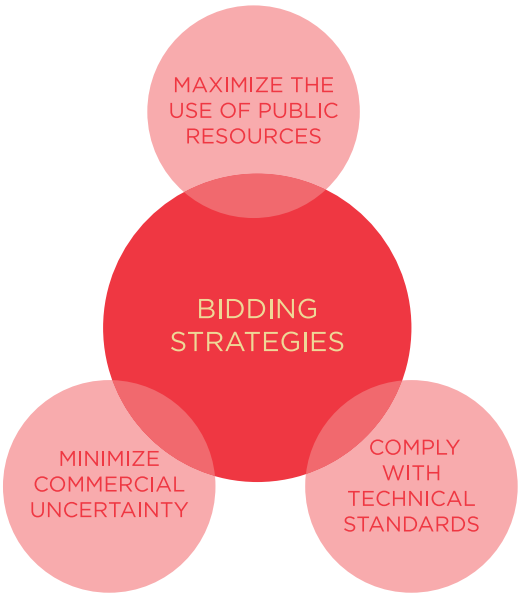
FORMATTING GOVERNMENTAL PROCUREMENT STRATEGIES

In this context, FGV has developed a specific methodological framework for governmental purchases through a series of studies on formatting governmental-procurement strategies. These studies were carried out for the National Fund for Development of Education (FNDE)[1] and are listed below:

I. "Strategies for Acquiring Micro-informatics Products" – July 2006
II. "Strategies for Acquiring School Transportation Vehicles for the 'The Way to School' Program" – July 2007
III. "Strategies for Acquiring School Laptops for the 'A Computer for Every Pupil' Project" – July 2008
IV. "Strategies for Acquiring Micro-informatics Products – the PROINFO Project" – July 2008
V. "Strategies for Acquiring Medicines for University Hospitals" – March 2009
VI. "Strategies for Acquiring School Furniture" – April 2009
VII. "Strategy for Acquiring School Uniforms" – December 2009
VIII. "Strategy for Acquiring Bicycles" – April 2010

The methodological framework was developed with a view to optimizing the use of public resources by minimizing commercial uncertainty in governmental procurement and observing desirable technical standards[2], as shown in Chart 2:

Chart 2: Objectives in defining bidding strategies



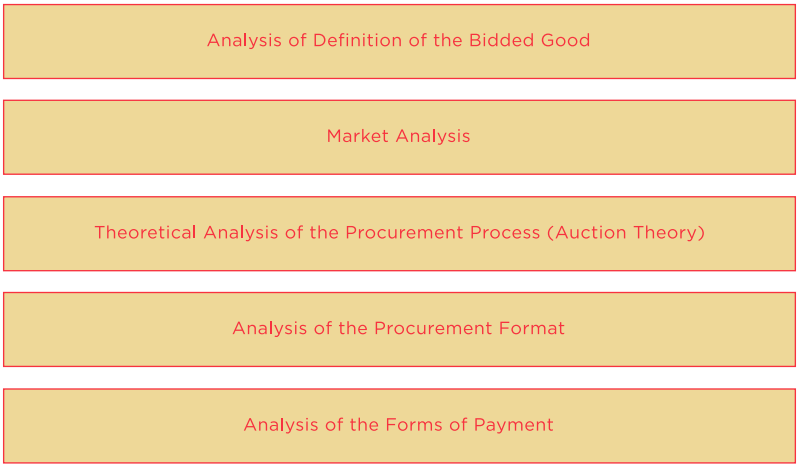
Source: FGV Foundation

[1] The FNDE, a federal agency linked to the Ministry of Education (MEC), makes large-scale acquisitions on behalf of the government.

[2] Other objectives are possible in designing strategies for governmental procurement, such as using them as an instrument of public policy.

Based on the pillars of the Auction Theory and "Big Data", the following dimensional analysis was taken into account by the methodological framework (Chart 3):

Chart 3: Dimensional analysis of the methodological framework used



Source: FGV Foundation

The analyses carried out used "Big Data" collected from different sources, including official national databases covering areas such as family consumption, employment, housing, company revenue and costs, and public purchases. Chart 4 summarizes the main data banks used.

Chart 4: Data banks

Source: FGV Foundation

Using such "Big Data" is not only helpful but also enlarges the scope of the analyses carried out in drawing up governmental-procurement strategies. In the market-analysis stage, for example, it can be used to characterize both the demand for the product under bidding (PNAD and POF) and the supply (PIA-Product and PIA-Company), thereby helping to understand the dimension of the market in question and the sector's cost-structure profile. The information on the profile of employment (RAIS) is also of great interest in this mapping analysis in that it helps to spatialize and profile the units of the productive chain in question. The database on previous governmental procurement (ComprasNet) is also of special interest at this stage since it provides parameters for establishing the reference price (see Appendix A).

Two pillars: Auction Theory and "Big Data"

The database on previous governmental procurement is also important for analyses subsequent to the bidding processes aimed at identifying the profile of the participants and winning bidders of the auctions, the level of competitiveness, and possible evidence of bid-rigging (collusion) among the participants. Furthermore, these bases can help public administration agencies to plan their demand for goods and services and to evaluate and possibly re-adjust this demand.

This article aims to present the methodological framework for formatting governmental purchases based on the pillars of Auction Theory and "Big Data". The work is divided into eight sections and an appendix. Five of these sections focus on describing each one of the dimensional analyses of the methodological framework, namely the analysis of defining the product being bid upon (Section 2), market analysis (Section 3), theoretical analysis of the purchasing process (auction theory) (Section 4), analysis of the purchasing format (Section 5), and analysis of the forms of payment (Section 6). Section 7 contains a case study in which the methodological framework was used. The last section contains closing comments with regard to the framework presented, while the Appendix provides a description of the most relevant databases for the work undertaken.

2. ANALYSIS OF DEFINING THE BIDDED PRODUCT

In the stage involved with defining the product under bidding, the characteristics of the product to be specified by the bid notice must be made explicit, taking into account compliance with the technical standards of the market and the range of products offered by suppliers. Likewise, the minimum requirements and functional characteristics must be specified for the bid notice, together with the delivery, installation, configurations and guarantee (maintenance and replacement) of the item.

Many procurement agencies and purchase departments are known to rely on catalogues of products that offer the specifications of the products typically acquired. In this regard, the catalogue is an integral part of the procurement strategy. One notices, for instance, that the diversity of specifications for the same category of items can affect possible economies of scale in governmental purchases in that they prevent items from being concentrated in the same lot by virtue of the different specifications given to the items.

This being the case, creating mechanisms that increase standardization of governmental procurement is desirable and feasible because in principle the specifications of consumer and proprietary goods acquired by public administration dispense with design-related attributes. It is also important that the catalogues include mechanisms available for ensuring standardization, such as controlling the inclusion of new items.

Using “Big Data” can help to prepare a suitable catalogue for the needs of public administration and to meet the objectives of optimizing the use of public resources, minimizing commercial uncertainty, and complying with desirable technical standards. The database can find product specifications that meet and make compatible the specific demands of the various agencies (or departments) involved in the procurement process by optimizing and diminishing the diversity of specifications present in the catalogue of products being used. To this end, “Big Data” must contain the whole set of items demanded by the agencies (or departments) and their respective specifications, as well as a broad base containing the products available in the market and their respective specifications, in order to cross-check information and define other possible areas of specifications.

3. MARKET ANALYSIS

This stage of the study involves analyzing the market that includes the item being bid upon. This analysis is based on information collected by relevant industries and trade associations, by

using "Big Data" collected from official national surveys, and through a review of the available literature. The dimensions studied in these market analyses are:

- Analysis of the productive chain
- Prices applied
- Location
- Area of activity
- Concentration of production
- Capacity of production
- Make-up of costs
- Logistics
- Case studies (involving specified suppliers and/or others)

The reference price constitutes a fundamental variable in the dynamic of the bidding process.

METHODOLOGY OF REFERENCE PRICES

As one of the most significant aspects of market analysis, the reference price constitutes a fundamental variable in the dynamic of the bidding process. It is important that the reference price is defined using specific methodologies that must be implemented and developed by a specific specialized technical team. With respect to the methodology of reference prices, a set of procedures and guidelines have been drawn up which, if followed, contributes toward improving the methodology of prices as well as minimizing implementation costs.

- The cost of the freight must be considered in the reference prices, either through collecting a "price with freight" or by using specific methodologies to estimate the freight component in the price.
- The characteristics of the market where the product being bid upon is supplied must be taken into account by the methodology used. For example, places with no industries or wholesalers may have retail suppliers or a higher freight price for the product which must be considered in the reference price.
- The prices of previous procurement auctions can be used to set current reference prices. In this case, a specific methodology must be used, in addition to the preparation of "Big Data".
- Public indices can be used to update reference prices to make price surveys less frequent and bring down their cost.
- There are cases where the seasonality of prices should be considered in setting the reference price, rather than just the result of a specific price survey, since the purchase price often involves supplying products or providing services for medium to long periods of time.
- Using relative prices among products can be evaluated by means of previous studies that analyze their correlation, formation and specificities.

- The methodology of reference prices can divide the supply region and thereby produce regional reference prices that are different from those usually charged. In this case, previous studies should be conducted for the purpose of analyzing the feasibility of this type of methodology.
- Price ratios among different supply locations can be studied to enable the methodology of reference prices to be included in such information, which in turn can be used to test the prices collected and/or lower the cost of prices surveys. In this latter case, the costs can be brought down by simplifying the survey, for instance by researching a single parameter and applying the ratio to estimate the prices in the other regions based on the parameter researched.

"Big Data" can be used to develop and implement the methodology of prices by aggregating price data from different sources, including previous governmental purchases and bids submitted during previous auctions, price indices, and information on freight.

4. THEORETICAL ANALYSIS OF THE BUYING PROCESS (AUCTION THEORY)

In contrast with the administrative freedom enjoyed in private firms, public administration operates under binding laws which, in this particular case, limits the discretionary power of the public administrator. The suppliers that public administration has to choose from must all meet the criteria of legality, impersonality, morality, transparency and other factors set by legislation applicable to bids and public contracts. In this sense, the freedom of public managers in the procurement process is restricted.

Law 8.666 of 21 June 1993 rules on article 37, sub-item XXI of the Federal Constitution, by instituting norms for bids and public administration contracts, establishing that bid notices bind the contract for the supply pursuant to the bidding process, which shall contain the specific conditions for carrying out the contract, deadline dates, and conditions of payment and penalties for non-payment, among other clauses which the law holds to be necessary.

Bearing in mind the Brazilian juridical framework, drawing up bid notices becomes the focal point in defining strategies in the process of government procurement since it binds the supply contract, to which nothing can be added without having been stipulated as a possibility beforehand. Accordingly, the supply contract to the public administration becomes an adhesion contract under which the conditions are pre-established since negotiation is not permitted during the bidding process, unlike what happens in the realm of private administration.

The absence of contractual flexibility reduces the scope for competition in the bidding process, reducing this scope to the matter of price or technical capability, and leads to the public

administration being charged a supply price that includes all sorts of risk premiums and is therefore higher thanit would be under regular market conditions since contingences, for which no provision was made in the contract/public bid notice, always arise.

In itself, the specification of the object being bid upon is another aspect relevant to this process, because it can be sufficiently narrow to effectively select a single winning bidder, which, for example, would extinguish the competitiveness of the buying process.

The problem of specification relates to the questions of formatting the buying process, which are multidimensional. The complexity of this area has led to important areas of study such as single-object and multi-object auctions. The interaction with the theory of design of mechanisms also bears important results concerning the formatting of governmental-procurement strategies.

Auction theory has offered seemingly infinite applications to governments.

The purpose of this section is to present a theoretical discussion based on important findings drawn from the academic literature on auctions, which are of interest in the drawing up of governmental procurement strategies.

FORMATTING STRATEGIES FOR AUCTIONS

The use of auction theory to analyze how public purchasing operates became very popular in the mid-1990s, with the big telecommunications auctions in the United States and medical procurement in the United Kingdom. Based on these successful cases, auction theory has offered seemingly infinite applications to governments, applied to structure a whole variety of bids, whether radio-electric spectrum licenses, electricity, privatizations or concessions in public-private partnerships.

Formally speaking, auctions consist of allocating property rights based on bidding by price among buyers (or sellers) for the right to buy (or sell) a good. In the case of public procurement, the opposite takes place: bidding is held among sellers for the right to sell.

The complexity of formatting bids stems from the fact that the purchasing party does not know with precision the lowest price for which a good or service could be bought. This is where auction theory comes in. Just as the main objective in an auction is for the price reached to be higher than what the buyer is prepared to pay, by analogy, in an auction the objective is for the seller to be the one who offers the lowest cost.

The key question related to formatting bids is actually the same as in auction theory – that is, the effects of informational asymmetry in the buying process. In neither case does the government (or the auctioneer) know the real production costs (or the actual amount the other party would be willing to pay) of the participants in the bid (or auction). If it were possible for the government to obtain such information, there would be no need to organize a formal buying process. It would be sufficient to acquire the good from the firm offering the lowest price. These are essentially symmetrical problems, which is why auction theory is being used in academic literature and by governments engaged in making bids.

Although auctions are a practice that man has been engaged in for centuries, theoretical economic literature on this issue is relatively new, having been introduced by Vickrey in 1961 in the first application of game theory to the problem, which won him a Nobel Prize in 1996. Myerson's seminal article (1981) announced a new literature focused on the optimal design of auctions for different situations.

Analysis of the format for procurement should be made with a view to presenting the practical parameters to support this formatting.

Recently, academic literature has lent more and more importance to the question of multi-object auctions, largely as a result of recent governmental auctions to sell radio spectrums (Milgrom, 2004). This literature emphasizes certain additional points of complexity not found in single-object cases, such as the possible heterogeneity and complementarity of the goods in question, as well as the existence of externalities among those taking part in the auctions.

Various options are offered to the organizer of a multi-object auction. The first of these is the choice between holding several auctions or just one. In the former case, the goods are generally sold one by one in several auctions, which the theory treats as sequential. In the latter case, the goods are sold in a single auction, though not necessarily by the same buyer.

The second option has to do with the format of the auction. In the case of separate auctions, one of the basic formats must be selected, for instance open and first-price sealed-bid auctions, or with open-ascending-bid and open-descending-bid auctions. In the case of a second-price, sealed-bid auction, aside from choosing to allocate the goods to the winners in a single big lot, individually or separately in packages, different formats can be chosen. In the case of homogeneous goods that are individually allocated, for example, such as government bonds, two options are uniform-price auctions, where all the winners pay the same price, and discretionary-price auctions.

In the Brazilian case, however, the bidding format involves descending bids, with the winner selected based on the lowest price. Accordingly, the principal choice in this case is whether

to hold one or several auctions. Nonetheless, a broad presentation and analysis of the various auction formats for the case of multi-objects can be found in Krishna (2009).

A preliminary analysis of the case of heterogeneous multi-objects was carried out by Palfrey (1983) for the case in which a monopolist seller must decide whether to sell two different objects in a single auction or to sell them in two different auctions. The author shows that in an atmosphere where the goods are independent (that is to say, their costs and values do not depend on the others), the greater the number of competitors, the better it is for the seller to sell the goods separately.

From the perspective of bidding, this result is intuitive, since the higher the number of participants, the easier it is to find competitors who are specialists in the production of one good to the detriment of another. Nevertheless, it is worth noting that the existence of complementarity among the goods in question weakens this conclusion, since the possible economies of scale in the production of the goods in conjunction makes the production of both goods together cheaper than it would be if they were produced separately. The validity of the preceding conclusion was more recently reaffirmed by Krishna and Tranaes (2002).

The balance between economies of scale associated with a single lot and exploring regional comparative advantages associated with fractioned auctions does not constitute the only relevant force in analyzing the design of a bid. In a recent study, Pesendorfer (2000) comments on the existence of a series of public bids that took place between 1988 and 1993 in which the Antitrust Division of the United States Department of Justice sued the suppliers for bid-rigging. Minimizing this risk should be the main concern in preparing a bid.

In general, the literature describes two ways to organize a cartel internally, either by using monetary transfers between winners and losers (lateral transfers), or by dividing the market among firms. The first case is logically the more lucrative for the cartel, since it allows the participants no advantage in deviating from how the cartel behaves. Nonetheless, by offering proof against the participants, the cartel often makes these bidders prefer to avoid lateral transfers.

Bearing this in mind, as Pesendorfer claims, it is often preferable to offer larger-size lots to avoid this market-dividing behavior while at the same time increasing the participants' gains by deviating from the conduct of the cartel.

Moreover, as McAfee and McMillan (1992) see it, it is also possible to practice less advantageous bid-rigging by setting a lower reserve price than would be determined if cartels did not exist. Furthermore, according to the authors, by keeping this reserve value secret (that is, its existence may be announced but not its value), the auctioneer ends up causing closer communication among the members of the cartel, which makes coordination difficult.

Chart 5 presents a synthesis of the advantages and disadvantages of each of the models discussed in this section.

Chart 5: Advantages and disadvantages of the procurement models

SINGLE-LOT PROCUREMENT		GEOGRAPHICALLY SEPARATED-LOT PROCUREMENT	
ADVANTAGES	DISADVANTAGES	ADVANTAGES	DISADVANTAGES
Economy of scale affecting price	Bigger risk in meeting delivery deadlines	Smaller risk in meeting delivery deadlines	Loss of scale affecting price
Managing one single contract	Depending on one single supplier	Not depending on one single supplier	Managing multiple contracts
Standardization	Incentive to concentrate on one single production complex	Incentive to regional development	Less standardization

Source: FGV Foundation

5. ANALYSIS OF THE PROCUREMENT FORMAT

Based on the theoretical analysis of the bidding process, analysis of the format for procurement should be made with a view to presenting the practical parameters to support this formatting. In this sense, there are two possible dimensions for dividing the bidding: separating the portfolio of products, or separating geographically. In this sense, four types of format are outlined:

- Single lot (no separation by geography or product): a joint auction of all the items, for all locations
- Lot separated by product or group of products (no geographical separation): one auction per item or lot of items, for all locations
- Geographically separated lot (no separation by product): a joint auction of all the items, for each location or group of locations
- Lot separated by product and location: one auction per item, for each location

Generally speaking, purchasing in fewer lots tends to be more advantageous since it allows buying for the lowest cost per unit of the item being bid upon, thanks to economies of scale.

However, there are limits to obtaining advantages by virtue of volume. As for adopting separate models (auctions separated by item and/or location), at first it allows fuller use of the comparative advantages of the suppliers in addition to increasing the number of potential participants.

Other aspects worth considering in separating lots are the location and frequency of delivery of a service or product/set of products. This calls for an evaluation to be made on the distance between the points of delivery and the frequency of delivery. There are cases in which the quantity of delivery points and the distance between these points can make it impractical for potential participants to take part in the procurement process. These factors may raise the supply price and cause an additional selection bias in the procurement process, thereby contributing to fewer potential suppliers participating in the bidding. This makes for less competitiveness in the process, which may also bear an effect on the valorization of the price of the product or service being bid upon.

In the bidding process, public administration is often seen not to use a specific criteria for formatting lots, frequently preferring parameters linked to the perspective of product catalogues (grouping by family and sub-family according to the classification used in the catalogues) which do not always correspond to the economic logic of the sector at the production level. This aspect is most important because a producer could a priori be a supplier offering a more advantageous price to the state vis-à-vis distributors and retailers, with the price applied including resale profit margins, not to mention less bargaining capacity for discounts. In this sense, the market-analysis stage is important to sustain the choice of optimal formats for lots.

Indeed, the market-analysis stage reacts powerfully with the stage of analyzing the procurement format for it provides the second stage with a series of relevant parameters and information, such as the spatialization of the industry in question, the characteristics of the production chain, the level of competition and the dynamics of prices.

Mention should be made, for instance, of the case of information-technology items, which neither the analysis of procurement format nor market analysis would recommend buying via the Prices Register System. This system offers the supplier the possibility of selling a micro-computer with specifications and price fixed up to six months in advance (or one year if the Prices Register Act is extended). Bearing in mind that information-technology items are characterized by rapid obsolescence and the specificities related to price given by Moore's Law, it can be seen that the "time window" allowed by the Prices Register Actis is of no benefit to public administration. This is so because although the specification of a machine bought via the Prices Register System may still attend to public administration at the time of acquisition, six months or one year after the price is fixed by the Prices Register, it will prove to be too outdated when compared with the prices practiced by the market (in this case, higher).

Another important aspect to be emphasized regarding the stage of analyzing the format of procurement by public administration agencies is the planning of purchases. Defining a wider horizon for planning governmental purchases makes it possible for lots to be formed with a size that may be optimal for the market to which the product belongs. When a specific organ centralizes public purchases, it is desirable that agencies or demanding areas deliver a plan for purchases to the central unit in order to enable it to act as the central planner in the proper formatting of lots.

6. ANALYZING THE FORMS OF PAYMENT

This stage of the study analyzes the models and forms of payment and their effect on the procurement process. Usually, the form of payment of government purchases is linked not to economic or market criteria but rather to the legal and procedural aspects of public administration. There are cases where governmental purchases are used as tools of public policies for the purpose of developing local economies and/or micro and small companies (MPEs), for example. In such special cases, the analysis of the forms of payment takes on a relevant role in formatting the procurement strategy, given the sensitivity of these agents to payment deadlines.

Payment deadline dates represent an increasingly important aspect since they are closely related to managing the working capital of companies, especially MPEs, where sensitivity is variable. Extensive payment deadlines increase the need for working capital in supplier companies, which in turn has two main effects. The first is the increase in the supplier companies' financial expenses and the subsequent transfer to the tenders offered. The second effect is to inhibit companies with restricted access to lines of financing, and hence working capital, from participating in the auctions, which potentially reduces the number of participants and the level of competitiveness in the procurement process. In this sense, payment deadlines are a risk variable in the procurement process for they affect attractiveness and may even increase the barrier to access to the bidding process since they impose an additional working-capital cost on the supplier.

7. CASE STUDY

This section presents a case study which uses the methodological framework presented. This study was carried out for the FNDE for the purpose of formatting strategies to acquire antibiotics for federal university hospitals.

STRATEGIES FOR ACQUIRING ANTIBIOTICS FOR FEDERAL UNIVERSITY HOSPITALS

The objective of this case study was to analyze and propose strategies for holding an electronic auction with registered prices for a set of 89 antimicrobial-class medicines in order to maximize the use of public resources, and at the same time minimizing commercial uncertainty and complying with the technical standards set forth in the public bid notice. In order to satisfy these objectives, five analyses were conducted: analysis to define the bidded product, market analysis, theoretical analysis of the procurement process (auctions theory), analysis of the procurement format, and analysis of forms of payment. These analyses were carried out by means of a comprehensive review of the economic literature on the matter, information publicly available and gathered from industry, and "Big Data", comprised of governmental databases.

Econometric models were prepared based on a databank with 2,758 auctions of the products in question held by the Federal University Hospitals (UHs) between 2006 and 2008 and involving the acquisition of 89 products by 36 UHs from 76 laboratories and 174 suppliers. The analysis of this databank and the information gathered from industry explored various other issues concerning the market, its competitiveness and dynamics, the market power of players, the capacity to meet the demand represented by the auction in question, and other aspects.

Based on the econometric models, reference prices were estimated for the quantities demanded of each product, with respective confidence intervals of 95%. These reference prices mainly incorporate the significant economies of scale that would be expected in an auction of the dimensions in question. In addition, other factors which might affect the final auction prices were analyzed quantitatively and qualitatively, such as changes in the macro-economic scenario (through its reflexes on the exchange rate and commodity prices) and the level of competitiveness in the auctions. To sustain these analyses, use was also made of a databank containing results of auctions held by the São Paulo State Health Department. It was estimated that at the average price of the previous auctions, the total cost would be R$ 40.4 million, whereas at the reference price the total cost would be R$ 29.8 million (confidence interval of 95%: between R$ 24.3 and R$ 37.2 million). Accordingly, the total savings was estimated at R$ 10.6 million (trust interval of 95%: between R$ 3.2 and R$ 16.1 million), or 26.3% in percentage terms (trust interval of 95%: between 7.9% and 39.9%). These data point to the possibility of obtaining even bigger economies as a result of scale and competition among suppliers, besides other factors.

Accordingly, the total savings was estimated at R$ 10.6 million (trust interval of 95%: between R$ 3.2 and R$ 16.1 million), or 26.3% in percentage terms (trust interval of 95%: between 7.9% and 39.9%).

A theoretical analysis of the procurement process was carried out, with emphasis placed on the theory of multi-object auctions with synergy, with uncertainty and the risk of bid-rigging and cartelization. In addition, analyses were conducted on the forms of purchase and payment, considering the various alternatives available, their advantages and disadvantages and impact on the possible results of the auction, taking into account the results of the other analyses.

Two possible separate types of auction were observed: a separate portfolio of products, and geographical separation (by UH or group of UHs). Accordingly, four possible types of formats are defined below:

- Single lot (no geographical separation, or by product): a joint auction of all the items, for all the UHs
- Lot separated by product or group of products (no geographical separation): one auction per item or lot of items, for all the UHs
- Lot separated by UH or group of UHs (no separation by product): a joint auction of all the items, for each UH or group of UHs
- Lot separated by product and UH (equivalent to the existing model)

Chart 6 presents a synthesis of the advantages and disadvantages of each of the formats:

Chart 6: Advantages and disadvantages of the procurement formats

MODEL	SINGLE LOT	LOT SEPARATED GEOGRAPHICALLY	LOT SEPARATED BY PRODUCT	LOT SEPARATED GEOGRAPHICALLY AND BY PRODUCT
ADVANTAGES	Maximizes economies of scale (among distributors)	Uses the competitive advantages of distributors	Maximizes economies of scale (among laboratories) Incentive to exclude distributors Uses the competitive advantages of laboratories No restriction to access/ competitiveness (among laboratories) Diversity of items incentivizes competition	Incentive to exclude distributors Uses the competitive advantages of laboratories No restriction to access/ competitiveness (among laboratories) Diversity of items incentivizes competition

MODEL	SINGLE LOT	LOT SEPARATED GEOGRAPHICALLY	LOT SEPARATED BY PRODUCT	LOT SEPARATED GEOGRAPHICALLY AND BY PRODUCT
DISADVANTAGES	Distributors need to participate Does not use the competitive advantages of laboratories Does not use the competitive advantages of distributors Strong restriction against access/ competitiveness Having so few items lends incentive to bid-rigging	Does not maximize economies of scale Distributors need to participate Does not use the competitive advantages of laboratories Strong restriction against access/ competitiveness Having so few items lends incentive to bid-rigging	_____	Does not maximize economies of scale

Source: FGV Foundation

The choice of the model followed considerations about maximizing economies of scale, lending incentives to competition and minimizing risks of bid-rigging. It also took into account the presence of two types of players, laboratories and distributors, the latter being less able to offer discounts due to their position as intermediaries in the productive chain.

Based on these considerations, the option in favor of the product-separated lot (one auction per item or lot of items) presented the most favorable balance. Nevertheless, there still remained the question of whether this separation should be total (one auction per item) or partial (one auction per lot of items). Note that this introduces a trade-off between the possible advantages obtained from grouping together more than one good in a lot (bigger economies of scale and synergy, with greater use of the competitive advantages of the laboratories best prepared to supply these lots) and those liable to be reduced or lost due to this grouping (introduction of restrictions against access for laboratories, especially small ones, and decrease of the number of goods bidded, both of which facilitate bid-rigging). Furthermore, two risks are introduced. The first has to do with the actual selection of the products to be grouped together. If this selection is made based on incomplete or imperfect information about the portfolio and productive capacity of the laboratories, it could cause significant distortions with regard to the desired result. The second risk involves the possibility of juridical questioning of the validity of the auction on the part of small laboratories that are likely to be excluded under such a model.

Based on statistical results and information collected, the risk of facilitating bid-rigging (by introducing restrictions against access of laboratories and reducing the number of goods bidded) is believed to be greater than the possible benefits from any economies of scale obtained from grouping together. Furthermore, one must take into account the additional risks presented by this grouping (namely, the economic risk of distortions and the legal risk of the auction being questioned). These two observations together indicated that the most suitable option would be to hold an auction with total separation of products, without grouping.

8. CLOSING COMMENTS

This article set out to present the methodological framework for formatting governmental procurement developed and based on the pillars of the Auction Theory and "Big Data". Section 2 presented the first dimensional analysis of the methodological framework, namely the analysis to define the product being bid upon. This stage defines the specifications of the product to be bid upon, a process in which the catalogue of products plays an important part. It has been mentioned that standardizing procedures are, for several reasons, desirable for the strategy of government procurement, and that this is a process that starts in the catalogue of products. Moreover, assembling a catalogue suitable for the needs of public administration and the objectives of optimizing the use of public resources by minimizing commercial uncertainty and complying with the desirable technical standards can be developed by using "Big Data".

Section 3 addresses market analysis and important aspects related to the methodology of reference prices. A set of specific procedures and guidelines was presented, which, if followed, could contribute toward improving the methodology of prices and minimizing the cost of executing such a methodology. In this sense, "Big Data" can be used to aggregate data on prices from various sources, including past governmental procurement and bids made during previous auctions, prices indices, information on freight, and so on.

Section 4 addressed the theoretical analysis of the procurement process, focusing on auction theory. As mentioned above, this analysis precedes and supports the analysis of the procurement format (Section 5), which is the stage that defines the practical parameters that will serve as the foundation for formatting procurement and dividing the auction (separating the product portfolio and geographical separation).

Section 6 dealt with an analysis of the forms of payment, where the models and forms of payment and their impacts on competitiveness in the procurement process are analyzed. Emphasis was given to the importance of payment deadline dates, actually a risk variable in the procurement

process, since this has a bearing on attractiveness, raising the barrier to access to the bidding process, which in turn represents an additional cost to the supplier's working capital.

Section 7 presented a case study carried out for FNDE which used the methodological framework presented. This study, aimed at formatting strategies for buying antibiotics for federal university hospitals, made use of "Big Data" comprised of governmental data that enabled specific econometric models to be developed to estimate reference prices. By implementing the developed strategy, an estimated savings of R$ 10.6 million was made in governmental procurement of antibiotics for federal university hospitals, or 26.3% in percentage terms.

The volume and economic relevance of governmental procurement point to the need for a specific strategy for this context. As the case study presented made explicit, the estimated savings made possible by applying a specific methodological framework for governmental procurement is impressive and constitutes an important innovation in public management. In this sense, it would seem important for this methodology to be applied to the state and municipal spheres of public administration.

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APPENDIX

This Appendix contains a description of the main databases used in the studies made to format governmental procurement strategies.

COMPRASNET

ComprasNet is by definition a virtual system for acquiring goods and services that functions like an auction in reverse. The system allows for two modalities of bidding: waiver by value, and auction (presential and electronic). It should be mentioned that the auctions can be followed on the site of ComprasNet.

Public bodies, agencies and state foundations announce their needs concerning procurement or contracting of services on the site and wait for bids from suppliers, in the case of waiver by value, and negotiate the bids, in the case of auctions, until the lowest price is reached.

All public bodies are accredited to use this instrument, which makes the procurement process easier, reduces bureaucratic red tape, and makes it easier to control and check the legality of the procedures, hence the name "purchases manager". As for suppliers, only those registered in the state are allowed to take part in the auctions (in 2012, registered suppliers numbered over 270,000 nationwide).

In the period from 2002 to 2011, more than 17 million procurement items were auctioned through this system. Chart 7 shows the number of procurement items according to the type of supplier and the year of reference. Note that the number of individual participants is smaller than the number of corporations.

Chart 7: Participation of the number of procurement items[3], according to the type of supplier and the year – 2002 to 2011 (January to December)

YEAR	OTHER TYPES	INDIVIDUALS	CORPORATIONS	TOTAL
2002	0	55,586	1,709,964	1,765,550
2003	0	43,511	1,624,121	1,667,632
2004	0	41,833	1,760,042	1,801,875
2005	2	41,856	1,730,599	1,772,457
2006	0	41,276	1,764,906	1,806,182
2007	1	36,682	1,790,598	1,827,281
2008	0	35,219	1,812,869	1,848,088

[3] An auction to buy office materials, for example, can contain different items, such as pens, clips and erasers, and different suppliers can win the dispute to supply different items in a single auction.

(cont.)

YEAR	OTHER TYPES	INDIVIDUALS	CORPORATIONS	TOTAL
2009	0	33,893	1,767,651	1,801,544
2010	0	30,198	1,722,911	1,753,109
2011	0	25,221	1,604,749	1,629,970
TOTAL	3	385,275	17,288,410	17,673,688

Source: Ministry of Planning

ANNUAL LIST OF SOCIAL INFORMATION – RAIS

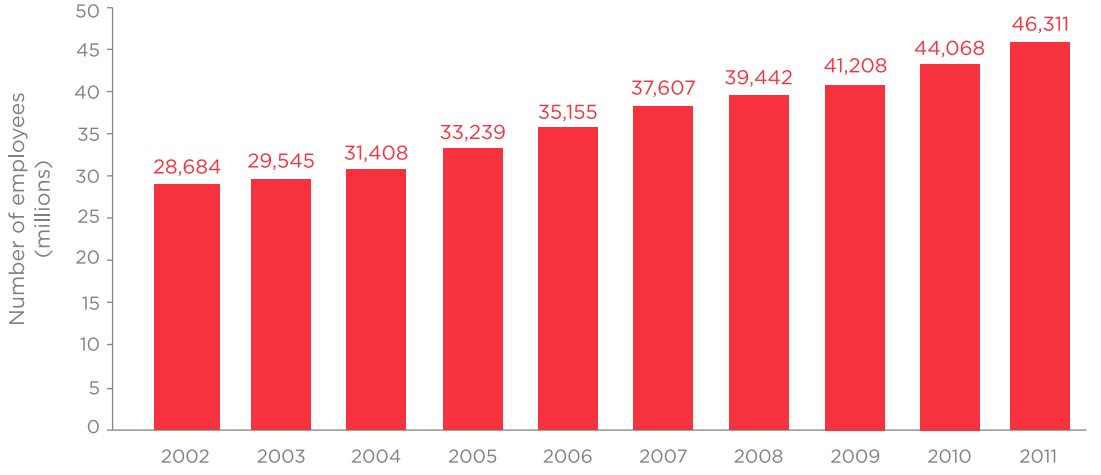
The Annual List of Social Information (RAIS), prepared each year by the Ministry of Labor and Employment, was created with the aim of providing the control, statistics and information needed by governmental entities in the social area. The objectives of RAIS are to:

- Meet needs related to the control of labor activities in the country
- Provide data to prepare statistics involving labor
- Provide governmental entities with information on the labor market

The purpose of collecting data is for RAIS to attend to the needs of the legislation concerning nationalization of labor, control of the registers of the FGTS, the Tax Collection and Social Security Concession and Benefits Systems, technical statistical and actuarial studies, and identification of employees entitled to the PIS/PASEP salary bonus.

Chart 8 presents the number of formal employees in Brazil registered in the period from 2002 to 2011 (an increase of over 60% in a decade). Parallel to this, a series of data is collected by the RAIS through the delivery of obligatory declarations stipulated by the Ministry of Labor and Employment.

Chart 8: Number of employees in Brazil in the period 2002-2011



Source: Ministry of Labor and Employment

NATIONAL HOUSEHOLD SAMPLE SURVEY – PNAD

The National Household Sample Survey (PNAD) is prepared each year by the Brazilian Institute of Geography and Statistics (IBGE). PNAD studies general characteristics of the population, such as education, work, income and housing on a permanent basis. Other items are researched with variable frequency, depending on national needs for information, such as migration, fertility, marriage rates, health, and food security.

These statistics have been gathered for 44 years and constitute an important instrument for formulating, validating and evaluating policies geared to socioeconomic development and living conditions in Brazil.

Visits were made to 146,000 households in 2011, and interviews were held with 359,000 people. These results addressed the basic themes investigated and provided the dimension and quantity of information made available in this research.

DEMOGRAPHIC CENSUS[4]

Prepared by IBGE, the Demographic Census is carried out once every ten years. The last census was conducted in 2010 and included a detailed survey of all the households in the country. During the period that the data was gathered and supervised, 191,000 census-takers visited 67.6 million

[3] Conducted by the IBGE.

households (Brazil has a population of 190,732,694) in 5,565 Brazilian municipalities to collect information on who we are, how many we are, where we live, and how we live.

The results of the census were made public with the publication of the following items:

- Education and displacement
- Work and income
- Marriage rates, fertility and migration
- Families and households
- General characteristics of the population, religion, and people with disabilities
- Child labor
- Income
- Urban characteristics in the vicinity of the household
- Sub-normal agglomerates
- National register of addresses for statistics
- Other

ANNUAL INDUSTRIAL SURVEY – PIA PRODUCT AND COMPANY

Each year, IBGE conducts industrial surveys on products and companies for the purpose of gathering information on the products made in Brazilian industries and the line of production of industrial companies in the country with 30 or more employees.

Mention can be made of some points that differentiate the methodological approach used in these two surveys. PIA-Company focuses on industrial firms and it is centered on the economic-financial data provided by central accounting, following the probability-sampling design. PIA-Product, on the other hand, is directed towards local industrial units, obtaining its information from analytical accounting, and it is exhaustive within a given limit of representativity, defined in relation to the set of companies surveyed by PIA-Company.

ANNUAL INDUSTRIAL SURVEY – COMPANY

The Annual Industrial Company Survey (PIA Company) presents a set of economic-financial information that enables an estimate of the basic structural characteristics of the business segment of industrial activity in the country, as well as its evolution over the years.

The results of PIA-Company 2010 reveal that 416,633 industrial companies met the criteria to define the target-population[5]. The sample triage involved selecting 52,814 companies. The main variables investigated in the companies were:

[5] Target-population: the set of formally constituted industrial companies selected based only on CEMPRE and employing one or more people. Up to 2007, the population was restricted to companies with five or more people employed.

- Employed people
- Salaries, pension withdrawals, and other remuneration
- Revenue
- Costs and expenses
- Acquisitions, improvements and losses of tangible assets during the year

Among other aspects, this survey offers data on employed people, salaries, pension withdrawals and other remuneration, income, costs and expenses, the figures for production and the transformation industry. The results are also based on version 2.0 of the National Classification of Economic Activities (CNAE).

ANNUAL INDUSTRIAL SURVEY – PRODUCT

Each year, the Annual Industrial Product Survey (PIA Product) presents the quantity produced and sold and the figures for production and sales of products and services generated in the country, highlighting the 100 largest according to the national ranking of the product, which is defined in terms of sales and regions of the country.

The scope and detailing of these results, presented by class according to the National Classification of Economic Activities (CNAE 2.0) and the Mercosur Common Nomenclature (NCM), are a source of information on the Brazilian industrial sector and allow national standardization and international comparability of statistics.

As PIA-Product is a intentional selected panel based on the PIA-Company, the updating of the survey registers is done each year based on the data of the PIA-Company for the same reference year.

In addition to PIA, there are other surveys that gather information on industry in Brazil, such as the Monthly Industrial Survey of Physical Production[6] (PIM-PF) and the Monthly Industrial Survey of Employment and Salaries (PIMES).

MONTHLY EMPLOYMENT SURVEY

The Monthly Employment Survey (PME) has been prepared by IBGE since January 1980. PME presents monthly indicators on the labor force in order to enable an evaluation of fluctuations and medium and long-term tendencies of the labor market in the areas surveyed. It is a reliable indicator of the effects of the economic situation on this market, in addition to meeting other important needs of national socio-economic planning.

[6] Produces short-term indicators of the behavior of the real product of the extractive and transformation industries.

PME covers information referring to the status of the activity, employment figures, average nominal and real income, employment status, and possession of signed work documents, among other items, with the household being the unit of the sample. The main variables investigated in the section on education are literacy, school attendance, and professional-training courses. The size of the sample is approximately 44,000 households[7] per month, totaling over 500,000 households per year.

FAMILY BUDGET SURVEY - POF

The Family Budget Survey (POF) conducted each year by IBGE consists on a household sample that seeks information on characteristics of the households, families, inhabitants and their respective household budgets, that is, their expenses and incomes.

The survey, based on representative samples of a particular population, aims at measuring the structure of spending (expenses), revenue (income), and savings of this segment of the population. The objectives of the survey include its use in updating the weight structures of the consumer price indices produced by IBGE and other institutions.

The frequency of POF, which began in 1987, is eventual. Since it was founded, IBGE has conducted four surveys: in 1987-1988, 1995-1996, 2002-2003 and 2008-2009. The last survey published by IBGE covered a sample of 55,970 households.

[7] Situated in the Metropolitan Regions of Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo and Porto Alegre.