FINAL REPORT

ABIIS PUBLIC PURCHASE INDEX - IACP

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ABIIS Aliança Brasileira da Indústria Inovadora em Saúde

Price Index for public purchase of medical devices

ABIIS Public Purchase Index - IACP

Executive Summary

This study herein aimed to analyze the price variations of medical devices and assess whether a possible increase in costs had an impact on high inflation in healthcare, as the topic raises important public policy issues. Therefore, an index was developed consisting of a sample of products consisting of: diagnostic reagents, implantable medical devices and imaging diagnostic equipment, a sample that is considered representative in the purchases context by the Unified Health System (SUS). And, based on the index, the evolution of the average prices practiced in Brazilian public purchases was monitored. From the analysis, it was concluded that, in the period from 2015 to 2020, the nominal prices of this basket of products grew by 25.8%, in view of an accumulated inflation in the period of 51.5%. It represented a lag in prices in 2020 compared to 2015 of 17%.

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Summary

1. Introduction

This paper herein describes the result of a study contracted by Aliança Brasileira da Indústria Inovadora em Saúde [Brazilian Alliance for Innovative Health Industry] (ABIIS), with the objective of verifying whether the prices of medical devices have been rising, seeking to provide elements to assess whether any cost increase has impacted the rise. inflation in health, as the theme raises important public policy issues.
For this purpose, an index was developed consisting of a sample of products considered representative in the context of purchases from the Unified Health System (SUS). Based on the index, the evolution of the average prices practiced in Brazilian public purchases was monitored. Therefore, the seven products were selected, namely:

- Diagnostic reagents: Serological tests for Vitamin D, HIV and Thyroid Stimulating Hormone (TSH);
- Implantable medical devices: knee stents and prostheses;
- Diagnostic imaging equipment: ultrasound and mri devices.

Thus, this document presents a detailed description of the methodology that was adopted by the Web setorial team to calculate the price index practiced in public purchases of medical devices. The issues addressed herein range from discussions on the theory of index number construction, choice and characteristics of data and their sources and composition of the basket of goods that was monitored.
Thus, it was possible to provide the reader with a description of the procedures adopted for the construction of the indexes, present the results of their calculations and the conclusions of the analysis of the evolution of the prices of the aforementioned medical devices auctioned in the Brazilian market, covering the period from 2015 to 2020 .

2. Note on index numbers

The calculation of price or quantity variation is a simple task in the case where the consumer (producer) consumes only one good (input) and consumes (produces) only one product. In this simple case, the variation in cost reflects the variation in the price of the input in question and the variation in quantity, hence only the variation in the quantity used or consumed between two periods. As more than one item is systematically produced, problems arise with aggregation and weighting of different variations in prices and quantities. This is the discussion on which the so-called index number theory is devoted.

2.1. The types of indexes[1]

Index numbers are used to measure phenomena such as inflation of a basket of goods consumed (measure of variation in the costs of a basket of products consumed by a group of consumers), productivity of companies (variation in the amount of inputs used for the production of a given product unit) or production cost (variation of input costs used to produce a given good). In this sense, an infinite number of index numbers can be proposed, as there are countless possibilities of combinations between prices and quantities of the various items produced and their inputs.

[1] POLLAK, Robert A. *The theory of the cost-of-living index*. New York: Oxford University Press on Demand, 1989.

The indexes seek to break down the variation in value into prices and quantities. In the first case, they are called price indexes, and in the other case, quantity indexes. Therefore, the main indexes used in the literature are presented below. They are: the Laspeyres, Paasche, Fisher and Tornqvist-Theil (Divisia) indexes). Laspeyres's consists in comparing the prices of a particular basket of goods (or inputs), evaluated in relation to the prices – or quantities – of the goods (or inputs) in the period to be adopted as the basis or parameter for comparison.

Thus, the Laspeyres-type price index consists of a weighted average of relative prices given by $\frac{p_i^1}{p_i^0}$, applied on weights, which are calculated based on the participation of each item in the basket of goods (or inputs) consumed (or used) in the production of the product in the initial period.

The formula for the Laspeyres price index is given by equation (1):

$$L_p^{0,1} = \sum_{i=1}^{N} \frac{p_i^1 q_i^0}{p_i^0 q_i^0} = \sum_{i=1}^{N} w_i^L \frac{p_i^1}{p_i^0} \qquad (1)$$

In which, $w_i^L = \frac{p_j^0 q_j^0}{\sum_{i=1}^{N} p_i^0 q_i^0}$

the quantity index of the Laspeyres type is given by equation (2):

$$L_q^{0,1} = \sum_{i=1}^{N} \frac{p_i^0 q_i^1}{p_i^0 q_i^0} = \sum_{i=1}^{N} w_i^L \frac{q_i^1}{q_i^0} \qquad (2)$$

The difference is that, in this case, quantity relatives are used instead of price relatives. The Paasche index consists of comparing the costs of a given basket (of goods or inputs) valued at prices or quantities in the final period. The formula for the Paasche price index is given by equations (3) and (4).

$$P_p^{0,1} = \sum_{i=1}^{N} \frac{p_i^1 q_i^1}{p_i^0 q_i^1} = \sum_{i=1}^{N} \frac{1}{w_j^0 \left(\frac{p_i^1}{p_i^0}\right)} \qquad (3)$$

$$P_Q^{0,1} = \sum_{i=1}^{N} \frac{p_i^1 q_i^1}{p_i^1 q_i^0} = \sum_{i=1}^{N} \frac{1}{w_j^0 \left(\frac{q_i^1}{q_i^0}\right)} \qquad (4)$$

In which, $w_i^P = \frac{p_j^1 q_j^1}{\sum_{j=1}^{N} p_j^1 q_j^1}$

The Paasche-type price index consists of a harmonic average of prices (3), whose weights are calculated based on the share of each item in the basket of goods (inputs) consumed (used) in the final period. The index of quantities of type Paache is given by equation (4). In this case, changes in the index are measured based on the change in quantities between the periods considered.
Fisher's index consists of a geometric mean of the Laspeyres and Paasche indexes, described above. The Fisher price index is given by (5):

$$F_p^{0,1} = \sqrt{P_p^{0,1} L_p^{0,1}} \qquad (5)$$

The Fisher index of quantities is given by equation (6):

$$F_Q^{0,1} = \sqrt{P_Q^{0,1} L_Q^{0,1}} \qquad (6)$$

The Tornqvist-Theil (Divisia) index number measured from price differentials is given by (7):

$$TT_p^{0,1} = \prod_{i=1}^{N} \left(\frac{p_i^1}{p_i^1}\right)^{w_i^{TT}} \qquad (7)$$

In which, $w_i^{TT} = \frac{w_i^P + w_i^L}{2}$.

The weights are given by the average of the share of each expenditure in the product (or input) considered in the basket at the beginning and end of the period. The Tornqvist-Theil (Divisia) index number measured from quantity differentials is given by (8):

$$TT_Q^{0,1} = \prod_{i=1}^{N} \left(\frac{q_i^1}{q_i^1}\right)^{w_i^{TT}} \qquad (8)$$

The weights are the same defined in the same way as in the price index.

2.2.Desired properties of index numbers

Price indexes must comply with some basic properties considered ideal.
They are, namely: (i) Identity; (ii). Homogeneity; (iii) Proportionality; (iv) Determination; (v) Reversibility; (vi) Circularity.
The identity criterion says that if there is no change in prices (in the case of price index) and quantities (in the case of quantity index), the variation in the period must be zero, that is, the index number in the initial period must equal the index number in the final period.
The homogeneity criterion says that the index number should not change if the unit of measurement of the goods is changed. For example, if a certain item turns to be measured in pounds instead of kilograms.

The proportionality criterion concerns the fact that, if all price relatives (or quantities) are equal, that is, the variations in all items are equal, then the index must be equal to the variation value. For example: if all prices rise by x percent in a given period, the index must be equal to x percent.
The determination criterion says that the index may not be null, infinite or indeterminate if a single price or quantity is null, that is, the index result may not depend on a single item to be satisfactorily calculated. Finally, there is the criterion of reversibility. Calculating the price variation between the period between 0 and 1 and between period 1 and 0, the inverse result must be obtained, in such a way that both results cancel each other out, that is, if the index at 1 is x percent , greater than period 0, so the index between 0 and 1 must be x percent smaller.
The Laspeyres and Paasche indexes satisfy properties (i) to (iv). Fisher's index satisfies the properties of (i) to (v). Whereas the Tornqvist-Theil (Divisia) index satisfies them all.

2.3.Feasible index numbers

In many practical cases, lifting the weights each period is unfeasible due to operational and cost issues.

This is the case, for example, with the consumer price index, which requires a detailed survey of the consumption habits of a large group of consumers who are monitored during a certain period. There is also a need to lift weights at every moment for the construction of cost indexes under the modalities: Paasche, Fisher and Tornqvist-Theil (Divisia) are calculated.

Technically, the answer to this type of restriction consists in using an update of the weights based on the global information of the index and on the relative prices of inputs.
At each period, the weights are modified, assuming that there were only variations in input prices and not in the amount used in them.

In price indexes, this is a strong assumption, although it is widely used across all institutes. As for the calculation of a cost index, such a hypothesis – of no variation in the amount of inputs used – is much more reasonable since major technological changes do not occur during the periods in which the research for the initial definition of weights is carried out.
Items whose variations occurred above the global average have their weights corrected upwards, while items whose variations occurred below the average have their weights reduced.
This is the procedure also adopted by research institutes such as BLS (Bureau of Labor Statistics), IBGE (Brazilian Institute of Geography and Statistics [Instituto Brasileiro de Geografia e Estatística]), FGV (Getúlio Vargas Foundation [Fundação Getúlio Vargas]) and FIPE (Institute of Economic Research Foundation [Fundação Instituto de Pesquisas Econômicas]) among others.

3. Calculation of price indices for public purchases of medical devices

For the purposes of this study, the Laspeyres price index was used, and for the calculation of the price indices, the products that were monitored according to their relevance in the basket of goods of companies associated with ABIIS were defined.

3.1. Data collection

To calculate the index of average prices of medical devices practiced in Brazilian public purchases, the price and quantity data of the seven selected products were acquired from the company IBIZ Inteligência de Mercado (www.ibiz.com.br), which brings together the database data from bids made by health service providers in various entities of the Federation. The data are public, therefore not infringing the Brazilian competition law. The scope of the base is effective transactions at the national level and the collection universe is all public purchases that took place in the considered period (2015 to 2020).

3.2. Disaggregation level

The level of disaggregation available is the prices and quantities traded in the transactions for the case of the seven chosen products, in the five major regions of Brazil. They were added for the national calculation and in the three segments of the industry where they are inserted, namely: implantable medical devices, materials and equipment for health and reagents for in vitro diagnosis, for the subsequent calculation of the global index.

3.3. Calculated indexes and product weights in index

The indexes of the average nominal prices of products practiced in Brazilian public purchases were calculated for the general level and two more disaggregations. The weights of the products in the index were calculated based on the representativeness of the value traded by each product in the total negotiations (Table 1).

Table 1. Calculated indexes and their disaggregations

AGGREGATION	FIRST DISAGGREGATION	SECOND DISAGGREGATION	WEIGHTS
ABIIS Public Purchase Index - IACP			
ABIIS Index Public Purchase- IACP GLOBAL	IACP - Implantable Medical Devices	Stents	0.7%
		Knee Prostheses	2.7%
	IACP - Diagnostic Imaging Equipment	Ultrasound scanners	14.1%
		MRI	61.4%
	IACP - Reagents for *In Vitro* Diagnostics (IVD)	Vitamin D	9.6%
		TSH	4.5%
		SIDA	6.8%

Source: Web setorial Consultoria Econômica

4. Results

4.1. Result of calculating the indexes in the first disaggregation

Before calculating the global index of price variation for medical devices, the indexes for three disaggregations were calculated, namely: 1) IACP - In Vitro Diagnostic Reagents 2) IACP - Diagnostic Imaging Equipment, 3) IACP - Implantable Medical Devices. All indexes were based on December values for the month of December in the period 2015 to 2020, as there are no transactions, in all months of the year, for most products in the country (Tables 2 to 4).

Table 2. Results of IACP indexes - Reagents for *in vitro* diagnostics | from 2015 to 2020 in index numbers (base December 2015 = 100)

	IACP - REAGENTS FOR IVD (FIRST DISAGGREGATION)	SEROLOGICAL TEST FOR VITAMIN-D	HIV SEROLOGICAL TEST	TSH SEROLOGICAL TEST
2015	100.00	*100.00*	100.00	100.00
2016	99.49	144.82	54.32	318.68
2017	102.60	124.18	86.22	176.57
2018	96.71	94.99	86.22	160.85
2019	124.53	84.75	120.02	194.18
2020	101.77	82.42	105.44	100.85

Source: Web setorial Consultoria Econômica

In the accumulated period from 2015 to 2020, the nominal prices practiced in public purchases of the IVD reagent group, for the basket of the three products considered, suffered small fluctuations between the years and accumulated growth of 1.77%. In this calculation, the prices of serological tests for Vitamin D and TSH increased sharply in 2016, followed by retraction in the following years. Prices for HIV tests and for TSH showed sharp fluctuations over the years, culminating in positive nominal variations of 5.44% in the accumulated from 2015 to 2020 (Table 2).

Table 3. Results of IACP indexes - Diagnostic Imaging Equipment | from 2015 to 2020 in index numbers (Base December 2015 = 100)

	IACP - DIAGNOSTIC IMAGING EQUIPMENT (FIRST DISAGGREGATION)	MRI	ULTRASOUND SCANNER
2015	100.00	100.00	100.00
2016	96.97	90.97	123.07
2017	102.64	90.71	154.53
2018	119.31	119.32	119.26
2019	139.99	133.57	167.90
2020	135.29	128.33	165.56

Source: Web setorial Consultoria Econômica

In the case of nominal prices in public purchases of the imaging diagnostic equipment group, it is noted that the fluctuations in the index of this segment, over the years analyzed, resulted mainly from corrections in the prices of ultrasound scanners, in 2017, followed by a drop in 2018 and a new increase in 2019, stabilization in 2020. The result was a 35.29% increase in the nominal value, that is, before discounting inflation, in public purchases of diagnostic imaging equipment in the comparison between 2015 and 2020 (Table 3).

Table 4. Results of IACP indexes - Implantable Medical Devices | from 2015 to 2020 in index numbers (base December 2015 = 100)

	IACP - IMPLANTABLE MEDICAL DEVICES (FIRST DISAGGREGATION)	STENTS	KNEE PROSTHESES
2015	100.00	100.00	100.00
2016	180.50	173.90	182.33
2017	79.89	102.45	73.65
2018	70.80	62.46	73.12
2019	47.45	37.30	50.27
2020	64.11	29.01	73.84

Source: Web setorial Consultoria Econômica

In analyzing the evolution of nominal prices in public purchases of implantable medical devices, the prices of the two products that made up the sub-index of this group showed a strong increase in 2016 and a marked downward trend thereafter. The final result was a drop of 35.89% (100 - 64.11) in the prices of products in this group of products, even before discounting the inflation accumulated in the period (Table 4).

4.2. IACP index calculation result - GLOBAL

Table 5 describes the result of the global (nominal) index and the sub-indexes that composed it. It is noted that, due to the high value of transactions, even if sparse throughout the year, of imaging diagnostic equipment, they exert a strong influence (weight) given the high unit value of these equipment on the annual results of the global index.

Table 5. Results of the IACP-Global Index and its Sub-Indexes | from 2015 to 2020 in index numbers (base December 2015 = 100) and accumulated variations (%)

	IACP- GLOBAL	IACP - REAGENTS FOR IVD	IACP - DIAGNOSTIC IMAGING EQUIPMENT	IACP - IMPLANTABLE MEDICAL DEVICES
2015	100.00	100.00	100.00	100.00
2016	100.35	99.49	96.97	180.50
2017	101.85	102.60	102.64	79.89
2018	112.90	96.71	119.31	70.80
2019	133.58	124.53	139.99	47.45
2020	125.81	101.77	135.29	64.11
Accumulated variation from 2015 to 2020	+25.81%	+1.77%	+35.29%	-35.89%

Source: Web setorial Consultoria Econômica

4.3.Comparison of the results of the IACP - GLOBAL with the inflation indexes and with the exchange rate accumulated in the period

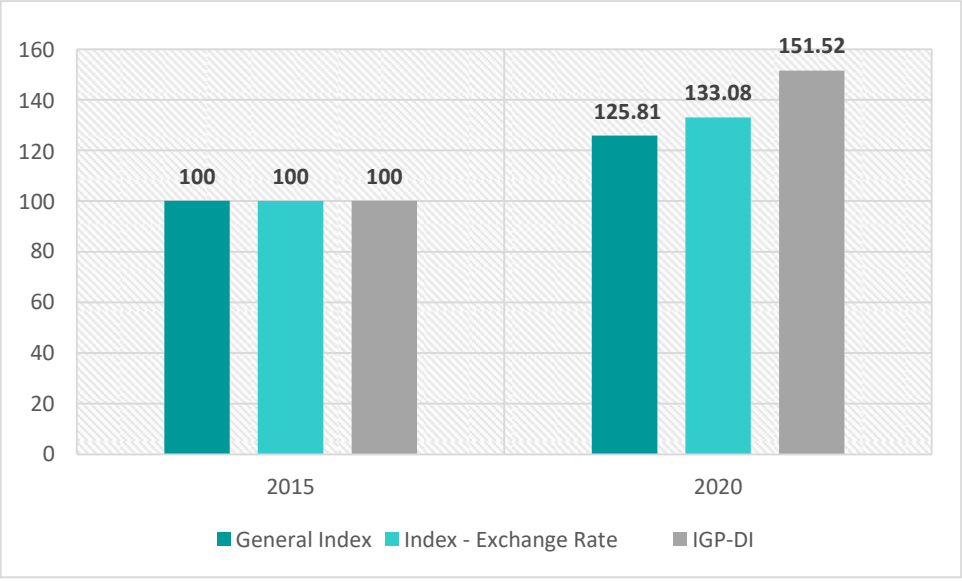
In the period considered from 2015 to 2020, the nominal prices of implantable medical devices represented in the IACP-GLOBAL increased by 25.8%, while the dollar increased by 33.08% and the IGP-M positively varied by 51.52% . Therefore, the global index did not follow the inflation of the period, much less the exchange rate variations, presenting a lag of 17.03% against the IGP-M and 7.37% against the US dollar (Table 6).

Table 6. IACP-GLOBAL comparison, exchange rate, inflation and deflated IACP-Global | from 2015 to 2020 in index numbers (base December 2015 = 100) and accumulated variations (%)

YEARS	IACP - GLOBAL (Nominal)	EXCHANGE RATE BRL/USD	EXCHANGE RATE INDEX BRL/USD	IGP-DI	IACP - GLOBAL deflated IGP-DI
2015	100.00	3.90	100.00	100	100.00
2016	100.35	3.26	83.46	107.18	93.63
2017	101.85	3.31	84.72	106.73	95.43
2018	112.90	3.87	99.23	114.31	98.77
2019	133.58	4.03	103.22	123.11	108.50
2020	125.81	5.20	133.08	151.52	83.03
Accumulated variation from 2015 to 2020	25.8%	33.1%	33.1%	51.5%	-17.0%

Source: Web setorial Consultoria Econômica

Graphic 1. IACP-GLOBAL comparison, exchange rate and inflation 2015 x 2020 | In index numbers (base December 2015 = 100)



Source: Web setorial Consultoria Econômica

5. Conclusions

The development of an index composed of seven medical devices considered as representative in the context of SUS purchases allowed us to conclude that, in the period from 2015 to 2020, the nominal prices of this basket of products appreciated by 25.8%, in view of an inflation accumulated in the period of 51.52%. It represented a lag in prices in 2020 compared to 2015 of 17.0%. The gaps of index products and indices in second disaggregation are also shown in table 7.

Table 7. Gaps or corrections in the prices charged for public purchases of medical devices, in the comparison 2020 with 2015, for the index corrected by the IGP-M | from 2015 to 2020 accumulated variations (%)

AGGREGATION	FIRST DISAGGREGATION	SECOND DISAGGREGATION	GAPS OR CORRECTIONS 2020 X 2015
Average price indexes for high-tech medical devices practiced in Brazilian bids			
IACP- GLOBAL (-17.0%)	IACP - Implantable Medical Devices (-57.7%)	Stents	*-80.9%*
		Knee Prostheses	*-51.3%*
	IACP - Diagnostic Imaging Equipment (-10.7%)	Ultrasound scanners	*9.3%*
		MRI	*-15.3%*
	IACP - Reagents for *In Vitro* Diagnostics (IVD) (-32.8%)	Vitamin D Test	*-45.6%*
		TSH Test	*-33.4%*
		HIV/SIDA Test	*-30.4%*

Source: Web setorial Consultoria Econômica