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PRICE VOLATILITY AND ELASTICITY MEASUREMENTS OF SOME FRUITS IN THREE SUPPLY CENTERS OF BRAZIL DURING THE PERIOD FROM 2017 AND 2021

Cindy Lee Cajachagua Pucuhuaranga
Universidad Nacional Autónoma Altoandina de Tarma (UNAAT),
Escola Superior de Agricultura "Luiz de Queiroz" da Universidade de São Paulo (ESALQ/USP)
cindy.desideratacp10@gmail.com

Risely Ferraz Almeida
Instituição: Escola Superior de Agricultura "Luiz de Queiroz" da Universidade de São Paulo (ESALQ/USP)
riselyferrazpecege@gmail.com

ABSTRACT

Fruits consumption has increased in recent years due to the predisposition of people to have a healthy diet, which includes the ingestion of fibers, vitamins and minerals present in Fruits. In Brazil, the five Fruits with highest consumption are: banana, oranges, apple, papaya, and watermelon. In this investigation we calculated the price volatility and the price elasticities measures (price elasticity of supply, price elasticity of demand or price inelasticity) of these five Fruits in three supply centers: CEAGESSP, CEASAMINAS, and CEASA/RJ and from 2017 to 2021. The results indicate that all the evaluated products had similar price volatility behavior or pattern from 2019 to 2021 in the three supply centers. Moreover, the year with higher instabilities of prices for banana, orange, apple, and watermelon were 2020. In addition, the result shows that price elasticity or inelasticity had independent behavior per supply center, however in this research we identified some periods of inelasticity where the price does not influence the quantity demanded or supplied of the evaluated product.
Keywords: Fruits; Price volatility; Elasticity of supply; Elasticity of demand; EIGEDIN.

RESUMO

O consumo de Frutas tem aumentado nos últimos anos devido à predisposição das pessoas a ter uma alimentação saudável, que inclui a ingestão de fibras, vitaminas e minerais presentes nas Frutas. No Brasil, as cinco Frutas com maior consumo são: banana, laranja, maçã, mamão, e melancia. Nesta investigação foram calculadas as medidas de volatilidade de preços e elasticidades de preços (elasticidade-preço da oferta, elasticidade-preço da demanda ou inelasticidade-preço) destas cinco frutas, em três centros de abastecimento: CEAGESSP, CEASAMINAS e CEASA/RJ e de 2017 a 2021. Os resultados indicam que todos os produtos avaliados tiveram um padrão ou comportamento semelhante de volatilidade de preços de 2019 a 2021 nos três centros de abastecimento. Além disso, os anos com maiores instabilidades de preços para banana, laranja, maçã, e melancia foi 2020. Ademais, o resultado mostra que a elasticidade ou inelasticidade do preço teve comportamento independente para cada centro de abastecimento, porém nesta pesquisa identificamos alguns períodos de inelasticidade onde o preço não influencia a quantidade demandada ou ofertada do produto avaliado.

Palavras-chave: Frutas; Volatilidade dos preços; Elasticidade da oferta; Elasticidade da demanda; EIGEDIN.

1 INTRODUCTION

Brazil is the 3rd largest fruit grower, this according to the data of the Food and Agricultural Organization (FAO) 2017 and 2015, respectively. Among the fruits with high production in Brazil are found: banana, orange, lemon, apple, papaya, mango, melon, grape, and watermelons (Camargo et al., 2015; NAN, 2020). However, its habitants, on average, do not consume the minimum daily amount of fruits and vegetables recommended by the World Healthy Organization (WHO), which is 400g or 6 to 7% of a total calories diaries of approximately 2300 Kcal (Claro et al., 2007; Nolasco et al., 2017).

The ingestion of fruits and vegetables are part of healthy eating patterns (Pessoa et al., 2015) that is why in the last decade, one of the priorities around the world is promote their consumption. According to different studies food demand depends on preferences or lack of access for socioeconomic or logistical reasons, being the last two the most recurrent in developing countries (Nolasco et al., 2017).

In this studied, we calculated the price volatilities and price elasticities of five Fruits (banana, oranges, apple, papaya, and watermelon) from the FV sector, and in three different supply centers: CEAGESSP, CEASAMINAS and CEASA/RJ, which are the top three of supply centers with greater commercialization of fruit in 2018 (CONAB, 2018).

This study has two hypotheses: (i) due to the price volatilities in the fruits sector during the year, there are a pattern for each product, and (ii) the price elasticities of demand or supply are highly variable depending on the product within the fruit sector. The aim of the present study is identifying the price volatility and elasticity measures for Fruits with the highest production in Brazil in the period between 2017 and 2021, providing information to companies of the Fruit Sector (FS).

2 LITERATURE REVIEW

The price volatility is the variation of commodity price changes around their mean value. At the present time, it is an ongoing concern because it may have a negative impact at the macroeconomic level on growth and poverty as reported by some economists. Thus, it is important to know the evolution of price volatility in order to develop different instruments and

design appropriate policies to transfer risk or at least to lessen the extent of world market price volatility (Huchet et al., 2011).

Additionally, in agribusiness, it is important to do a demand and supply analysis cause the results of this studies allows to make any significant business decisions regarding market performance and market activities (Vukadinović et al., 2017). The elasticity is one of those analyzes, and is an economic instrument that measure the rate at which quantities of a product respond to price changes; the percentage at which a one percent change in prices will cause a certain percentage change in quantities (Jacob, 2014; Vukadinović et al., 2017; Rosales; Mercado, 2020).

There are four different elasticities measurements: price elasticity of demand, income elasticity of demand, price elasticity of supply and cross price elasticity (Mankiw, 2001). The size of the price elasticities is important from a policy perspective, cause if the price elasticity is absolutely greater than one, any increase in the price will lead to a reduction in the quantity exported, so the governments have to stabilize the income of farmers with subsidies (Noel; Jones, 1988). In the same way, it is relevant in marketing to stablish the optimal price. In general, the purpose of elasticity is to understand the market's response to changes in prices (Tiago; Queiroz, 2011), and in this study we focused two measures: price elasticity of demand and price elasticity of supplied.

3 METHODOLOGICAL PROCEDURES

Data collecting characterization

We selected five fruits to be studied (banana, orange, apple, papaya and melon), A set of different databases were used depending of the variable studied in these ten products. To analysed the price volatility, we used the data from the ’Boletim Hortigranjeiro’, available on the website: https://www.conab.gov.br/info-agro/hortigranjeiros-prohort/boletim-hortigranjeiro, to obtain prices from years 2017, 2018 and 2019. Moreover, the CONAB (National Supply Company) database, available on the website: https://portaldeinformacoes.conab.gov.br/mapeamentos-agricolas.html, were used to get the prices of years 2020 and 2021. For all the calculus, the units for these prices were reais per kilograms (R$/Kg). All the prices were corrected by the index IPCA (Índice de Preços ao Consumidor Amplo), which measure the inflation of a set of products sold in retail, using the online calculator, available in: https://www.ibge.gov.br/estatisticas/economicas/precos-e-

custos/9256-indice-nacional-de-precos-ao-consumidor-amplo.html?=&t=calculadora-do-ipca.

To analyzed the price elasticities, we utilized the previous data and complement with information of the quantity sold. The quantity sold from years 2017, 2018 and 2019 were estimated by the bar graphs from the Boletim Hortigranjeiro and using the WebPlotDigitizer online tool, available at: https://apps.automeris.io/wpd/, while data from years 2020 and 2021 were download from the CONAB database. The calculus of quantities used the kilogram unit in all the cases.

Price volatility

Price volatility could be defined as price variability around a central value. So, it is the tendency of individual prices to vary from its mean value. Thus, volatility is often defined as high deviations from a global tendency (Huchet et al., 2011). In this study, we calculated the historical volatility, based on past prices of the last five years, using Coefficient of Variation (CV) **(Equation 1)**, which is described in the investigations of Huchet et al., 2011; Bellemare, 2014 and Traore and Diop, 2021.

$$\mathbf{CV} = \frac{Standard\ deviation}{Mean} = \frac{\sqrt{\frac{\sum_{i=1}^{n}(P_i - \bar{P})^2}{n}}}{\bar{P}} \quad \textbf{(Equation 1)}$$

where n indicates the number of prices to be analyzed, which are twelve (one per month), P_i is the value of each price and $\bar{P}$ is the annual mean price changes.

This measure was calculated per year from 2017 to 2021 and for each of the ten products selected previously. The areas studied include three distribution centers: CEAGESSP (Sao Paulo), CEASAMINAS (Belo Horizonte), and CEASA/RJ (Rio de Janeiro).

Elasticity measurements

In this research we calculated three measures: price elasticity of demand, price elasticity of supply and income elasticity of demand. To obtain these measures we used the same data than to calculate the price volatility plus data of the quantity sold. We evaluated the same ten foods selected.

Price elasticity of demand

The price elasticity of demand or the elasticity of demand measures the responsiveness of consumers to a change in price (Barkley, A. 2016). Sometimes price elasticities of demand are

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reported as negative numbers. It because the percentage change in quantity will always have the opposite sign as the percentage change in price. In the present study, we used the absolute value for dropping the minus sign and report the results as positive numbers when we are comparing price elasticities of demand of a specific product, but we maintain the negative sign when we are trying to differentiate the price elasticities of demand from the price elasticities of supply. Thus, the price elasticity of demand is mathematically defined as the percentage at which a one percent change in prices will cause a certain percentage change in quantities **(Equation 2)** (Mankiw, G. 2001; 2008).

$$\boldsymbol{e_d} = \left|\frac{\%\Delta Q_d}{\%\Delta P}\right| \quad \textbf{(Equation 2)}$$

where $\boldsymbol{e_d}$ is the price elasticity of demand or coefficient of demand, $\%\Delta Q_d$ is the percentage change in quantity demanded and $\%\Delta P$ is the percentage change in price. To facilitate the calculation of the price elasticity of demand we used the midpoint method **(Equation 3)** (Mankiw, G. 2008).

$$\boldsymbol{e_d} = \left|\frac{\frac{Q_2 - Q_1}{\left(\frac{Q_1 + Q_2}{2}\right)}}{\frac{P_2 - P_1}{\left(\frac{P_1 + P_2}{2}\right)}}\right| \quad \textbf{(Equation 3)}$$

where $\boldsymbol{e_d}$ is the price elasticity of demand, Q_1 is the quantity demanded at time 1, Q_2 is the quantity demanded at time 2, P_1 is the price at time1, and P_2 is the price at time 2 (Mankiw, G. 2008). We can interpret the $\boldsymbol{e_d}$ as follows: if the $\boldsymbol{e_d}$ is greater than one the demand is elastic, so the quantity demanded changes by a larger percentage than does price; if $\boldsymbol{e_d}$ is equal to 1, the demand is unitary elastic, so the percentage increase in quantity demanded is equal to percentage decrease in price; and if the $\boldsymbol{e_d}$ is less than 1, the demand is inelastic which means that quantity demanded is relatively insensitive to price (McConnell, C. 2003; Mankiw, G. 2008; Besanko and Braeutigam, 2010).

Price elasticity of supply

The price elasticity of supply measures how much the quantity supplied responds to changes in the price. It because sometimes producers of a good offer to sell more of it when the price of the good rises (Mankiw, G. 2008). Thus, economists compute the price elasticity of supply as the percentage change in the quantity supplied divided by the percentage change in the price

(Equation 4). In addition, the price elasticity of supply is never negative, since price and quantity supplied are directly related (McConnell, C. 2003).

$$e_s = \frac{\%\Delta Q_S}{\%\Delta P} \quad \textbf{(Equation 4)}$$

where e_s is the price elasticity of supply or coefficient of supply, $\%\Delta Q_s$ is the percentage change in quantity supplied and $\%\Delta P$ is the percentage change in price. In the same way that the price elasticity of demand, the price elasticity of supply can be calculated by the midpoint method **(Equation 5)** (Mankiw, G. 2008).

$$e_s = \frac{\frac{Q_2 - Q_1}{\left(\frac{Q_1 + Q_2}{2}\right)}}{\frac{P_2 - P_1}{\left(\frac{P_1 + P_2}{2}\right)}} \quad \textbf{(Equation 5)}$$

where e_s is the price elasticity of supply, Q_1 is the quantity supplied at time 1, Q_2 is the quantity supplied at time 2, P_1 is the price at time 1, and P_2 is the price at time 2 (Mankiw, G. 2008). The degree of price elasticity or inelasticity of supply is measure by the e_s. If the e_s is greater than one the supply is elastic, which means that producers are relatively responsive to price changes. If the e_s is equal to 1 the supply is unit elastic, which indicates that the quantity produced change in the same percentage that the price. On the other hand, if the e_s is less than 1, the supply is inelastic, so the producers are relatively insensitive to price changes (McConnell, C. 2003; Mankiw, G. 2008).

4 DISCUSSION AND DATA ANALYSIS

The results of price volatilities and price elasticities are analyzed per food. We showed the results in tables containing four statistic measures: standard deviation (SD), mean, maximum value (Max) and minimum value (Min) to have a context in data set (price volatilities and price elasticities calculated), per supply center (CEAGESSP, CEASAMINAS or CEASA/RJ) and from 2017 to 2021.

BANANA

General price analysis and price volatilities of banana

Analyzing the results, we concluded that the average prices suggest that banana, during these five years, tend to be cheaper in CEASAMINAS and more expensive in CEASA/RJ. In addition, the prices in the three supply centers have been increasing from 2018 to 2021 **(Figure 1A, Mean).** On the other hand, the prices ranged between 2.70 and 4.77 R$/Kg in CEAGESP, between 1.89 and 4.09 R$/Kg in CEASAMINAS and between 2.62 and 5.47 R$/Kg in CEASA/RJ **(Figure 1A, Min and Max).** Moreover, the SD data indicates that dispersion of prices are equal or higher 1.00 R$/Kg in 2020 and 2021 years between the three supply centers **(Figure 1A, SD).**

About price volatilities, these results were showed as Coefficients of Variation (CV) in a table. The higher values of price volatilities were found in 2020 (CV ≥ 0.4) and highlighted in green color while the lower values were presented in 2017 and 2021 years (CV ≤ 0.3) and highlighted in sky blue color **(Figure 1B).** Price volatilities data of the five studied years are displayed in a graph. Comparing data of the three supply centers, we concluded that the price volatility of banana has similar behavior from 2019 to 2021 in all the three locations although the prices are different **(Figure 1C).**

A.

Supply centers	Price variable	Years					Average
		2017	2018	2019	2020	2021	
CEAGESP	SD (R$/Kg)	0.58	0.73	0.96	1.98	1.00	1.05
	Mean (R$/Kg)	2.77	2.70	3.28	3.65	4.77	3.43
	Max (R$/Kg)	3.95	4.59	5.61	8.51	5.85	5.70
	Min (R$/Kg)	1.62	1.62	2.39	1.37	3.11	2.02
CEASAMINAS	SD (R$/Kg)	0.55	0.62	0.83	1.58	1.05	0.93
	Mean (R$/Kg)	2.02	1.89	2.49	2.88	4.09	2.67
	Max (R$/Kg)	3.20	3.50	4.67	7.26	5.84	4.89
	Min (R$/Kg)	1.08	0.99	1.67	0.95	2.25	1.39
CEASA/RJ	SD (R$/Kg)		0.92	0.91	1.62	1.05	1.13
	Mean (R$/Kg)		2.62	3.31	3.92	5.47	3.83
	Max (R$/Kg)		5.18	5.78	8.12	7.47	6.64
	Min (R$/Kg)		1.29	2.40	1.77	4.01	2.37

B.

Supply centers	Banana Price Volatility (CV) per year				
	2017	2018	2019	2020	2021
CEAGESP	0.21	0.27	0.29	0.54	0.21
CEASAMINAS	0.27	0.33	0.33	0.55	0.26
CEASA/RJ		0.35	0.28	0.41	0.19

C.

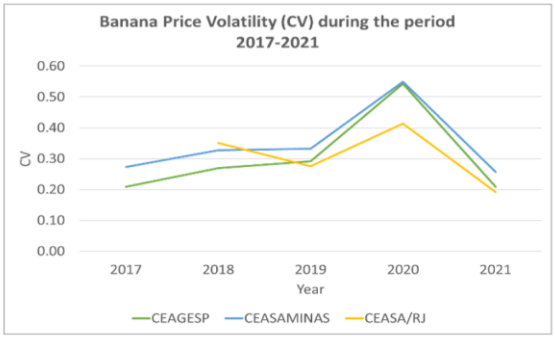

Figure 1. Statistic measures and price volatility from 2017 to 2021 regarding the banana. A. Calculation of SD, Mean and Maximum and Minimum values per supply center and from 2017 to 2021. **B.** Data showing price volatilities as CV in a table**. C.** Price volatilities were showed in a graph.

Price elasticities measurements of banana

Price elasticities measurements variables from 2017 to 2021 were presented in three separated tables, one per supply center. According to our analysis the price elasticities of banana have different behaviours in each supply center. In CEAGESP as we can see in the table, we have two squares in red color during March, April and May months which indicates the presence of price elasticity of demand (e_d), so in these months the demand depends on the banana p. Using

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the absolute values of the negative numbers, we can see three months where the e_d is higher than 1, so the quantity demanded by consumers was affected by the changes in prices. In addition, the price elasticity of supply (e_s) is present from September to October, indicating that the decision of the producers is being affected by the changes in price.

On the other hand, in the CEASAMINAS, the e_d (where $|e_d| \geq 1$) is present in the period from February to March, and from April to May. Furthermore, the e_s (where $e_s \geq 1$) is present from September to October.

In contrast, in the CEASA/RJ, the e_d (where $|e_d| \geq 1$) is present in four periods: from February to March, from April to May, from July to August and from October to November. Furthermore, the e_s (where $e_s \geq 1$) is present in three periods: from March to April, from June to July and from September to October.

Comparing the three supply centers, is common that e_s was present in the period from September to October. Additionally, evaluating the SD of all the three tables we deduced that we have three periods of high stability (with low values of SD and presence of price inelasticity), which are: from May to June, from August to September and from November to December **(Figure 2).**

Price elasticity of supply | Price elasticity of demand | Price inelasticity of supply or demand | SD≥1

Banana Price Elasticity in CEAGESP (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	1.22	-0.20	1.99	-1.66
FEB-MAR	2.47	-0.78	3.35	-4.07
MAR-APR	3.27	-1.12	1.69	-7.43
APR-MAY	2.18	-1.66	0.23	-5.38
MAY-JUN	0.23	0.37	0.64	0.08
JUN-JUL	0.59	0.34	1.32	-0.21
JUL-AUG	0.91	-0.65	0.49	-2.24
AUG-SEP	0.28	0.35	0.78	0.02
SEP-OCT	4.41	2.22	10.94	-0.90
OCT-NOV	0.21	0.16	0.57	-0.05
NOV-DEC	0.53	-0.46	0.01	-1.48

Banana Price Elasticity in CEASAMINAS (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	3.46	1.82	8.71	-0.19
FEB-MAR	3.88	-2.84	-0.01	-10.53
MAR-APR	1.63	0.99	4.23	0.00
APR-MAY	2.37	-1.39	0.36	-6.01
MAY-JUN	0.32	0.13	0.74	-0.25
JUN-JUL	0.29	0.02	0.52	-0.25
JUL-AUG	1.31	0.46	3.02	-0.63
AUG-SEP	0.38	-0.19	0.20	-0.85
SEP-OCT	4.50	3.74	11.97	-0.50
OCT-NOV	0.50	-0.09	0.29	-1.04
NOV-DEC	0.13	-0.14	0.02	-0.30

Banana Price Elasticity in CEASA/RJ (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	3.99	-0.43	4.43	-6.51
FEB-MAR	4.05	-3.50	0.34	-9.87
MAR-APR	7.40	4.32	17.12	-0.37
APR-MAY	2.11	-1.22	0.78	-4.75
MAY-JUN	0.62	0.46	1.44	-0.15
JUN-JUL	0.64	1.05	1.84	0.08
JUL-AUG	241.68	-139.00	1.36	-557.60
AUG-SEP	0.03	-0.05	-0.02	-0.08
SEP-OCT	8.22	4.83	19.06	-0.25
OCT-NOV	3.39	-2.05	0.03	-7.92
NOV-DEC	0.21	-0.26	0.05	-0.50

Figure 2. Banana price elasticities from 2017 to 2021. Tables showing four statistic measures of all the banana price elasticities data: standard deviation (SD), mean, maximum value (Max) and minimum value (Min). Values of $\mathbf{e_d}$ are in red color, values of $\mathbf{e_s}$ are in green color, values of price inelasticity are in white color and valued with SD ≥ 1 are in light green color.

ORANGE

General price analysis and price volatilities of orange

Analyzing the results, we concluded that the average prices suggest that orange, during these five years, tend to be cheaper in CEASAMINAS and more expensive in CEAGESP. Moreover, the prices in the three supply centers have been increasing from 2017 to 2021 **(Figure 3A, Mean).** On the other hand, the prices ranged between 2.17 and 4.03 R$/Kg in CEAGESP, between 1.64 and 3.44 R$/Kg in CEASAMINAS and between 1.84 and 3.51 R$/Kg in CEASA/RJ **(Figure 3A, Min and Max).** Moreover, the SD data indicates that the year 2020 had the higher dispersion of prices in the three supply centers with values equal or higher 1.00 R$/Kg. In addition, comparing the SD of the three supply centers, the lower values of SD in CEASA/RJ denoted that it is the more stable supply center respect to prices **(Figure 3A, SD).** About the orange price volatilities, these results were showed as Coefficients of Variation (CV) in a table. The higher values of price volatilities were found in 2020 (CV ≥ 0.4) and highlighted

in green color while the lower values were presented in 2021 (CV ≤ 0.3) and highlighted in sky blue color. So, of the five years evaluated, 2020 was the year with higher instability and 2021 the more stable year for the orange market **(Figure 3B).** Price volatilities data of the five studied years are displayed in a graph. Comparing data of the three supply centers, we concluded that the price volatility of orange has similar behavior from 2019 to 2021 **(Figure 3C).**

A.

Supply centers	Price variable	Years					Average
		2017	2018	2019	2020	2021	
CEAGESP	SD (R$/Kg)	0.61	0.63	0.96	1.41	0.98	0.92
	Mean (R$/Kg)	2.17	2.32	2.35	2.53	4.03	2.68
	Max (R$/Kg)	3.31	3.98	4.27	5.73	6.21	4.70
	Min (R$/Kg)	1.45	1.45	1.18	0.96	2.76	1.56
CEASAMINAS	SD (R$/Kg)	0.48	0.56	0.73	1.00	0.91	0.73
	Mean (R$/Kg)	1.64	1.83	1.90	2.16	3.44	2.19
	Max (R$/Kg)	2.45	3.41	3.24	4.29	5.31	3.74
	Min (R$/Kg)	0.82	1.15	1.07	0.82	2.31	1.23
CEASA/RJ	SD (R$/Kg)		0.51	0.49	1.03	0.56	0.65
	Mean (R$/Kg)		1.84	1.91	2.33	3.51	2.40
	Max (R$/Kg)		3.21	3.10	4.53	4.57	3.85
	Min (R$/Kg)		1.13	1.32	1.05	2.50	1.50

B.

Supply centers	Orange Price Volatility (CV) per year				
	2017	2018	2019	2020	2021
CEAGESP	0.28	0.27	0.41	0.56	0.24
CEASAMINAS	0.29	0.30	0.39	0.46	0.26
CEASA/RJ		0.28	0.26	0.44	0.16

C.

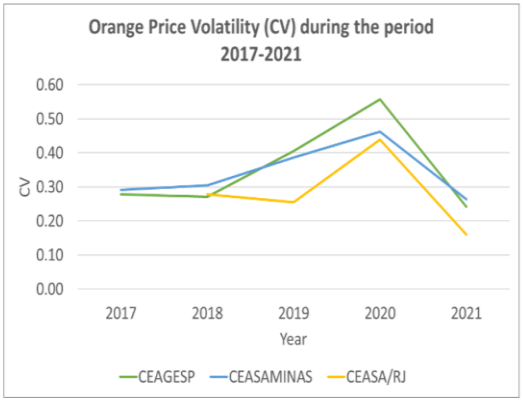

Figure 3. Statistic measures and price volatility from 2017 to 2021 regarding the orange. A. Calculation of SD, Mean and Maximum and Minimum values per supply center and from 2017 to 2021. **B.** Data showing price volatilities as CV in a table**. C.** Price volatilities were showed in a graph.

Price elasticities measurements of orange

Price elasticities measurements variables from 2017 to 2021 were presented in three separated tables, one per supply center. According to our analysis the price elasticities of orange have different behaviours in each supply center. In CEAGESP as we can see in the table, we have two squares in red color during two periods: from July to August and from September to October indicating the presence of price elasticity of demand (e_d), so there was more demand of orange during this period. Using the absolute values of the negative numbers, we can see two periods where the e_d is higher than 1, so the quantity demanded by consumers was affected by the changes in prices.

In reference to the price elasticity of supply (e_s), CEAGESP did not present period of e_s.

On the other hand, in the CEASAMINAS, the e_d (where $|e_d| \geq 1$) is present in two periods, from January to March, and from August to September. Furthermore, the e_s (where $e_s \geq 1$) is present from September to October.

In contrast, in the CEASA/RJ, the e_d (where $|e_d| \geq 1$) is present in one period: from January to

February. Moreover, the e_s (where $e_s \geq 1$) is present in three months: February, March and April. Comparing the three supply centers there were not common characteristics respect to e_d and e_s. Additionally, evaluating the SD of all the three tables we deduced that we have on period of high stability (with low values of SD and presence of price inelasticity), in the three supply centers: from May to June **(Figure 4).**

Price elasticity of supply
Price elasticity of demand
Price inelasticity of supply or demand
SD≥1

Orange Price Elasticity in CEAGESP (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	2.57	0.94	6.06	-0.58
FEB-MAR	1.59	-0.57	1.13	-2.65
MAR-APR	0.69	-0.06	0.67	-1.03
APR-MAY	2.92	0.91	6.37	-2.36
MAY-JUN	0.13	0.08	0.23	-0.07
JUN-JUL	1.08	0.99	2.93	0.10
JUL-AUG	2.97	-1.01	2.00	-6.71
AUG-SEP	0.21	0.22	0.54	-0.04
SEP-OCT	3.12	-1.75	0.13	-7.98
OCT-NOV	0.36	-0.37	-0.03	-1.01
NOV-DEC	0.29	0.10	0.65	-0.13

Orange Price Elasticity in CEASAMINAS (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	1.37	-1.56	-0.47	-3.74
FEB-MAR	2.28	-1.08	2.93	-3.28
MAR-APR	0.56	0.16	0.73	-0.85
APR-MAY	1.12	-0.54	0.57	-2.69
MAY-JUN	0.25	-0.02	0.27	-0.36
JUN-JUL	1.29	0.83	3.23	-0.39
JUL-AUG	2.27	-0.40	2.95	-4.07
AUG-SEP	5.26	-2.79	0.28	-13.28
SEP-OCT	5.11	3.06	13.27	0.14
OCT-NOV	1.47	0.15	2.49	-2.01
NOV-DEC	0.24	0.15	0.50	-0.21

Orange Price Elasticity in CEASA/RJ (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	15.52	-12.81	-0.86	-39.45
FEB-MAR	52.17	29.18	119.52	-2.33
MAR-APR	2.35	1.56	5.55	-0.43
APR-MAY	1.57	-0.90	0.14	-3.61
MAY-JUN	0.34	0.14	0.49	-0.24
JUN-JUL	0.78	0.19	1.25	-0.92
JUL-AUG	1.41	0.88	3.17	-0.36
AUG-SEP	0.56	-0.20	0.28	-1.11
SEP-OCT	3.64	-0.41	4.54	-5.58
OCT-NOV	0.40	-0.34	0.05	-0.91
NOV-DEC	1.25	-0.01	1.36	-1.67

Figure 4. Orange price elasticities from 2017 to 2021. Tables showing four statistic measures of all the orange price elasticities data: standard deviation (SD), mean, maximum value (Max) and minimum value (Min). Values of e_d are in red color, values of e_s are in green color, values of price inelasticity are in white color and valued with SD ≥ 1 are in light green color.

APPLE

Price volatilities of apple

Analyzing the results, we concluded that the average prices suggest that apple, during these five

years, tend to be cheaper in CEASAMINAS and more expensive in CEAGESP. Moreover, the prices in the three supply centers have been increasing from 2017 to 2021 **(Figure 5A, Mean).** On the other hand, the prices ranged between 5.42 and 9.18 R$/Kg in CEAGESP, between 3.42 and 7.13 R$/Kg in CEASAMINAS and between 5.50 and 8.81 R$/Kg in CEASA/RJ **(Figure 5A, Min and Max).** Moreover, the SD data indicates that the year 2020 had the higher dispersion of prices in the three supply centers with values around 4.00 ± 0.2 R$/Kg, while the SD in the other years were maximum 2.08 R$/Kg. In addition, comparing the SD of the three supply centers, the lower values of SD were in CEASAMINAS denoted that it is the more stable supply center respect to the apple prices **(Figure 5A, SD).**

About the apple price volatilities, these results were showed as Coefficients of Variation (CV) in a table. The higher values of price volatilities were found in 2020 (CV ≥ 0.5) and highlighted in green color while the lower values were presented in 2021 (CV ≤ 0.25) and highlighted in sky blue color. So, of the five evaluated years, 2020 was the year with higher instability and 2021 the more stable year for the apple market. In addition, with exception of 2020 year all the CVs are around 0.26 ± 0.2 R$/Kg **(Figure 5B).** Price volatilities data of the five studied years are displayed in a graph. Comparing data of the three supply centers, we concluded that the price volatility of apple has similar behavior from 2018 to 2021 **(Figure 5C).**

A.

Supply centers	Price variable	Years					Average
		2017	2018	2019	2020	2021	
CEAGESP	SD (R$/Kg)	1.30	1.79	1.80	4.10	1.67	2.13
	Mean (R$/Kg)	5.42	6.44	6.76	8.25	9.18	7.21
	Max (R$/Kg)	7.70	11.19	10.43	17.40	11.14	11.57
	Min (R$/Kg)	4.31	4.31	4.49	2.97	5.62	4.34
CEASAMINAS	SD (R$/Kg)	1.01	1.02	1.48	3.88	1.37	1.75
	Mean (R$/Kg)	3.42	3.70	4.70	6.72	7.13	5.13
	Max (R$/Kg)	5.34	6.40	7.70	16.22	9.24	8.98
	Min (R$/Kg)	1.78	2.45	3.01	2.29	4.10	2.72
CEASA/RJ	SD (R$/Kg)		1.48	1.60	4.10	2.08	2.32
	Mean (R$/Kg)		5.50	5.56	7.67	8.81	6.89
	Max (R$/Kg)		9.36	9.40	16.59	13.27	12.15
	Min (R$/Kg)		3.69	3.62	2.84	5.16	3.83

B.

Supply centers	Apple Price Volatility (CV) per year				
	2017	2018	2019	2020	2021
CEAGESP	0.24	0.28	0.27	0.50	0.18
CEASAMINAS	0.30	0.27	0.32	0.58	0.19
CEASA/RJ		0.27	0.29	0.53	0.24

C.

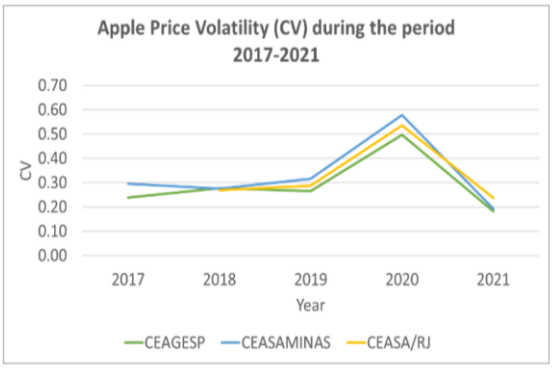

Figure 5. Statistic measures and price volatility from 2017 to 2021 regarding the apple. A. Calculation of SD, Mean and Maximum and Minimum values per supply center and from 2017 to 2021. **B.** Data showing price volatilities as CV in a table**. C.** Price volatilities were showed in a graph.

Price elasticities measurements of apple

Price elasticities measurements variables from 2017 to 2021 were presented in three separated

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tables, one per supply center. According to our analysis the price elasticities of apple have different behaviours in each supply center.

In CEAGESP as we can see in the table, we have one squares in green color so there is price elasticity of supply (e_s) from September to October and during this time there is a tendency of increase or decrease the supply of fruit by producers depending to the price in the market. On the other hand, in the CEASAMINAS there was one period of price elasticity of demand (e_d), from July to August, so there was more demand of apple during this period if the price decrease. In contrast, in the CEASA/RJ, the e_d (where $|e_d| \geq 1$) is present in one period: from April to May. Moreover, the e_s (where $e_s \geq 1$) is present in three periods: from January to February, from June to August and from October to August.

Comparing the three supply centers there were not common characteristics respect to e_d and e_s. Additionally, evaluating the SD of all the three tables we deduced that we have two periods of high stability (with low values of SD and presence of price inelasticity), in the three supply centers: from March to April and from August to September **(Figure 6).**

Price elasticity of supply | Price elasticity of demand | Price inelasticity of supply or demand | SD≥1

Apple Price Elasticity in CEAGESP (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	3.13	-0.36	2.27	-6.37
FEB-MAR	0.79	-0.14	1.25	-0.76
MAR-APR	0.54	-0.01	0.95	-0.67
APR-MAY	1.04	-0.45	0.89	-2.22
MAY-JUN	0.57	0.41	1.34	-0.23
JUN-JUL	0.39	0.52	1.02	-0.10
JUL-AUG	1.37	-0.71	0.98	-2.68
AUG-SEP	0.28	-0.03	0.39	-0.33
SEP-OCT	6.17	5.02	14.93	0.12
OCT-NOV	0.43	-0.24	0.27	-0.96
NOV-DEC	0.39	-0.14	0.60	-0.43

Apple Price Elasticity in CEASAMINAS (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	2.55	-0.27	2.19	-5.09
FEB-MAR	1.49	0.02	2.99	-0.92
MAR-APR	0.19	0.23	0.50	-0.07
APR-MAY	0.62	-0.14	0.39	-1.36
MAY-JUN	0.66	0.38	1.46	-0.28
JUN-JUL	0.28	-0.07	0.45	-0.38
JUL-AUG	10.70	-6.57	-0.31	-27.94
AUG-SEP	0.46	0.04	0.48	-0.82
SEP-OCT	1.66	-0.69	0.77	-3.90
OCT-NOV	1.12	0.34	2.25	-1.14
NOV-DEC	0.29	-0.07	0.22	-0.64

Apple Price Elasticity in CEASA/RJ (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	2.15	1.83	4.92	-1.15
FEB-MAR	1.31	-0.22	2.05	-1.05
MAR-APR	0.24	0.88	1.17	0.56
APR-MAY	1.48	-1.29	0.16	-3.43
MAY-JUN	1.42	0.73	3.05	-0.66
JUN-JUL	11.98	8.08	28.74	0.15
JUL-AUG	11.92	6.49	27.11	-1.20
AUG-SEP	0.49	-0.63	-0.17	-1.45
SEP-OCT	1.29	-0.12	2.05	-1.23
OCT-NOV	15.09	8.03	34.17	-1.00
NOV-DEC	1.54	0.27	2.01	-1.74

Figure 6. Apple price elasticities from 2017 to 2021. Tables showing four statistic measures of all the orange price elasticities data: standard deviation (SD), mean, maximum value (Max) and minimum value (Min). Values of $\mathbf{e_d}$ are in red color, values of $\mathbf{e_s}$ are in green color, values of price inelasticity are in white color and valued with SD ≥ 1 are in light green color.

PAPAYA

Price volatilities of papaya

Analyzing the results, we concluded that the average prices suggest that papaya, during these five years, tend to be cheaper in CEASAMINAS and more expensive in CEAGESP. Furthermore, the prices in the three supply centers have been increasing from 2017 to 2021 **(Figure 7A, Mean).** On the other hand, the prices ranged between 2.71 and 5.01 R$/Kg in

CEAGESP, between 1.71 and 4.55 R$/Kg in CEASAMINAS and between 3.07 and 4.77 R$/Kg in CEASA/RJ **(Figure 7A, Min and Max).** Moreover, the SD data indicates that from 2019 to 2021 the dispersion of prices are higher than 1.00 R$/Kg in the three supply centers. In addition, comparing the SD of the three supply centers, the higher values of SD were in CEASA/RJ denoted that it is the more instable supply center respect to the papaya prices **(Figure 7A, SD).** About the papaya price volatilities, these results were showed as Coefficients of Variation (CV) in a table. The higher values of price volatilities were found in 2020 (CV $\geq$ 0.4) and highlighted in green color while the lower values were presented in 2017 (CV $\leq$ 0.25) and highlighted in sky blue color. So, of the five evaluated years, 2020 was the year with higher instability and 2017 the more stable year for the papaya market. In addition, 2018, 2019 and 2021 years have CVs around 0.35 ± 0.05 R$/Kg **(Figure 7B).** Price volatilities data of the five studied years are displayed in a graph. Comparing data of the three supply centers, we concluded that the price volatility of papaya has similar behavior from 2018 to 2021 **(Figure 7C).**

A.

Supply centers	Price variable	Years					Average
		2017	2018	2019	2020	2021	
CEAGESP	SD (R$/Kg)	0.49	1.23	1.80	1.54	1.61	1.33
	Mean (R$/Kg)	2.71	3.79	4.65	3.28	5.01	3.89
	Max (R$/Kg)	3.54	6.83	8.52	6.52	7.34	6.55
	Min (R$/Kg)	2.01	2.01	2.01	1.14	2.90	2.02
CEASAMINAS	SD (R$/Kg)	0.35	0.80	1.17	1.40	1.79	1.10
	Mean (R$/Kg)	1.71	2.34	3.02	2.58	4.55	2.84
	Max (R$/Kg)	2.17	4.05	6.00	5.89	7.45	5.11
	Min (R$/Kg)	0.95	1.23	1.75	0.82	2.40	1.43
CEASA/RJ	SD (R$/Kg)		1.05	1.33	2.50	1.22	1.52
	Mean (R$/Kg)		3.07	3.55	3.95	4.77	3.84
	Max (R$/Kg)		5.67	7.14	8.96	6.84	7.15
	Min (R$/Kg)		1.69	2.01	1.14	3.22	2.01

B.

Supply centers	Papaya Price Volatility (CV) per year				
	2017	2018	2019	2020	2021
CEAGESP	0.18	0.32	0.39	0.47	0.32
CEASAMINAS	0.21	0.34	0.39	0.54	0.39
CEASA/RJ		0.34	0.38	0.63	0.26

C.

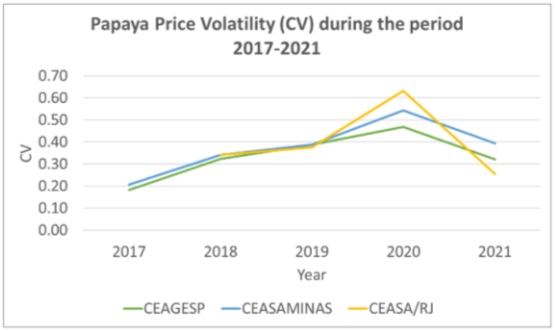

Figure 7. Statistic measures and price volatility from 2017 to 2021 regarding the papaya. A. Calculation of SD, Mean and Maximum and Minimum values per supply center and from 2017 to 2021. **B.** Data showing price volatilities as CV in a table**. C.** Price volatilities were showed in a graph.

Price elasticities measurements of papaya

Price elasticities measurements variables from 2017 to 2021 were presented in three separated tables, one per supply center. According to our analysis the price elasticities of papaya have different behaviours in each supply center. However, there is no presence of price elasticities of supply (e_s) just price elasticity of demand (e_d), during the five studied years. It indicates that there is more likely that the quantity demanded by consumers will be affected by the changes in prices than the quantity supply be affected by the changes in price in papaya market.

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In CEAGESP as we can see in the table, we have five squares in red color which comprise four periods: from January to February, from March to April, from May to June and from July to August. It implies the presence of e_d (where $|e_d| \geq 1$).

On the other hand, in the CEASAMINAS there was three months with presence of e_d (where $|e_d| \geq 1$) which are: September, October and November.

In contrast, in the CEASA/RJ, the e_d (where $|e_d| \geq 1$) is present in three squares involving two period: from April to June and from August to September.

Comparing the three supply centers there were not common characteristics respect to e_d and e_s. Additionally, evaluating the SD of all the three tables we deduced that we have two periods of high stability (with low values of SD and presence of price inelasticity), in the three supply centers: from February to March and from November to December **(Figure 8).**

Price elasticity of supply | Price elasticity of demand | Price inelasticity of supply or demand | SD≥1

Papaya Price Elasticity in CEAGESP (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	3.02	-2.17	-0.10	-8.12
FEB-MAR	0.82	0.01	1.62	-0.57
MAR-APR	1.99	-1.14	0.24	-5.07
APR-MAY	0.51	-0.08	0.68	-0.91
MAY-JUN	3.84	-1.60	0.53	-9.27
JUN-JUL	0.25	-0.08	0.34	-0.43
JUL-AUG	10.50	-5.29	0.97	-26.26
AUG-SEP	2.94	-1.38	0.71	-7.19
SEP-OCT	3.99	-0.62	5.19	-7.35
OCT-NOV	0.75	0.14	1.57	-0.56
NOV-DEC	0.75	-0.94	-0.34	-2.39

Papaya Price Elasticity in CEASAMINAS (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	0.53	-0.11	0.74	-0.84
FEB-MAR	0.30	0.09	0.56	-0.26
MAR-APR	0.83	0.50	1.53	-0.39
APR-MAY	0.97	-0.69	-0.08	-2.62
MAY-JUN	0.56	-0.17	0.35	-1.21
JUN-JUL	0.12	-0.33	-0.14	-0.46
JUL-AUG	1.35	0.48	3.12	-0.64
AUG-SEP	0.59	-0.60	0.01	-1.65
SEP-OCT	2.41	-1.89	-0.15	-6.61
OCT-NOV	2.18	-1.02	0.42	-5.36
NOV-DEC	0.35	0.05	0.49	-0.46

Papaya Price Elasticity in CEASA/RJ (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	0.36	-0.99	-0.45	-1.39
FEB-MAR	0.16	-0.68	-0.54	-0.93
MAR-APR	0.57	-0.03	0.67	-0.65
APR-MAY	1.43	-1.16	0.73	-3.14
MAY-JUN	76.99	-44.03	0.84	-177.39
JUN-JUL	0.40	-0.18	0.17	-0.86
JUL-AUG	1.79	0.79	3.74	-1.07
AUG-SEP	3.55	-2.66	0.26	-8.73
SEP-OCT	1.24	-0.47	1.65	-1.51
OCT-NOV	0.97	0.67	1.79	-0.39
NOV-DEC	0.22	0.34	0.48	-0.03

Figure 8. Papaya price elasticities from 2017 to 2021. Tables showing four statistic measures of all the orange price elasticities data: standard deviation (SD), mean, maximum value (Max) and minimum value (Min). Values of $\mathbf{e_d}$ are in red color, values of $\mathbf{e_s}$ are in green color, values of price inelasticity are in white color and valued with SD ≥ 1 are in light green color.

WATERMELON

Price volatilities of watermelon

Analyzing the results, we concluded that the average prices suggest that watermelon, during these five years, tend to be cheaper in CEASAMINAS and more expensive in CEASA/RJ. Furthermore, the prices in the three supply centers have been increasing from 2019 to 2021 **(Figure 9A, Mean).** On the other hand, the prices ranged between 1.80 and 2.38 R$/Kg in CEAGESP, between 1.06 and 2.81 R$/Kg in CEASAMINAS and between 2.10 and 3.43 R$/Kg

in CEASA/RJ **(Figure 9B, Min and Max).** Moreover, the SD data indicates that during the five years the dispersion of prices were lower than 0.90 R$/Kg in the three supply centers. In addition, comparing the SD of the three supply centers, the lower values of SD were in CEASAMINAS since 2017 to 2019, then in 2020 and 2021, the lower SD were in CEAGESP. Therefore, from 2017 to 2019 the more stable market was CEASAMINAS and from 2020 and 2021 the more stable supply was CEAGESP **(Figure 9A, SD).**

About the watermelon price volatilities, these results were showed as Coefficients of Variation (CV) in a table. The higher values of price volatilities were found in 2020 (CV ≥ 0.35) and highlighted in green color while the lower values were presented in 2017 and 2021 (CV ≤ 0.30) and highlighted in sky blue color. So, of the five evaluated years, 2020 was the year with higher instability and 2017 and 2021 the more stable years for the watermelon market **(Figure 9B).** Price volatilities data of the five studied years are displayed in a graph. Comparing data of the three supply centers, we concluded that the price volatility of papaya has similar behavior from 2018 to 2021 **(Figure 9C).**

A.

Supply centers	Price variable	Years					Average
		2017	2018	2019	2020	2021	
CEAGESP	SD (R$/Kg)	0.39	0.66	0.45	0.65	0.42	0.51
	Mean (R$/Kg)	1.80	2.05	1.85	1.57	2.38	1.93
	Max (R$/Kg)	2.30	3.82	2.90	2.99	2.99	3.00
	Min (R$/Kg)	1.33	1.33	1.16	0.60	1.42	1.17
CEASAMINAS	SD (R$/Kg)	0.24	0.39	0.44	0.86	0.77	0.54
	Mean (R$/Kg)	1.06	1.17	1.40	1.67	2.81	1.62
	Max (R$/Kg)	1.44	2.12	2.41	3.73	4.78	2.90
	Min (R$/Kg)	0.55	0.69	0.92	0.58	1.69	0.89
CEASA/RJ	SD (R$/Kg)		0.81	0.53	0.89	0.60	0.71
	Mean (R$/Kg)		2.10	2.18	2.39	3.43	2.52
	Max (R$/Kg)		4.43	3.23	3.90	4.41	3.99
	Min (R$/Kg)		1.34	1.44	0.94	2.36	1.52

B.

Supply centers	Watermelon Price Volatility (CV) per year				
	2017	2018	2019	2020	2021
CEAGESP	0.22	0.32	0.24	0.41	0.18
CEASAMINAS	0.22	0.33	0.32	0.52	0.27
CEASA/RJ		0.39	0.24	0.37	0.17

C.

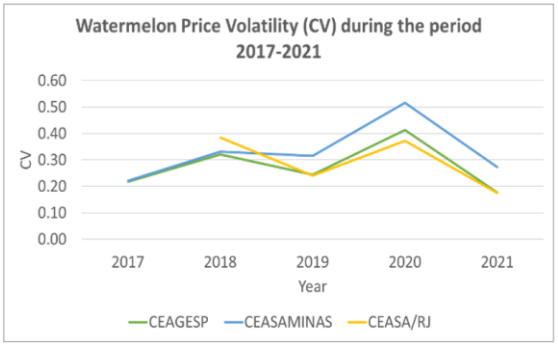

Figure 9. Statistic measures and price volatility from 2017 to 2021 regarding the watermelon. A. Calculation of SD, Mean and Maximum and Minimum values per supply center and from 2017 to 2021. **B.** Data showing price volatilities as CV in a table**. C.** Price volatilities were showed in a graph.

Price elasticities measurements of watermelon

Price elasticities measurements variables from 2017 to 2021 were presented in three separated tables, one per supply center. According to our analysis the price elasticities of watermelon have different behaviours in each supply center.

In CEAGESP as we can see in the table, we have one squares in red color so there is price

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elasticity of demand (e_d, where $|e_d| \geq 1$) from August to September during this time it is very likely that consumers make their decision based on price. Furthermore, we have four squares in green color so there is price elasticity of supply (e_s, where $e_s \geq 1$) in four periods: from February to March, from July to August, from September to October and from November to December. In these periods the producers could have made decisions regarding the price of watermelons in the market.

On the other hand, in the CEASAMINAS there was also one period of e_d (where $|e_d| \geq 1$), from July to August, so there was more demand of watermelon when the price decrease. Additionally, the e_s (where $e_s \geq 1$) were present in three periods: from February to March, from April to May and from August to September.

In contrast, in the CEASA/RJ, the e_d (where $|e_d| \geq 1$) is present in three squares involving three periods: from January to February, from April to May and from August to September. Moreover, the e_s (where $e_s \geq 1$) were present in four squares comprising three periods: from February to April, from July to August and October to November.

Comparing the three supply centers, is common that e_s was present in the period from February to March. Additionally, evaluating the SD of all the three tables we deduced that we had three months with high stability (with low values of SD and presence of price inelasticity), in the three supply centers: May, June and July **(Figure 10).**

Price elasticity of supply | Price elasticity of demand | Price inelasticity of supply or demand | SD≥1

Watermelon Price Elasticity in CEAGESP (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	0.94	-0.70	0.56	-1.87
FEB-MAR	21.98	13.10	56.47	-1.26
MAR-APR	1.09	-0.54	0.87	-2.06
APR-MAY	1.55	0.23	1.94	-2.41
MAY-JUN	0.47	0.67	1.13	0.04
JUN-JUL	0.29	0.03	0.48	-0.33
JUL-AUG	14.75	5.93	35.34	-3.56
AUG-SEP	6.26	-1.88	3.06	-14.15
SEP-OCT	5.74	1.09	11.46	-6.19
OCT-NOV	0.72	0.49	1.44	-0.32
NOV-DEC	1.61	1.20	3.80	-1.06

Watermelon Price Elasticity in CEASAMINAS (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	1.24	0.61	2.45	-0.64
FEB-MAR	6.30	2.80	15.10	-2.16
MAR-APR	2.27	0.18	3.08	-3.86
APR-MAY	10.55	6.05	27.00	-1.07
MAY-JUN	0.27	0.14	0.45	-0.20
JUN-JUL	0.41	-0.15	0.56	-0.66
JUL-AUG	18.79	-8.97	1.04	-46.55
AUG-SEP	5.72	2.86	10.03	-5.91
SEP-OCT	1.95	0.80	3.93	-2.19
OCT-NOV	0.88	0.32	1.70	-0.62
NOV-DEC	0.55	0.24	1.07	-0.38

Watermelon Price Elasticity in CEASA/RJ (2017-2021)				
Month	SD	Mean	Max	Min
JAN-FEB	2.18	-2.07	-0.48	-5.81
FEB-MAR	6.33	2.82	13.71	-1.81
MAR-APR	9.70	6.00	22.79	0.04
APR-MAY	14.47	-10.72	0.12	-31.16
MAY-JUN	0.36	0.19	0.45	-0.32
JUN-JUL	1.20	-0.07	1.92	-1.11
JUL-AUG	2.31	2.03	5.98	0.24
AUG-SEP	2.76	-1.93	0.67	-6.55
SEP-OCT	0.97	0.08	0.70	-1.60
OCT-NOV	2.96	1.73	6.82	-0.44
NOV-DEC	1.65	0.58	2.17	-2.18

Figure 10. Watermelon price elasticities from 2017 to 2021. Tables showing four statistic measures of all the orange price elasticities data: standard deviation (SD), mean, maximum value (Max) and minimum value (Min). Values of $\mathbf{e_d}$ are in red color, values of $\mathbf{e_s}$ are in green color, values of price inelasticity are in white color and valued with SD ≥ 1 are in light green color.

5 CONCLUSIONS

During the five evaluated years, the five fruits (banana, orange, apple, papaya, and watermelon) were cheaper in CEASAMINAS. On the other hand, the orange, apple, and papaya were more expensive in CEAGESP. Moreover, the banana and watermelon were more expensive in CEASA/RJ.

About the price volatility, all the evaluated products had similar behavior from 2019 to 2021 in the three supply centers. In addition, comparing the CVs of the three supply centers, in the same year, we conclude that banana, apple, and papaya had similar price volatilities with differences ≤ 0.10, and orange, and watermelon with differences ≤ 0.15. Furthermore, the years with higher stabilities of prices were 2021 for orange and both 2017 and 2021 for banana, papaya, and watermelon. Moreover, the years with higher instabilities of prices were 2020 for

banana, orange, apple, and watermelon.

About the price elasticity or inelasticity, we concluded that all the evaluated market had independent behavior per supply center. Additionally, evaluating the means and SD results we suggest some periods where is likely to found price inelasticity (periods where the price does not influence the quantity demanded or supplied of the product). In banana, the periods were from May to June, from August to September and from November to December. In orange, from May to June. In apple, from March to April and from August to September. In papaya, from February to March and from November to December, and in watermelon, from May to June and from June to July.

REFERENCES

BARKLEY, A. 2016. The Economics of Food and Agricultural Markets. Kansas State University Libraries. New Prairie Press. NPP eBooks. ISBN-13: 978-1-944548-05-6.

BELLEMARE, M. 2014. Rising food prices, food price volatility, and Social unrest. Amer. J. Agr. Econ. 1-21.

BESANKO, D.; BRAEUTIGAM, R. 2010. Microeconomics. Fourth Edition. ISBN 978-0-470-56358-8.

CLARO, R. M.; CARMO, H.; MACHADO, F.; MONTEIRO, C. 2007. Renda, preço dos alimentos e participação de frutas e hortaliças na dieta. Revista de Saúde Pública 41: 557-564.

CAMARGO, W.; CAMARGO, F. 2017. A quick review of the production and commercialization of the main vegetables in Brazil and the world from 1970 to 2015. Horticultura Brasileira 35: 160-166.

CONAB. 2018. Centrais de Abastecimento: Comercialização Total de Frutas e Hortaliças. Companhia Nacional de Abastecimento. Brasília. ISSN: 2595-2838.
Food and Agricultural Organization (FAO). 2015. Availble in https://www.fao.org/home/en

HUCHET, M. 2011. Agricultural Commodity Price Volatility: An Overview. OECD Food, Agriculture and Fisheries Working Papers.

JACOB W. 2014. Price Impacts of Increased Peruvian Table Grape Supply. Department Agricultural Economics. Open Access Theses. Purdue University, 442.

KALKUHL, M.; BRAUN, J.; TORERO, M. 2016. Food Price Volatility and Its Implications for Food Security and Policy. Springer Open.
Netherlands Agricultural Network (NAN). 2020. Brazilian Fruit Production Opportunities for Business and Investments.

NOEL, D. U.; JONES, J. D. 1988. The price elasticity of export demand for US agricultural commodities reconsidered. Agricultural Systems 28: 273-297.

NOLASCO, C.L.; SOLER, L.S.; FREITAS, M.W..; LAHSEN, M.; OMETTO, J.P. 2017. Scenarios of Vegetable Demand vs. Production in Brazil: The Links between Nutritional Security and Small Farming. Land 6: 49.

MANKIW, G. 2001. Principles of Microeconomics, 2nd edition, Chapter 5. Discuss factors that determine demand and supply elasticity.

MCCONNELL, C.; BRUE, S.; BARBIERO, B. 2003. Microeconomics, The McGraw−Hill Companies. Ninth Canadian Edition.

PESSOA, M.; LOURES, L.; TEIXEIRA, W.; CARVALHO, M.; VELÁSQUEZ, G. 2015. Availability of food stores and consumption of fruit, legumes and vegetables in a Brazilian urban area Nutrición Hospitalaria, 31: 1438-1443.

ROSALES, G.; MERCADO, W. 2020. Efecto de los cambios en el precio de los alimentos sobre el consumo de la quinua y la seguridad alimentaria rural en el Perú. Scientia Agropecuaria 11: 83-93.

TIAGO, L.; QUEIROZ, A. 2011. A elasticidade-preço da demanda e a elasticidade-preço da oferta nas *commodities* agrícolas milho e soja no brasil. Revista de Economia 7: 48-65.

TRAORE, F; DIOP, I. 2021. Measuring Food Price Volatility. AGRODEP.
United States Department of Agriculture (USDA). 2017. U.S. Agricultural Export Opportunities in Brazil.

VUKADINOVIĆ, P.; DAMNJANOVIĆ, A.; KRSTIĆ-RANĐIĆ, J. 2017. The analysis of indiference and the price elasticity of demand between different categories of agricultural products. Economics of Agriculture 64: 671-685.