Behaviour of market volumes and prices of root crops: The case of Trinidad and Tobago

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Root crops are important staples in Trinidad and Tobago shown by the total traded volume of 60 million (mn) kilograms (kgs) during the period 2006-2015. Sweet potato was found to be the most traded with an average volume of 1.6 mn kgs, this was followed by carrots and dasheen with respective volumes of 1.4 mn kg and 1mn kg. However, fluctuations have been observed in the main wholesale market and as a result prices were unstable which could have negatively impacted consumers and producers. Therefore, this study seeks to analyse the behaviour of root crop market volumes and prices. Specifically, carrots, cassava, yam, dasheen, eddoes, sweet potato and ginger. Monthly volume and price data for both local and imported root crops were collected from the National Agricultural Marketing and Development Corporation (NAMDEVCO). Linear growth rates were calculated using trend analysis of the ten root crops while the coefficient of variation along with the minimum and maximum prices assessed price spreads. The highest growth rate in the price was found in ginger (0.158) and the lowest in sweet potatoes (0.015). However in case of volumes, the highest growth rate (993.14) was seen in the arrival of sweet potatoes, while a negative growth (-153.38) was noticed in cassava. Besides, seasonality index was worked out using moving average decomposition method and lagged prices were tested to identify any relation with current prices. The results of this study could be used to guide policy decisions and production planning towards market stabilization.

Key words: market prices, market volumes, root crops, lagged prices, trend analysis, seasonality index.

Introduction

The Northern Wholesale Market (NWM) is the main market where fresh fruits and vegetables

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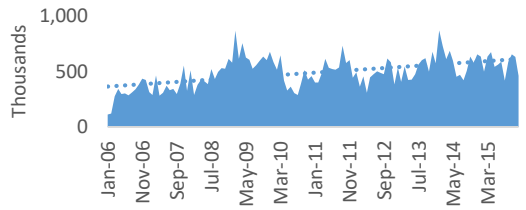
are traded (NWM, 2016). Data accumulated by the National Agricultural Marketing and Development Corporation showed that the total traded volume of root crops was 60 million (mn) kilograms (kgs) during the period 2006-2015 (NWM,2016). This represented approximately 30% (2006-2015avg) of total market volumes, and therefore showing the importance of root crops to Trinidad and Tobago (Fig 1). Root crop volumes increased from 114,000kgs in January 2006 to 463,000kgs in December 2015.

Figure 1: Traded root crops at the NWM 2006-2016



In the year 2015, 6.9mn kgs were traded with local sweet potatoes being the most traded with a market share of 31.4% followed by carrots (16.5%) and imported dasheen (16%).

There were fluctuations in the volume of root crops traded which could have influenced variations in their respective prices. It was observed that local sweet potato prices on average increased by TTD$3.54/kg from 2006-2015, while carrot and imported dasheen prices had positive movements of TTD$2.33/kg and TTD$3.09/kg respectively. It should be noted the ginger prices increased by TTD19.35/kg, which was a 146% increase over a 9years.

Market prices are influenced by macroeconomic and microeconomic factors along with the supply of their volumes (D. Childs, 2013). Therefore price and volume behaviour can have significant impact on each other. In addition, previous prices have an effect on future prices and therefore could influence volumes (RLEV, 2016). As a result of this relationship consumer and producer welfare can be affected due to the volatility of a market (S. Garcia-German etal, 2013).

Therefore, this study seeks to analyse the behaviour of root crop market volumes and prices. Specifically, carrots, cassava, yam, dasheen (local and imported), eddoes (local and imported), sweet potato (local and imported) and ginger.

Methodology

Monthly Wholesale prices and volumes for the period 2006-2015 of all the root crops traded were collected from the NAMDEVCO database (NWM, 2016). NAMDEVCO collects this information at the start of each trading day, (Monday to Friday) and builds a monthly database using the daily mode of prices and total daily volumes. The root crops traded in the market are carrots, cassava, yam, dasheen, eddoes, sweet potato and ginger. It should be noted that only cassava had no imports, and carrots are not produced locally. The Statistical Programme for Social Science (SPSS) and Microsoft Excel where used for the following analysis.

Time Series Regression

Linear growth rates were calculated using trend analysis of the ten root crops. This was estimated using time series regression for each of the ten root crops for 120 months from 2006-2015. The regression provided the coefficient of the relationship between time and traded volumes along with their prices.

The regression model is denoted below:

$$Y_{t=1,2,3,....n} = a + \beta X_{t=1,2,3,....n}$$

Where;

Y = traded volumes or price

a= constant

β= coefficient of relationship

X= time in months

Growth Rate

The growth rate is the ratio between the coefficient of the time series relationship and the respective mean values. The growth rate provided the study the ability to identify the top performers in traded volumes and also the change in prices during the period.

$$GR\% = \frac{\beta}{\bar{y}} * 100$$

Where;

GR = Growth Rate

β = coefficient of relationship

$\bar{y}$ = mean price or volume

Price and Volume Spreads

The maximum, minimum and average root crop prices along with volumes were extrapolated from the NAMDEVCO database to assess price and volume spreads. Price spreads would show the gain producer surplus during the period and indicate the economics of production. Volume analysis would provide the average quantity supplied and the gaps between market lows and highs.

Furthermore, the coefficient of variation (CV) which is the ratio of the standard deviation of the time series regression and its mean values. The CV shows the statistical dispersion of volumes and prices during the study period to assess the degree of difference between the means. A greater variation would indicate a more volatile market in terms of volumes since the market would have inconsistent supply which could influence market prices. The formula follows:

$$CV = \frac{SD}{\bar{y}} * 100$$

Where;

SD = standard deviation of price or volume

$\bar{y}$ = mean price or volume

Seasonality

Using Microsoft excel the moving average decomposition method was used to assess the seasonality index. The seasonal index are calculated such that there average is one (1) and the sum of their averages are equal to the total period. In this study seasonal indices were calculated over a twelve (12) month period. Therefore providing some justification for volume and price behaviour. Initially, the monthly index which is the ratio of the monthly values for price/ volume and the twelve (12) Month Double Centred Moving Average was found.

$$MIV = \frac{V}{DCMA}$$

Where;

MIV = Monthly Index Value

V = Volume or Price

DCMA = 12 Month Double Centered Moving Average

Then the index was the adjusted by finding the Average Index (AI) of the months from January to December:

$$AI_{n=9} = (\sum MIV_{M=1,2\ldots,12})/n_m$$

Where;

M= month

n =year

The Average Annual Index (AAI) was calculated using:

$$AAI_{n=12} = (\sum AI_{M=1,2\ldots n})/n$$

Using the values of the AAI and the AI and adjusted Index (I) was found by calculating the ratio of AI for each month and the AAI for the period.

$$I_{n=12} = (AI_{m=1,2\ldots.n})/ AAI$$

The results of the AAI will indicate that during the months where the values are greater than one (1) supply would be above average and below average when values are less than one (1).

The Seasonality percentage (S) was then found using the formula (Sharma, 2011) denoted below:

$$S_i = [(I_h - I_l)/I_l]* 100$$

Where;

I_h = highest value of seasonal index

I_l = lowest value of seasonal index

i = root crop

Therefore stakeholders would be able to forecast when prices along with volumes will be higher or lower.

Price Volume Relationship

Sharma (2011) showed that current volumes along with the lagged price of a tomato influenced their current market price. Therefore, the model used in that study was applied to assess if this relationship existed in the case of root crops prices in the NWM. The model used a linear regression with to independent variables (lagged price and current volume) and is shown below:

$$P_t = f(P_{t-1}, Y_t)$$

Where;

P_t = current price

P_{t-1} = lagged price

Y_t = current volumes of selected root crops

Results and Discussion

Trends in volumes and prices of root crops.

The market volumes and prices of ten root crops in Trinidad and Tobago were identified for trend analysis and the trend values are presented in Table 1 below: This study used the volumes and prices for ten root crops traded in the NWM. The time series analysis revealed significant relationships in most of the root crop volumes and prices. Those that showed no significance with time were; carrot volumes (p-value = 0.730), local dasheen volumes (p-value = 0.835), and imported sweet potato volumes (p-value = 0.323).

In terms of the root crop volumes, locally produced sweet potatoes had the highest coefficient in market volumes of β=993, which meant there was a linear increase of 933kg/ month. This was followed by dasheen (β=643)

and eddoes (β=510) which were both imported. In addition, the relationship between time and root crop prices there were small movements. The greatest linear movement were observed for ginger TT$0.158/kg (β=0.158), then local eddoes (β=0.0683) and local dasheen (β=0.0626).

In the Growth rate analysis the highest linear rate for volumes was for imported dasheen (1.02%), whereas the lowest (-1.21958%) was local eddoes. In the case of prices the common yam had the highest growth rate in prices of (0.87867%) and the lowest (0.16365%) was shown in cassava.

Table 1: Trends in volumes and prices of root crops traded at the NWM

Name of crops	Trend for	Constant	Co- efficient	t	Sig	R^2	Linear growth rate
Carrots	volumes	123362	-33.478	-0.346	0.730	0.001	-0.02759
		6753.837	96.878				
	prices	**7.321**	**0.0133**	**3.079**	**0.003**	**0.0743**	**0.16365**
		0.302	0.004				
Cassava	**volumes**	**60914**	**-153.38**	**-3.413**	**0.001**	**0.0899**	**-0.29705**
		3132.704	44.936				
	prices	**3.3556**	**0.032**	**8.161**	**0.000**	**0.3608**	**0.60482**
		0.273	0.004				
Common yam	**volumes**	**8789.6**	**-42.165**	**-3.563**	**0.001**	**0.0971**	**-0.67587**
		825.027	11.834				
	prices	**2.8029**	**0.0524**	**15.621**	**0.000**	**0.674**	**0.87687**
		0.234	0.003				
Dasheen local	volumes	21010	-8.131	-0.208	0.835	0.0004	-0.03963
		2722.055	39.046				
	prices	**5.5426**	**0.0626**	**8.562**	**0.000**	**0.3832**	**0.67075**
		0.510	0.007				
Dasheen imported	**volume**	**24013**	**643**	**8.629**	**0.000**	**0.3869**	**1.0220**
		5195.086	74.519				
	prices	**7.0121**	**0.0268**	**3.582**	**0.000**	**0.0981**	**0.7276**
		0.521	0.007				
Eddoes local	**volumes**	**15099**	**-109.1**	**-4.866**	**0.000**	**0.1671**	**-1.21958**
		1562.912	22.419				
	prices	**6.331**	**0.0683**	**5.769**	**0.000**	**0.22**	**0.6529**
		0.825	0.012				
Eddoes imported	**volume**	**20393**	**510.55**	**7.517**	**0.000**	**0.3238**	**0.99558**
		4735.185	67.922				
	prices	**9.8955**	**0.0348**	**5.769**	**0.000**	**0.0972**	**0.28991**
		0.682	0.010				
Sweet potato local	**volume**	**45323**	**993.14**	**9.592**	**0.000**	**0.4381**	**0.94218**
		7218.214	103.539				
	prices	**5.3546**	**0.0237**	**3.492**	**0.001**	**0.0937**	**0.27118**
		0.473	0.007				
Sweet potato imported	volume	27109	44.834	0.993	0.323	0.0083	0.150339
		3147.002	45.141				
	prices	**7.8292**	**0.015**	**2.070**	**0.041**	**0.035**	**0.17163**
		0.507	0.007				
Ginger	**volume**	**18576**	**235.52**	**6.454**	**0.000**	**0.2609**	**0.71749**
		2544.077	36.492				
	prices	**11.268**	**0.158**	**5.125**	**0.000**	**0.1821**	**0.75859**
		2.149	0.031				

Price and volume spreads

The market volumes and price behavior for root crops during the period 2006-2015 was done using statistical analysis such as minimum values, maximum values, averages and CV (Table 2). The study showed that the highest CV in prices was for ginger (61.84) with an average price of TT$20.82/kg. During the period ginger price had a maximum of TT$70.79/kg and a minimum of TT$8.29/kg which was followed by local eddoes with an average price of TT$10.46 which had a maximum of TT$31.00/kg and a minimum of TT$4.00/kg during the study period.

However, local eddoes showed the highest CV in terms of volumes (109.2) with an average volume of 8545kgs and its maximum volume was 55,534kgs. Common yam followed with an average volume of 6000kgs and its maximum volume of 27000kgs.

Table 2: Measures of variation in prices and volumes of root crops traded at the NWM

	Volumes				Prices			
Name of Commodity	Min	Max	Mean/ Average	CV	Min	Max	Mean/ Average	CV
Carrots	31116.96	240340	123874.5	30.18	5.45	12.57	8.126917	20.91
Cassava	14949.32	121606.2	52537.78	34.47	3.27	9.99	5.290833	35.01
Common Yam	72	27608.04	6099.266	75.44	2.96	13.16	5.975833	37.18
Dasheen(Local)	162.72	70224.57	21960.53	71.92	4.55	17.57	9.332819	37.72
Dasheen(Imported)	2709	172443.2	66813.77	57.16	4.42	17.64	8.631083	34.44
Eddoes (Local)	0	55534.01	8545.445	109.22	4.24	31.02	10.461	48.40
Eddoes (Imported)	2393.28	147691.1	53863.56	60.86	5.97	22.81	12.00383	32.39
Sweet Potatoes (Local)	13752	222546.7	110850	49.52	2.375	15.57	6.787333	39.65
Sweet Potatoes (Imported)	2655	94796.9	30153.59	57.44	4.11	16.86	8.739667	32.00
Ginger	1228.35	92904.35	33933.61	48.86	8.29	70.79	20.82813	61.84

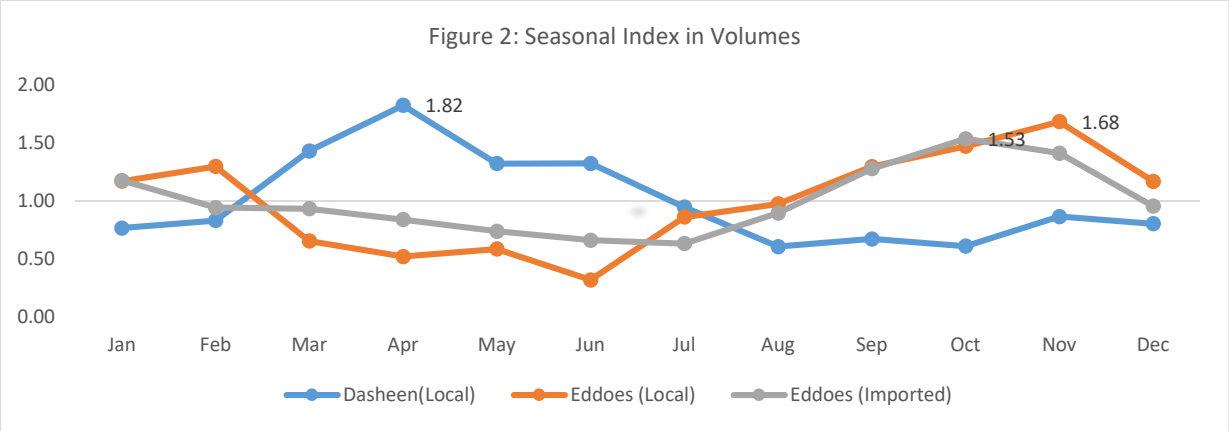
Seasonality in volumes and prices of root crops

There were fluctuation in all the root crops traded in the NWM. The seasonal index of price was the highest for ginger in July (1.45) while imported eddoes was the lowest (0.70) in November. In terms of volumes local eddoes had an index of 1.68 (November) which was the highest and ginger's index was the lowest in July (0.58). Observation of the seasonality percentage in volumes showed that locally produced dasheen, eddoes and imported eddoes were the highest with 82.16%, 68.14% and 54.51% respectively (Table A1 & A2). However, in the case of prices the study found that local eddoes (60.58), ginger (44.93) and imported eddoes (38.67) had the highest seasonality.

Given that seasonality could indicate volatility identification of the months were the greatest fluctuations occurred would be beneficial for stakeholders.

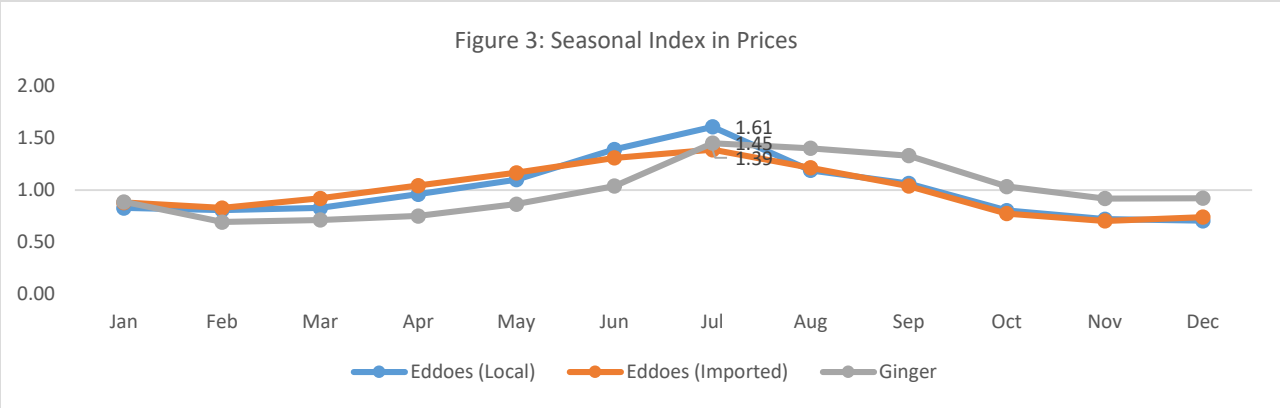
Volumes

Local dasheen index showed to fall below average during the months August to January while both local and imported eddoes index were above average during the same period (Fig 2). Dasheen index reached a maximum of 82% above its average in April, while in November local eddoes peaked at 68% above average and imported eddoes (53%) in October.



Prices

Ginger's index was above average from July to September, while eddoes (imported and local) during the months May to September. In Figure 3, commodities peaked in July with local eddoes reaching 61% higher than average followed by ginger (45%) and imported eddoes (39%).



Relationship between root crop prices and traded volumes

Prices of the ten root crops where lagged by one month along with the current volume to assess they influenced the present price (Table 4). The results of the regression showed that lag prices were significant in explaining the current price of the commodity. However, volume was found not to influence the current prices of local dasheen, local sweet potatoes and imported sweet potatoes.

The relationship between price and volume were inverse with the exception of imported dasheen (β=0.836, p-value<1%) and local eddoes (β=0.684, p-value<1%). Imported dasheen lag price also showed an inverse relationship with current price with its coefficient value of -1.03E-05. Therefore as the lagged price increases the current price would decrease. All the other root crops which were significant had positive coefficients with Cassava's lag price having the greatest influence on current price (β=0.965, p-value<1%). This meant that for every TT$1 increase in the lagged price current price would increase by 96 cents.

It should be noted that all the linear relationships with the exception of carrots had R^2 values greater than 50% which meant that more than

50% of the current prices were explained by the current volume and the lagged price.

Conclusion

The study found that local sweet potatoes had the greatest increase in volumes of 933kg. However, imported dasheen had the largest growth rate of 1.02%. In terms of root crop prices ginger prices experienced the largest growth of TT$0.158/kg but common yam's growth rate was the highest of 0.88%. The CV showed that ginger with an average price of TT$20.82/kg had a variation of 61.84 which was meant that ginger price was the most unstable. This was supported the difference between its maximum (TT$70.79) and its minimum price of TT$8.29. Local eddoes had the highest CV with an average volume of 8,545kgs.

The volumes of root crops traded at the NWM experienced seasonal fluctuations with locally produced dasheen, eddoes and imported eddoes having the highest seasonal percentage. It should be noted that local eddoes price spiked in July reaching 60% above average, along with ginger (45%) and imported eddoes (39%).

Lagged prices and current volumes were shown to influence current prices with volume mainly having an inverse relationship. However, imported dasheen and local eddoes had positive coefficients. Lagged prices also showed to positively influence current prices with cassava's lagged price having the largest coefficient (0.965).

The results of the study highlights the behavior of price and volume over time for root crops in the NWM and provides the relationship between past current prices. Policy makers, producers and tradesmen can use this analysis to better guide their decisions to improve their welfare.

Table 4: Relationship between prices and traded volumes of root crops in the NWM

		Coefficients				
name of commodity	constant	lag price	p-value	volume	p-value	R^2
Carrots	6.144	0.418	0.000	-1.153E-005	0.003	0.074
Cassava	0.464	0.965	0.000	-5.08E-06	0.003	0.977
Common Yam	1.075	0.888	0.000	-5.58E-06	0.003	0.846
Dasheen(local)	1.177	0.909	0.000	-1.363E-005	0.142	0.864
Dasheen(Imported)	2.088	-1.03E-05	0.013	0.836	0	0.723
Eddoes (Local)	4.217	0	0.003	0.684	0	0.55
Eddoes (Imported)	4.910	0.743	0.000	-3.492E-005	0.000	0.660
Sweet Potatoes (Local)	1.749	0.812	0.000	-4.51E-06	0.11	0.668
Sweet Potatoes (Imported)	2.615	0.773	0.000	-2.095E-005	0.025	0.639
Ginger	8.021	0.847	0.000	0	0	0.771

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Appendix

Table A1: Seasonal Indices of volumes and prices of root crops traded at the NWM

	kg	TT$	kg	TT$	kg	TT$	kg	TT$	kg	TT$
ROOT CROPS	Carrots	Carrots	Cassava	Cassava	Common Yam	Common Yam	Dasheen (Local)	Dasheen(Local)	Dasheen (Imported)	Dasheen(Imported)
Jan	1.01	0.95	0.88	1.03	1.38	0.92	0.77	1.08	1.36	1.02
Feb	0.85	1.01	0.94	1.01	1.22	0.84	0.83	0.97	1.04	0.87
Mar	1.01	1.01	1.12	0.98	1.41	0.88	1.43	0.89	1.10	0.84
Apr	0.93	1.05	1.06	0.99	1.55	0.91	1.82	0.87	0.87	0.91
May	0.95	1.03	0.96	0.99	1.47	0.87	1.32	0.90	0.78	1.09
Jun	0.97	0.92	1.04	1.00	1.26	0.91	1.32	0.96	0.75	1.05
Jul	1.05	1.01	1.07	1.01	0.86	1.02	0.95	1.01	0.82	1.16
Aug	0.98	1.13	1.00	0.99	0.40	1.02	0.61	1.00	0.85	1.12
Sep	0.94	1.12	1.08	0.98	0.18	1.16	0.67	1.08	0.99	1.10
Oct	1.10	0.94	0.92	1.00	0.36	1.30	0.61	1.08	1.18	0.97
Nov	1.16	0.88	0.99	1.02	0.68	1.16	0.87	1.13	1.16	0.97
Dec	1.04	0.95	0.94	1.01	1.24	1.02	0.80	1.04	1.11	0.92
Seasonality %	15.86	13.11	12.04	3.30	54.51	29.77	82.16	12.81	36.34	15.64

Table A2: Seasonal Indices of volumes and prices of root crops traded at the NWM

	kg	TT$	kg	TT$	kg	TT$	kg	TT$	kg	TT$
ROOT CROPS	Eddoes (Local)	Eddoes (Local)	Eddoes (Imported)	Eddoes (Imported)	Sweet Potatoes (Local)	Sweet Potatoes (Local)	Sweet Potatoes (Imported)	Sweet Potatoes (Imported)	Ginger	Ginger
Jan	1.17	0.83	1.18	0.88	1.07	0.93	0.97	0.96	1.34	0.89
Feb	1.30	0.81	0.94	0.83	0.93	0.91	1.01	0.91	1.08	0.69
Mar	0.66	0.83	0.93	0.92	0.98	1.01	1.24	0.96	1.16	0.71
Apr	0.52	0.96	0.84	1.04	0.92	1.06	1.29	0.99	0.93	0.75
May	0.59	1.10	0.74	1.17	0.95	1.10	1.05	1.12	0.77	0.86
Jun	0.32	1.39	0.66	1.31	0.96	1.10	1.05	0.96	0.79	1.04
Jul	0.86	1.61	0.63	1.39	1.05	1.14	0.86	1.09	0.58	1.45
Aug	0.97	1.19	0.90	1.21	0.94	1.13	0.93	1.09	0.72	1.40
Sep	1.29	1.06	1.28	1.04	1.09	0.94	0.90	1.10	0.90	1.33
Oct	1.47	0.80	1.53	0.77	1.04	0.88	0.87	0.98	1.17	1.03
Nov	1.68	0.72	1.41	0.70	1.08	0.91	0.91	0.94	1.38	0.92
Dec	1.17	0.71	0.96	0.74	0.99	0.90	0.92	0.91	1.19	0.92
Seasonality %	68.14	60.58	53.34	38.67	9.10	14.00	28.58	11.64	37.78	44.93