Fluctuations in Food Prices with Evidence from Communities in Kwara State, Nigeria

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Abstract- ***The price of commodities have been unstable. This study seeks to study the price fluctuation of food items in Nigeria with a focus on ten markets within the communities in Kwara State, Nigeria. The food items used in this study are rice, beans, garri and maize. Ten markets were accessed namely, Owode market, Offa; Ojo-Oba, Offa; Kara market, Ajase; Ipata market, Ilorin; Oja-Oba, Ilorin; Yoruba road market, Ilorin; Mandate market, Ilorin; Oja-Oba, Omu-Aran; Oja Tuntun market, Ilorin and Ganmo market, Ilorin to collect data on selected food items between years 2015 and 2022. Laspeyres, Paasches, Edgeworth/Marshall and Fisher's ideal price indexes were used to investigate the price changes. With the base year as 2015, there is a 229.51 percent increase in prices of the selected food commodities using the four price models. No decrease in price of food commodities was observed. The causes for fluctuation in food in prices should be determined to stabilize food prices and prevent food insecurity.***

Indexed Terms- Prices, Food, Changes, Index

I. INTRODUCTION

Food is anything that provide nutrients to the human body. Nutrients provide energy for activity, growth, breathing, digestion and keeping warm. Materials for growth and repair of the body and to boost the immune system is provide by nutrients from food. Food has an impact on mental health. We need food to live and so what we eat matters. The World food Day 2022 with the theme leave no one behind finds us with an ongoing pandemic, conflicts, climate warming, rising prices and international tensions affecting global food security. There is an urgent need to build a sustainable world where everyone everywhere has regular access to enough nutritious food. No one should be left behind (FAO, 2022).

The dramatic change in the prices of food items within our local communities have become a major concern. Yet, the Sustainable Development Goal 2 seeks sustainable solutions to end hunger in all its forms by 2030 and to achieve food security. The aim is to ensure that everyone everywhere has enough good-quality food to lead a healthy life. Achieving this Goal will require better access to food and the widespread promotion of sustainable agriculture. This entails improving the productivity and incomes of small-scale farmers by promoting equal access to land, technology and markets, sustainable food production systems and resilient agricultural practices. It also requires increased investments through international cooperation to bolster the productive capacity of agriculture in developing countries.

The value of money does not remain constant over time. It rises or falls and is inversely related to the changes in the price level. A rise in the price level means a fall in the value of money and a fall in the price level means a rise in the value of money. Thus, changes in the value of money are reflected by the changes in the general level of prices over a period of time. Changes in the general level of prices can be measured by a statistical device known as 'index number.' Index number is a technique of measuring changes in a variable or group of variables with respect to time, geographical location, or other characteristics. There can be various types of index numbers, but, in the present context, we are concerned with price index numbers, which measures changes in the general price level (or in the value of money) over a period.

Phoebe, Skye, Tracy, Ashleigh and Clare (2020) described a-priori diet quality indices used in children and adolescents, appraised the validity and reliability of these indices, and synthesised evidence on the relationship between diet quality and physical and mental health, and growth-related outcomes. Five electronic databases were searched until January 2019. An a-priori diet quality index was included if it applied a scoring structure to rate child or adolescent (aged 0–18-years) dietary intakes relative to dietary or nutrient guidelines. Diagnostic accuracy studies and prospective cohort studies reporting health outcomes were appraised using the Academy of Nutrition and Dietetics Quality Criteria Checklist. From the 15,577 records screened, 128 unique paediatric diet quality indices were identified from 33 countries. Half of the indices' scores rated both food and nutrient intakes ($n = 65$ indices). Some indices were age specific: infant (< 24-months; $n = 8$ indices), child (2–12-years; $n = 16$), adolescent (13–18 years; $n = 8$), and child/adolescent ($n = 14$). Thirty-seven indices evaluated for validity and/or reliability. Eleven of the 15 indices which investigated associations with prospective health outcomes reported significant results, such as improved IQ, quality of life, blood pressure, body composition, and prevalence of metabolic syndrome. Research utilising diet quality indices in paediatric populations is rapidly expanding internationally. However, few indices were evaluated for validity, reliability, or association with health outcomes.

In affluent societies people are constantly surrounded by food and problems associated with excess energy intake are increasing. Adult obesity is becoming a more serious problem than undernutrition even in many developing countries (WHO, 1998). It is tempting to believe that the availability of food or experience of hunger are not widely experienced serious problems in affluent societies (Feichtinger,1997), especially because thinness is more common among those with high socioeconomic status and an inverse relationship between body weight and socioeconomic status is often found (Sobal & Stunkard, 1989) .

Index numbers are used to aggregate detailed information on prices and quantities into scalar measures of price and quantity levels or their growth. Jeff Ralph, Rob O'Neill, Joe Winton (1995) described some areas of Index Numbers which are the subject of research activity. They considered how the inclusion of Big Data sources, such as scanner data, might influence the construction of indices. They examined how to construct indices for different populations and the use of chaining and the measurement of prices of difficult to measure goods in indices.

Jacek (2014) present and discussed several methods of the construction of confidence intervals for the Laspeyres price index. Heassumes that prices of commodities are normally distributed and considered both independent and dependent prices. Using Monte Carlo simulation, the paper compared the confidence interval computed from a simple econometric model with those obtained based on the Laspeyres density function. The conclusions can be generalized to other price index formulas.

Hedonic methods are currently considered state-of-the-art for handling quality changes when compiling consumer price indices. Mick and Saeed (2007) proposed first a mathematical description of characteristics and of elementary aggregates. In a following step, a hedonic econometric model was formulated, and hedonic elementary population indices defined. These indices extend from simple indices based on some average quality to universal formulae that incorporate the full quality spectrum of the respective elementary aggregate. The authors emphasised that population indices are unobservable economic parameters that need to be estimated by suitable sample indices. It was shown that most of the hedonic elementary index formulae used in practice are sample versions of particular hedonic elementary population indices.

Kenneth ,Izan ,Eliyathamby (2006) showed the stochastic approach as a new way of viewing index numbers in which uncertainty and statistical ideas play a central role. Rather than just providing a single number for the rate of inflation, the stochastic approach provides the whole probability distribution of inflation. They reviewed the key elements of the approach and then discussed its early history, including some previously overlooked links with Fisher's work contained in his book The Making of

Index Numbers. The authors then considered some more recent developments, including Diewert's well-known critique of the stochastic approach, and provided responses to his criticisms. They also provide a review of Theil's work on the stochastic approach, and presented and extended Diewert's work on this topic within the context of the Country Product Dummy method which measures price levels internationally. The paper also contained some recent material on the value of information from the perspective of the stochastic approach, as well as illustrative applications.

The stochastic approach to index numbers has been successfully applied to the estimation of inflation, the world interest rate and international competitiveness. One distinct advantage of this approach is that it provides the whole distribution of the index, not simply one value. Kenneth, Izan,Yihui(2013) extended the stochastic approach to the estimation of a stock market index. They demonstrated how this approach can be used to identify 'redundant stocks' that do not contribute significantly to the overall index. For index tracking purposes, these stocks can be safely excluded.

Walter (1999) showed a seasonal commodity is one that either (1) is not available during certain seasons or (2) is always available but its prices or quantities fluctuate with the season or time of year. The existence of type-1 seasonal commodities in consumer preference functions means that the usual economic approach to index number theory cannot be applied to construct a short-term month-to-month or quarter-to-quarter consumer price index. He postulated various separability assumptions on intertemporal preferences that can be used to justify various seasonal index number formulas. One of his approaches lead to an index number solution to the problem of seasonal adjustment.

Sebastian (2021) proved spatial price comparisons rely to a high degree on the quality of the underlying price data that are collected within or across countries. Below the basic heading level, these price data often exhibit large gaps. Therefore, stochastic index number methods like the Country–Product–Dummy (CPD) method and the Gini–Elteto–Koves–Szulc (GEKS) method are utilised for the aggregation of the price data into higher-level indices. Although the two index number methods produce differing price level estimates when prices are missing, Sebastian (2021) demonstrated that both can be derived from exactly the same stochastic model. For a specific case of missing prices, it was shown that the formula underlying these price level estimates differ between the two methods only in weighting. The impact of missing prices on the efficiency of the price level estimates was analysed in two simulation studies. It was shown that the CPD method slightly outperforms the GEKS method. Using micro data of Germany's Consumer Price Index, it was observed that more narrowly defined products improve estimation efficiency.

Daniel(2016) Scanner data are increasingly being used in the calculation of price indexes such as the CPI. The preeminent approach is the RYGEKS method. This uses multilateral methods to construct price parities across a rolling year then links these to construct a nonrevisable index. While this approach performs well there remain some unresolved issues, in particular, the optimal window length and the linking method. In this note, these questions are addressed. A novel linking method is proposed along with the use of weighted GEKS as opposed to a fixed window. These approaches are illustrated empirically on a large scanner dataset and perform well.

Jacek (2022) discussed scanner data can be obtained from a wide variety of retailers (supermarkets, home electronics, Internet shops, etc.) and provide information at the level of the barcode, i.e., the Global Trade Item Number or its European version: European Article Number. One of advantages of using scanner data in the Consumer Price Index measurement is the fact that they contain complete transaction information, i.e., prices and quantities for every sold item. One of new challenges connected with scanner data is the choice of the index formula which should be able to reduce the chain drift bias and the substitution bias. Multilateral index methods seem to be the best choice in the case of dynamic scanner data sets. These indices work on a whole-time window and are transitive, which is a key property in eliminating the chain drift effect. Following the so-called identity test, however, one may expect that even when only prices return to their

original values, the index becomes one. Unfortunately, the commonly used multilateral indices (GEKS, CCDI, GK, TPD, TDH) do not meet the identity test. The paper discusses the proposal of two multilateral indices, the idea of which resembles the GEKS index, but which meet the identity test and most of other tests. In an empirical study, these indices are compared, inter alia, with the SPQ index, which is relatively new and also meets the identity test. Analytical considerations as well as empirical study confirm the high usefulness of the proposed indices.

This study seeks to study the price fluctuation of food items in Nigeria with a focus on ten markets within the communities in Kwara State.

II. SCOPE OF THE STUDY

Ten markets were accessed namely, Owode market, Offa; Ojo-Oba, Offa; Kara market, Ajase; Ipata market, Ilorin; Oja-Oba, Ilorin; Yoruba road market, Ilorin; Mandate market, Ilorin; Oja-Oba, Omu-Aran; Oja Tuntun (Baboko Market), Ilorin; Ganmo market, Ilorin to collect data on selected food items between years 2015 and 2022.

The food items used in this study are rice, beans, garri and maize.

III. LIMITATIONS

The intended year of study is 1999 to 2022, but the paucity of data on prices of food items for the period lead to the concentration on 2015 to 2022. Marketers and consumers were not sure of the past prices of items. Also, there were no records of prices of food commodities in any of the markets visited.

IV. PRICE INDEXES

A. Laspeyres Price Index

The Laspeyres Price Index is a well-established economic tool used to measure changes in the price level of a fixed basket of goods and services over time. Named after its creator, Étienne Laspeyres, this index plays a crucial role in economics, finance, and public policy. This review aims to provide an in-depth analysis of the Laspeyres Price Index, examining its strengths, weaknesses, and applications.

The Laspeyres Price Index is constructed by taking a base year and comparing the cost of purchasing a fixed basket of goods and services at current prices with the cost of purchasing the same basket in the base year. The formula for the Laspeyres Price Index is as follows:

$$LPI = \frac{\sum(P_{curremt} \times Q_{base})}{\sum(P_{base} \times Q_{base})} \qquad (i)$$

Where:

- LPI is the Laspeyres Price Index
- $P_{curremt}$ is the current price of the item
- P_{base} is the base year price of the item
- Q_{base} is the quantity of the item in the base year

The Laspeyres Price Index is a fundamental tool for measuring price changes over time. While it offers simplicity and historical comparability, it has limitations due to its fixed basket and base year selection. It is essential for understanding inflation trends, cost of living adjustments, and policy formulation, but users should be aware of its shortcomings and consider supplementary methods to mitigate these issues.

B. Paasche's Price Index

The Paasche Price Index is a prominent economic indicator used to analyze changes in the price level of a variable basket of goods and services. Named after its creator, Hermann Paasche, this index is a valuable tool in economics, finance, and policy analysis. This review aims to provide a thorough assessment of the Paasche Price Index, examining its strengths, weaknesses, and real-world applications.

The Paasche Price Index is constructed by comparing the cost of purchasing a variable basket of goods and services at current prices with the cost of purchasing the same basket in the current year. The formula for the Paasche Price Index is as follows:

$$PPI = \frac{\sum(P_{curremt} \times Q_{current})}{\sum(P_{base} \times Q_{current})} \qquad (ii)$$

Where:

- PPI is the Paasche Price Index
- $P_{curremt}$ is the current price of the item
- P_{base} is the base year price of the item
- $Q_{current}$ is the quantity of the item in the current

year

The Paasche Price Index is a valuable instrument for understanding price changes in a dynamic economy. Its flexibility and ability to account for changing consumption patterns and product quality make it a suitable choice for various applications. However, its complexity and potential data challenges may limit its use in certain contexts. Users should carefully consider their specific needs and the availability of data before selecting this index over others like the Laspeyres index.

C. Edgeworth/Marshall's Price Index

The Marshall-Edgeworth Price Index, often referred to as the Edgeworth Price Index, is a widely used economic indicator employed to measure changes in the price level of a given basket of goods and services over time. This index, named after its creators Alfred Marshall and Francis Ysidro Edgeworth, has been an essential tool in economics, finance, and policy analysis. In this review, we will delve into the methodology, strengths, weaknesses, and practical applications of the Marshall-Edgeworth Price Index.

The Marshall-Edgeworth Price Index is designed to capture price changes in a basket of goods and services while considering the quantity adjustment that consumers make in response to price variations. The formula for this index is as follows:

$$MEI = \frac{\sum(P_{curremt} \times Q_{base})}{\sum(P_{base} \times Q_{base})} \times \frac{\sum(P_{base} \times Q_{current})}{\sum(P_{curremt} \times Q_{current})} \quad (iii)$$

Where:

- MEI is the Marshall-Edgeworth Price Index
- $P_{curremt}$ is the current price of the item
- P_{base} is the base year price of the item
- Q_{base} is the quantity of the item in the base year
- $Q_{current}$ is the quantity of the item in the current year

The Marshall-Edgeworth Price Index offers a more nuanced approach to measuring price changes by including both price and quantity adjustments. Its accuracy in reflecting consumer behavior makes it a valuable tool for various economic and financial applications. However, the index's complexity and data requirements may limit its use in certain contexts. Analysts and policymakers should consider the specific needs of their analysis and the availability of data when choosing the Marshall-Edgeworth Price Index over alternatives like the Laspeyres and Paasche indices.

D. Fisher's ideal Price Index

Fisher's Ideal Price Index, developed by American economist Irving Fisher, is a sophisticated and comprehensive measure used to assess changes in the price level of a basket of goods and services. Fisher's index is often considered one of the most theoretically sound price indices in economics. In this review, we will explore the methodology, strengths, weaknesses, and practical applications of Fisher's Ideal Price Index.

Fisher's Ideal Price Index is formulated to provide a balanced assessment of price changes by taking the geometric mean of the Laspeyres and Paasche indices. The formula is as follows:

$$Fisher\ Ideal\ Price\ Index = \sqrt{Laspeyres\ Index \times Paasche\ Index} \quad (iv)$$

Where:

- The Laspeyres Index measures the price change of a fixed basket of goods from a base period to a current period.
- The Paasche Index measures the price change of a basket of goods whose composition is determined in the current period.

V. RESULTS

Data Presentation and Analysis

Data Presentation

The table below gives the summarized data of the selected food item prices collected from the selected markets around Kwara State in Nigeria between the years of 2015 and 2022.

```
PIS<-data.frame("Year"=c(2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022),
"Quantity (kg)"=c(50, 50, 50, 50, 50, 50, 50, 50),
"RIce"=c(8567, 11469, 18341, 15610, 16500,26000, 22630, 23769),
"Beans"=c(11500, 14629, 16500, 16200, 15285, 11500, 15483, 18252),
"Garri"=c(5000, 8806, 14015, 10265, 8484, 5926,
```

```
9718, 11996),
"Maize"=c(3000, 8000, 7546, 9759, 7522, 6360,
9075, 10400))

PIS
##   Year Quantity..kg. RIce Beans Garri Maize
## 1 2015            50  8567 11500  5000  3000
## 2 2016            50 11469 14629  8806  8000
## 3 2017            50 18341 16500 14015  7546
## 4 2018            50 15610 16200 10265  9759
## 5 2019            50 16500 15285  8484  7522
## 6 2020            50 26000 11500  5926  6360
## 7 2021            50 22630 15483  9718  9075
## 8 2022         50 23769 18252 11996 10400
```

Source: Authors

Data Analysis

Laspeyres Price Index

```
library(PriceIndices)
library(IndexNumber)

prices <-matrix (c(8567, 11469, 18341, 15610,
16500,26000, 22630, 23769, 11500, 14629, 16500,
16200, 15285, 11500, 15483, 18252, 5000, 8806,
14015, 10265, 8484, 5926, 9718, 11996, 3000, 8000,
7546, 9759, 7522, 6360, 9075, 10400), ncol =4)
 weights <-matrix (c(50, 50, 50, 50, 50, 50, 50, 50,
50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50,
50, 50, 50, 50, 50, 50, 50, 50, 50, 50), ncol =4)

laspeyres.index.number(prices,weights,"Price",opt.
plot=TRUE,opt.summary=TRUE)
##
## Laspeyres index number
##
## Summary
## Min.=152.862792603413
## Stage=1
## Max.=229.511525991378
## Stage=7
```

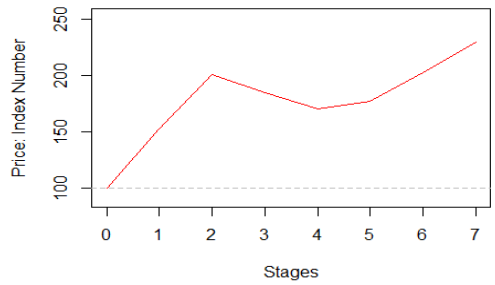

Figure 1: Laspeyres Price Index for the selected food items between the years of 2015 and 2018

Source: Authors

```
##                                        $Summary
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   152.9   173.8   184.7   188.3   201.9   229.5
##
##                $`Agg.          index          number`
##   Stages Price 1 Price 2 Price 3 Price 4 Agg. index
number
## 1      1       0    8567   11500    5000    3000
100.0000
## 2      2       1   11469   14629    8806    8000
152.8628
## 3      3       2   18341   16500   14015    7546
200.9549
## 4      4       3   15610   16200   10265    9759
184.6795
## 5      5       4   16500   15285    8484    7522
170.2747
## 6      6       5   26000   11500    5926    6360
177.3827
## 7      7       6   22630   15483    9718    9075
202.7506
## 8      8       7   23769   18252   11996   10400
229.5115
```

Source: Authors

With the base year as 2015, there is a 229.51 percent increase in prices of the selected food commodities.

Paasche's Price Index

```
paasche.index.number(prices,weights,"Price",opt.pl
ot=TRUE,opt.summary=TRUE)
##
## Paasche index number
##
## Summary
## Min.=152.862792603413
## Stage=1
## Max.=229.511525991378
## Stage=7
```

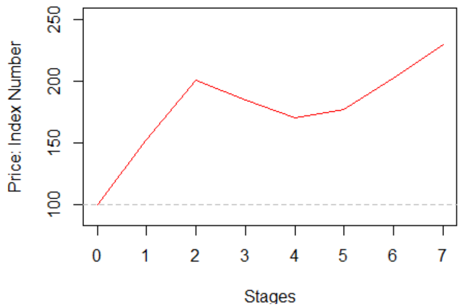

Figure 1: Paasche's Price Index for the selected food items between the years of 2015 and 2018
Source: Authors

```
##                                          $Summary
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   152.9   173.8   184.7   188.3   201.9   229.5
##
##            $`Agg.          index          number`
##   Stages Price 1 Price 2 Price 3 Price 4 Agg. index
number
## 1      0    8567   11500    5000    3000
100.0000
## 2      1   11469   14629    8806    8000
152.8628
## 3      2   18341   16500   14015    7546
200.9549
## 4      3   15610   16200   10265    9759
184.6795
## 5      4   16500   15285    8484    7522
170.2747
## 6      5   26000   11500    5926    6360
177.3827
## 7      6   22630   15483    9718    9075
202.7506
## 8      7   23769   18252   11996   10400
229.5115
```

Source: Authors

With the base year as 2015, there is a 229.51 percent increase in prices of the selected food commodities.

- *Edgeworth Marshall Price Index*

```
edgeworth.index.number(prices,weights,"Price",opt.plot=TRUE,opt.summary=TRUE)
##
## Edgeworth index number
##
## Summary
## Min.=152.862792603413
## Stage=1
## Max.=229.511525991378
## Stage=7
```

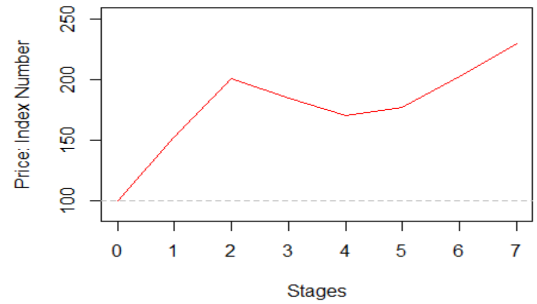

Figure 1: Edgeworth Marshall Price Index for the selected food items between the years of 2015 and 2018

Source: Authors

```
##                                          $Summary
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   152.9   173.8   184.7   188.3   201.9   229.5
##
##            $`Agg.          index          number`
##   Stages Price 1 Price 2 Price 3 Price 4 Agg. index
number
## 1      0    8567   11500    5000    3000
100.0000
## 2      1   11469   14629    8806    8000
152.8628
## 3      2   18341   16500   14015    7546
200.9549
## 4      3   15610   16200   10265    9759
184.6795
## 5      4   16500   15285    8484    7522
170.2747
## 6      5   26000   11500    5926    6360
177.3827
## 7      6   22630   15483    9718    9075
202.7506
## 8      7   23769   18252   11996   10400
229.5115
```

Source: Authors

With the base year as 2015, there is a 229.51 percent increase in prices of the selected food commodities.

- *Fisher's Ideal Price Index*

```
fisher.index.number(prices,weights,"Price",opt.plot=TRUE,opt.summary=TRUE)
##
## Laspeyres index number
```

```
##
##
##
## Paasche index number
##
##
##
## Fisher index number
##
## Summary
## Min.=152.862792603413
## Stage=1
## Max.=229.511525991378
## Stage=7
```

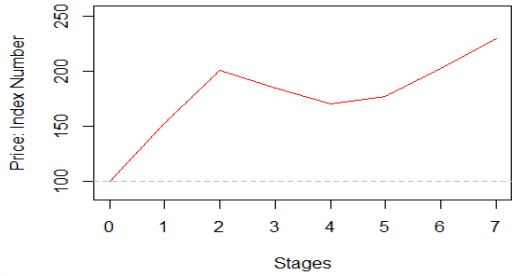

Figure 1: Fisher's Ideal Price Index for the selected food items between the years of 2015 and 2018

Source: Authors

```
##                                                    $Summary
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   152.9   173.8   184.7   188.3   201.9   229.5
##
##                    $`Agg.          index          number`
##  Stages Price 1 Price 2 Price 3 Price 4 Agg. index
number
## 1      0    8567   11500    5000    3000
100.0000
## 2      1   11469   14629    8806    8000
152.8628
## 3      2   18341   16500   14015    7546
200.9549
## 4      3   15610   16200   10265    9759
184.6795
## 5      4   16500   15285    8484    7522
170.2747
## 6      5   26000   11500    5926    6360
177.3827
## 7      6   22630   15483    9718    9075
202.7506
## 8      7   23769   18252   11996   10400
229.5115
```

Source: Authors

With the base year as 2015, there is a 229.51 percent increase in prices of the selected food commodities.

CONCLUSION

The results from the Laspeyres, Paasches, Marshall-Edgeworth and Fisher's ideal indexes are the same. This is a strong indication that the price of the selectedfood items is on the increase within Kwara State, Nigeria.

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