

WORKING PAPER

Empirical analysis of inflation sources in Senegal

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Abstract

The objective of this study is to explain the dynamics of inflation in Senegal. To this end, a Structural VAR model on monthly data covering the period January 2015 - July 2022 was used.

The econometric model includes various national macroeconomic variables (industrial production index, money supply, harmonised consumer price index) and foreign variables (oil price, imported product price index, Dollar/FCFA exchange rate). The results show that, in the short term, world prices are the main determinants of the general price level in Senegal. A 1% rise in imported product prices would generate a 0.55% rise in the HICP the following month. Furthermore, in the short term, over 75% of price fluctuations are explained by their own past variations (inertia effect), and between 21.5% and 25.2% by the prices of imported products.

Keywords: inflation, Senegal, SVAR model, inertia effect, imported inflation.

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Introduction

Some two and a half years after the start of the Covid-19 pandemic, inflation has become one of the world economy's major concerns. In most countries, it is reaching levels not seen for many years. The International Monetary Fund (IMF, 2022) has forecast inflation of around 7.2% in developed economies in 2022, the highest level in four decades; around 9.9% in developing and emerging economies, the highest since the early 2000s; around 14.4% in sub-Saharan Africa, the highest rate since 2000; and around 13.7% in North Africa and the Middle East, the highest level since 1995.

It is attributed to a variety of causes, including the fiscal and monetary stimulus measures implemented across the board, supply shortages and the Russian invasion of Ukraine.

Senegal is no exception to this global phenomenon, with rising prices for essential goods having rapidly become a major concern for many households, particularly the poorest, who spend a disproportionate share of their income on food.

Defined as a sustained increase in the general level of prices and services over time (Blanchard, 2000), inflation is generally accompanied by many negative effects. An increase in the general price level reduces the purchasing power of money and has a constraining effect on the main drivers of growth (C. Tidiane Ndiaye & M. Abdoulaye Konte, 2012). It reduces consumption and, therefore, production and employment. It has an inhibiting effect on investment (Greg Fischer, 2016), due to the rise in nominal wages and commodity prices, both in local and foreign currencies.

Inflation also contributes to the deterioration of the trade balance (H. Mercillon, 1958) when the prices of domestic goods and services rise more than those of foreign competitors. Added to this are its negative effects on social activity (Fenira, 2014), due to the deterioration in purchasing power.

For all these reasons, it is generally accepted that keeping inflation rates low and stable should be the primary objective of central banks. However, the sources of inflation are numerous and sometimes difficult to understand, which can undermine central banks' efforts to ensure price stability.

Many researchers have written about the determinants of inflation. However, very few studies have focused specifically on Senegal. What's more, of the few studies that have focused on UEMOA or Senegal (Doé and Diallo (1997), Dembo Toé and Hounkpatin (2007), Diouf (2007), Diop et al. (2008), etc.), most do not concern the recent period and, therefore, do not take into account the current national economic conjecture and recent global macroeconomic upheavals. Indeed, in the face of recent global macroeconomic upheavals, notably the consequences of the COVID-19 pandemic, the importance of inflation in Senegal has been raised to a higher level. These changes could affect the structure of the relationships between

inflation and its sources, as previously examined by the literature. It is therefore imperative to analyse the sources of inflation in Senegal, taking into account data from the COVID and post-COVID periods. This will enable us to understand these new dynamics and establish appropriate economic policies to manage inflation, preserve economic stability and support long-term development. Consequently, the study of inflation in Senegal in the current economic context has become particularly relevant.

Hence the interest of this present study, which seeks to empirically examine the sources of inflation in Senegal. To this end, a two-pronged approach has been adopted.

Firstly, a descriptive analysis of price trends was carried out, with the aim of identifying the main products behind inflation.

Secondly, a Structural VAR econometric model has been estimated on monthly data for the period January 2015-July 2022, in order to assess the dynamics of the Harmonised Index of Consumer Prices (HICP). The other variables in the empirical model employed include various national macroeconomic indicators (industrial production index, money supply, average interest rate on loans granted by banks) and international indicators (oil price, price index of imported products, Dollar/FCFA exchange rate).

The results show that world prices are the main determinants of the general price level in Senegal. Indeed, a 1% rise in the price of imported products would generate a 0.55% rise in the HICP the following month, whilst a 1% rise in industrial production generates very negligible negative effects from the 2nd month onwards. Similarly, the effects of the money supply are weak: when it increases by 1%, it causes a negligible (or even zero) rise in the HICP the following month, but this rise reaches 0.03% in the third month. Moreover, over 75% of price fluctuations are explained by their own past variations (inertia effect), and between 21.5% and 25.2% by the prices of imported products.

This document is structured in three parts. Part 1 reviews the literature. Part 2 analyses recent inflation dynamics. Finally, Part 3 estimates a Structural VAR econometric model on monthly inflation data and its determinants. The paper concludes with recommendations.

I Review of the literature

The aim of this section of the study is to present the main determinants of inflation that appear in the theoretical and empirical literature. The review is succinct, focusing on empirical studies carried out in the WAEMU zone.

- **Theoretical literature**

The monetarist approach to inflation agrees with Friedman (1970) that "inflation is always and everywhere a monetary phenomenon", in the sense that it is and can only be generated by an increase in the quantity of money outstripping that of production. According to this author, any excess in the supply of money relative to the real cash needed by economic agents translates into higher prices.

However, according to Keynes (1936), it is the demand for goods and services and its mismatch with supply that should be considered when explaining inflationary mechanisms. This demand-side approach to inflation, highlighted by classical economists and developed by Keynes, has long been used to explain inflation. According to this theory, monetary creation, however large, will only be inflationary to the extent that the production apparatus is unable to meet the increase in demand. Supply and demand are then adjusted through prices, rather than quantities, and this is compatible with any state of money creation.

The cost approach argues that inflation is triggered by an increase in production costs, as observed after the global oil shocks of the 1970s. Rising production costs push companies to raise the prices of goods and services which, in turn, leads to demands for higher wages, fuelling the inflationary spiral (Blaug, 1997).

- **Empirical literature**

Empirically, a number of studies have examined the determinants of inflation in the West African Economic and Monetary Union.

For the 8 UEMOA countries, several studies have shown that money supply is a non-negligible factor in explaining inflationary movements. Dembo Toé and Hounkpatin (2007), using a VAR model, have shown that changes in the money supply have a significant but weak impact on inflation in the WAEMU. Similarly, Keho (2016), using an ARDL model on data for UEMOA countries, found that expansionary monetary policy increases inflation in Côte d'Ivoire, Burkina Faso and Senegal. He also noted that the budget deficit cannot be held responsible for inflation in this economic zone, but it does cause an increase in the money supply in Côte d'Ivoire, Togo and Mali. Loungani and Swagel (2001) find that inflation stems more from money supply growth and exchange rate variations in developing countries with a variable exchange rate system, than in those with a fixed exchange rate system. A study by Barnichon and Peiris (2007) shows that the gap between money supply and demand determines inflation more than the output gap in 16 African countries. This conclusion was

also reached by Diouf (2007) and Diop et al. (2008).

Imported inflation is also an important factor in determining price trends in the UEMOA zone. Indeed, using a multi-sector model, Doé and Diallo (1997) found that, in both the short and long term, the main factor driving price trends in the WAEMU is imported inflation, in this case price trends in France. The influence of macroeconomic variables was found to be relatively weak.

Toé (2010) studied the link between oil prices and inflation in UEMOA countries and found that the impact of oil prices is not significant in the short term, but significant in the long term. For Toé (2010), this low elasticity of inflation to the price of oil is the result of policies to stabilise fuel prices at the pump.

Diallo (2003) assessed the impact of the local supply of food products on prices in the WAEMU. This study confirmed the statistical results generally obtained on the relationship between the food sectors and inflation in WAEMU countries.

Toé and Hounkpatin (2007) found that around 80% of inflation forecast error in the UEMOA is due to its own innovations and around 10% to developments in imported inflation. This highlights the strong inertial component of inflation in the UEMOA zone.

All in all, the empirical literature review shows that money supply, imported inflation, oil prices and the local supply of food products are the main factors determining consumer price trends in the WAEMU region. Empirical studies also point to the presence of a strong inertial component in inflation for countries in the zone. However, very few studies have focused specifically on Senegal and most of these do not concern the recent period. The analysis carried out in this study aims to fill this gap.

II Analysis of recent inflation dynamics in Senegal

II.1 Stylised facts

Senegal has been under inflationary pressure since the second half of 2021. Indeed, since June 2021, the Harmonized Index of Consumer Prices (HICP) has been in a phase of gradual growth (see graph 1). This upward trend has accelerated sharply since the beginning of 2022. In July 2022, the HICP, produced by the Agence Nationale de la Statistique et de la Démographie (ANSD), stood at 122.1, representing an appreciation of 3.83% compared with the previous month and over 8.59% compared with December 2021.

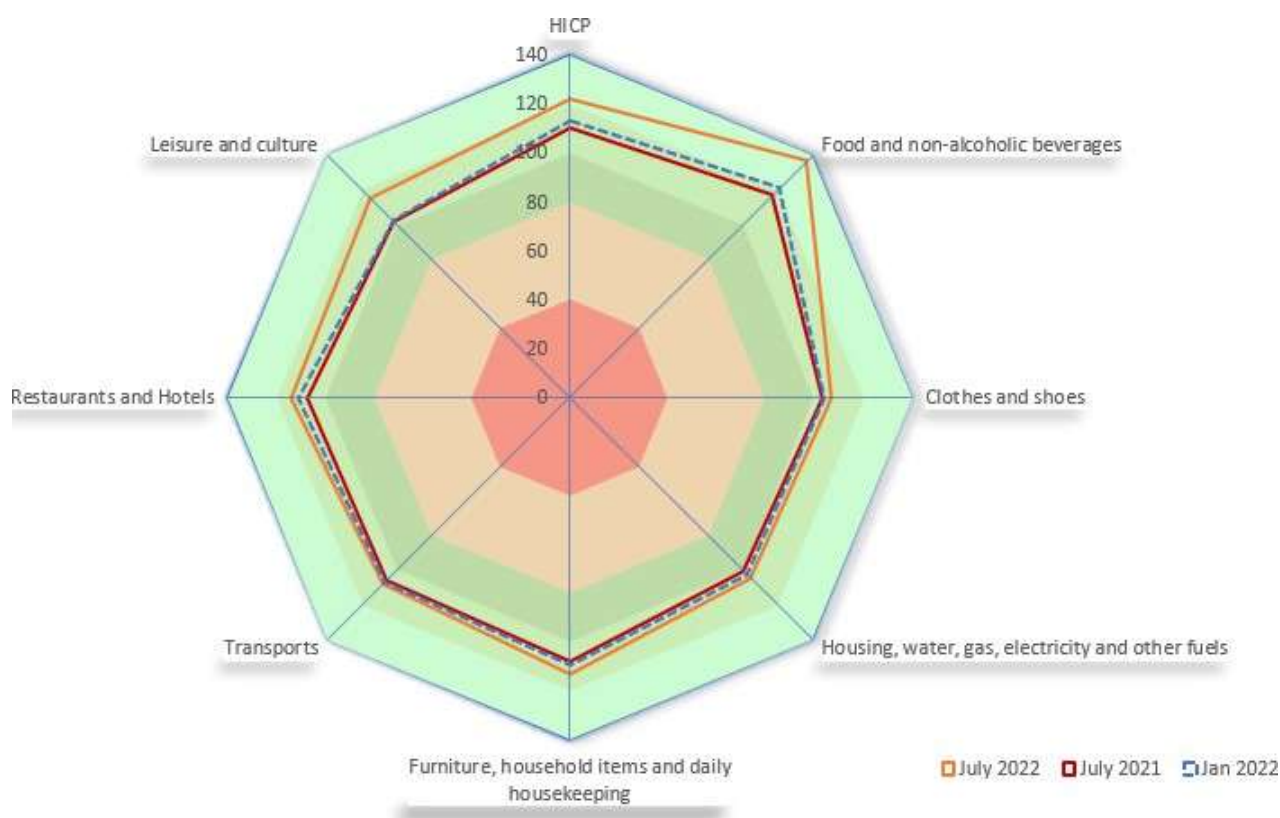
Year-on-year inflation has been above the EU target of 3% since September 2021. In July 2022, Senegal recorded a year-on-year inflation rate of 11%, after 8.9% in June 2022 and 7.4% in May 2022.

Graph1 - HICP evolution

Source: BPE (Data: ANSD & BCEAO)

Chart 2 shows the evolution of the HICP and some of its components for the months of July 2021, January 2022 and July 2022. Consumer prices for "Food products and non-alcoholic beverages", which account for a very high proportion (almost 50%) of the typical household's consumption basket, rose most in July 2022 compared with their January 2022 and July 2021 values. Compared with their January 2022 values, the overall price level for "Food and non-alcoholic beverages" rose by 12.91% in July 2022 and by over 17.16% year-on-year. Similarly, prices for "Leisure and culture" services rose sharply. The price index for "Leisure and culture" services stood at 115.3 in July 2022, up 12.75% on its January 2022 value and 13.71% year-on-year.

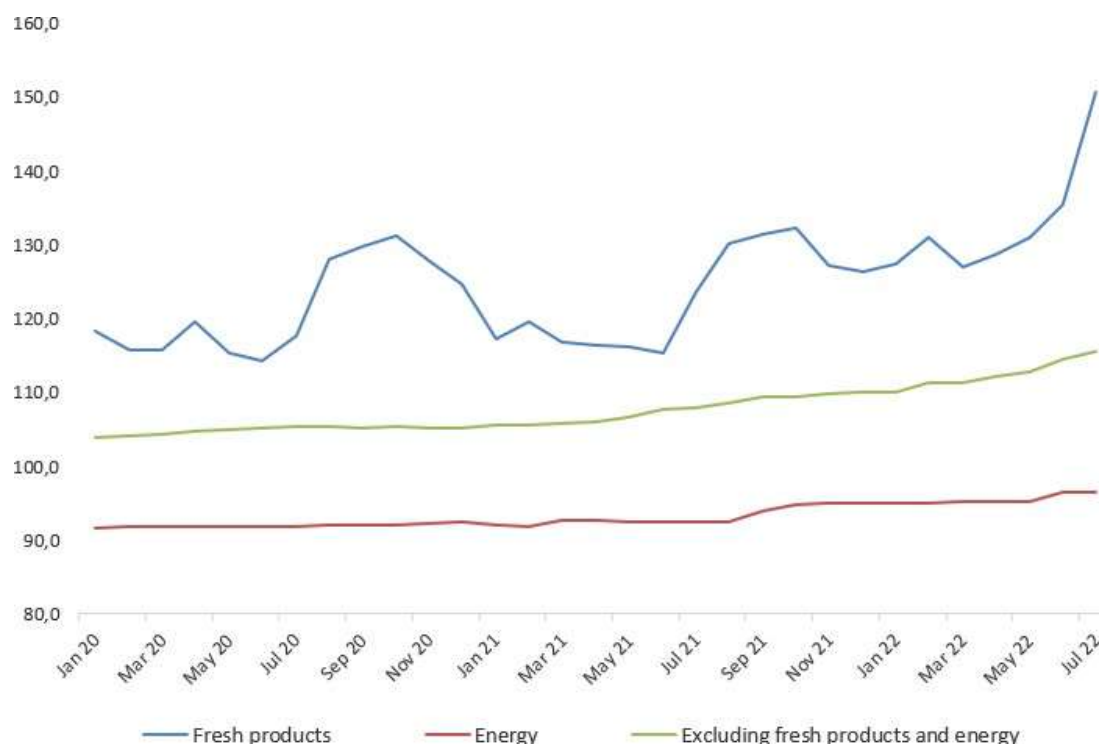
Indices for the other consumer functions recorded smaller variations, ranging from 2.06% (for the "Transport" function) to 5.74% (for the "Restaurants and Hotels" function) year-on-year.

Graph2 - Monthly trend in HICP consumption function indices

Source: BPE (Data: ANSD)

Underlying inflation, which represents the change in the general price index calculated excluding fresh produce and energy products, has also been on an upward trend since August 2021 (see graph 3). The year-on-year underlying inflation rate thus stood at 7.2% in July 2022, compared with 5.4% in February 2022, 4.3% in November 2021 and 3% in August 2021. Fresh produce prices are highly volatile (graph 3). In July 2022, they rose by 11.28% in monthly variation. Compared to the same period in 2021, they rose by 22.09%. Energy prices, meanwhile, are relatively stable, but have been on an upward trend since the second half of 2021. In July 2022, they were 1.67% higher than in January 2022. In annual variation, they have risen by 4.37%.

Over the first six months of 2022, Senegal's inflation rate was higher than that of most WAEMU countries (see table 1). Compared with other WAMU countries, Senegal has a higher inflation rate than Côte d'Ivoire, Benin, Niger, Guinea-Bissau and Togo. However, it has a lower inflation rate than Burkina Faso and Mali, which also saw marked increases in 2022.

Graph3 - Evolution of HICP sub-indices

Source: BPE (Data: ANSD)

Table 1: Inflation trends by WAEMU country (annual average, %)

Country	2021	T4-2021	T1-2022	T2-2022
Benin	1.7	3.3	4.1	-0.4
Burkina Faso	3.9	5.9	10.3	16.1
Ivory Coast	4.2	5.2	4.9	4.3
Guinea-Bissau	3.3	5.6	6.6	7.4
Mali	3.9	6.3	8.2	9.5
Niger	3.8	4.3	5.1	5.2
Senegal	2.2	3.3	6.1	7.8
Togo	4.5	5.8	8.2	7.4
UEMOA	3.6	5	6.4	7

Source: BCEAO

II.2 Descriptive analysis of inflation sources

In order to identify the functions and products that play a decisive role in the evolution of the Harmonised Index of Consumer Prices, the contributions of the various products or product groups have been calculated. Indeed, the overall inflation rate is determined not only by the variation in product prices, but also by the relative weights of the various products in the basket. The calculation of contributions takes these different aspects into account.

II.2.1 Analysis of the contribution of consumption functions

The results of the contribution calculations show that the functions driving inflation upwards are "Food and non-alcoholic beverages" and "Clothing and footwear". Between January and July 2022, these two functions contributed an average of 90.89 and 10.38 percentage points respectively to the rise in inflation, depending on the month.

The contributions of the other ten functions do not exceed 4% on average (see table 1 below).

Table 1 - Contributions to inflation

	Jan	Feb	March	April	May	June	July	Average
Food and non-alcoholic beverages	103.21	91.33	114.09	85.67	75.26	76.84	89.84	90.89
Alcoholic beverages, tobacco and drugs	0.16	0.24	-0.29	0.30	0.27	0.19	0.15	0.15
Clothing and shoes	5.21	1.19	-1.73	4.60	3.59	0.98	1.49	2.19
Housing, water, gas, electricity and other fuels	1.41	0.80	-2.76	7.79	7.15	1.82	0.99	2.46
Furniture, household items and daily housekeeping	4.76	1.44	-1.36	3.17	2.79	1.04	1.23	1.86
Health	2.37	0.55	-1.27	-2.47	4.01	-0.90	2.18	0.64
Transports	-1.24	-0.20	-2.35	1.17	-0.13	2.49	0.16	-0.02
Communication	-21.98	2.81	0.75	-4.12	5.02	1.79	-0.21	-2.28
Leisure and culture	1.67	0.01	-0.84	-0.12	0.36	13.82	3.36	2.61
Education	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Restaurants and Hotels	5.10	0.92	-3.15	2.46	0.95	1.41	0.14	1.12
Other goods and services	-0.65	0.92	-1.09	1.54	0.74	0.53	0.67	0.38
General index	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source : BPE

II.2.2 Analysis of the contribution of products

A more detailed analysis was carried out at product level. The results show that it was mainly the following products that drove up inflation over the period January 2020-September 2022: vegetable oil, ordinary and perfumed broken rice, and unshelled groundnuts. These are the products that recorded the highest average contributions over the period (see table 2 below).

The evolution of vegetable oil prices impacted HICP growth by more than 2.39% on average between January 2020 and September 2022. Over this period, this was the variety with the highest average contribution. This is mainly due to the strong variation in vegetable oil prices, but also to its predominant place in the daily consumption of Senegalese people. Indeed, amongst more than 500 product varieties included in the IHPC, its weight represents around 1.4% of the

Table 2 - Highest contributions over the period 2020 – 2022

Varieties n	Contribution averages	Median contribution s	Contribution (Avg. 2022)
Vegetable oil	2.39	1.20	2.12
Ordinary broken rice, retail	2.04	1.42	4.64
Vegetable oil pod 12.5 cl	1.77	0.90	2.09
Consumption of 30 m cube	1.22	0.60	2.91
Fragrant broken rice	0.94	0.68	1.85
Ordinary broken rice sold in 50 kg bags	0.75	0.68	1.42
Unshelled, unroasted peanuts	0.65	0.37	0.14
Peanut oil	0.52	0.17	0.22
Rent for a 1-bedroom apartment	0.45	0.00	0.05
Milk powder, Metal can or packaging in aluminum	0.36	0.12	0.49

Source: BPE

the total weight. Furthermore, between January 2020 and September 2022, the price per litre of vegetable oil recorded a sharp variation of over 44%, with its index rising from 103.35 to over 148.81.

Furthermore, between January 2020 and September 2022, the price per litre of vegetable oil recorded a sharp variation of over 44%, with its index rising from 103.35 to over 148.81.

However, monthly contributions for 2022 remain low compared with last year's values

for the March to July period (see appendix).

For 2022, the evolution of vegetable oil prices contributed 1.01% to the overall rise in prices at the beginning of the year (January 2022). This contribution rose to over 4.32% in September 2022.

Other oil varieties also make high contributions to the variation in HICP. These are vegetable oil in 12.5 cl pods (1.77%) and peanut oil (0.52%).

Several rice varieties are included in the group of products with the highest contributions between 2020 and 2022. These include "Ordinary retail broken rice".

Also "Perfumed broken rice sold at retail", and "Ordinary broken rice sold in 50 kg bags". "Ordinary retail broken rice" recorded an average contribution of 2.04% between 2020 and 2022. This is a highly consumed product (2.2% of the total weight of over 500 varieties), and its price rose by 16.14% between January 2020 and September 2022. Between January 2022 and September 2022, it was the variety whose price evolution had the greatest impact on the rise in the overall index. Its average contribution was 4.6%. However, this contribution fell sharply from 18.42% in January to just 4.46% in September. The general price level for "Ordinary broken rice sold at retail" rose by 6.6% between January 2022 and September 2022. "Fragrant broken rice sold at retail" and "Ordinary broken rice sold in 50 kg bags" recorded average contributions of 0.94% and 0.75% respectively between 2020 and 2022. In 2022, they rose to 1.85% and 1.42% on average.

The price of milk powder and the rent for a one-bedroom apartment (Studio) also contribute to this upward trend.

Certain products, such as long-grain retail rice, carrots, millet flour sold in bulk, fresh peppers, tapioca and cucumbers recorded negative average contributions over the period 2020-2022. This means that price trends for these products are contributing to the fall in the overall index. These are generally products whose prices have fallen. Retail "long grain" rice is the product that contributes most to the fall in the overall index. In January 2021, the price of this variety fell by 1.24% year-on-year.

The main conclusion to be drawn from these analyses is that it is the products in the "Food and non-alcoholic beverages" function that are driving up overall price levels. This is due to two mechanisms. Firstly, the index for the "Food and non-alcoholic beverages" function is the most positively correlated¹ with the HICP and the eleven other HICP consumption functions. Moreover, this function weighs highly in the household basket, which means that food products are the most heavily consumed in Senegal. Consequently, through their weight and the link with other products, an increase in the price of food and non-alcoholic beverages immediately leads to an overall rise in consumer prices. In fact, since January 2022, this function has contributed an average of 90.89% to the rise in inflation.

By variety, vegetable oil, ordinary and perfumed broken rice, and unshelled groundnuts all made the highest contributions over the period January 2020 - September

2022. Over this period, price trends for these products account for the largest share of the overall index.

II.2.3 Analysis of potential factors influencing inflation

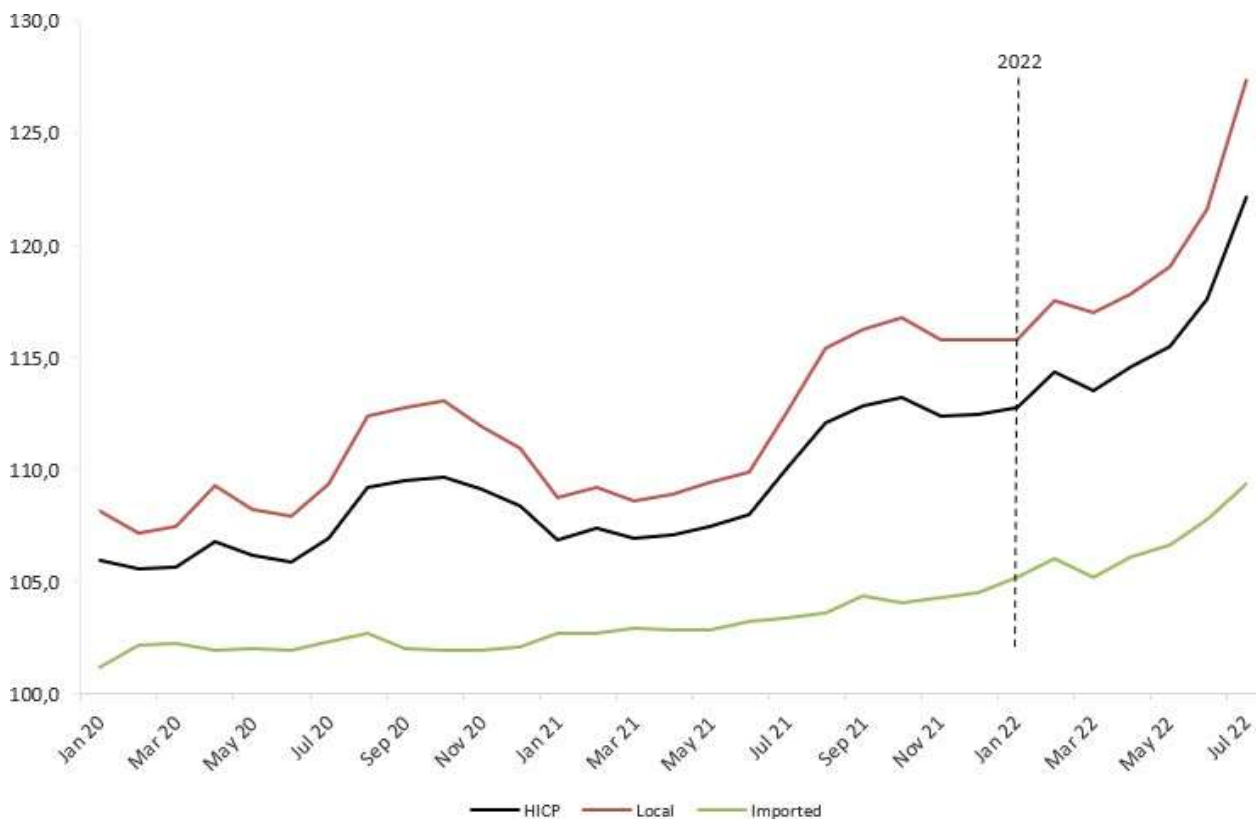
A number of internal and external factors may explain the surge in inflation in Senegal in 2022. On the external front, rising world food prices, higher international crude oil prices and the appreciation of the dollar against the euro are generating imported inflation. Internal factors relate to supply and demand shocks, as well as the margin behaviour of economic operators.

1. see results of correlation analysis in appendix

- **Imported inflation**

The role of imported inflation as a determinant of prices within the WAEMU has been highlighted by several studies, including that of L. Doe and M. Diallo (1997), who noted that in the countries of the Union, the structure of the economies and their integration into the world market inevitably expose them to the effects of external inflation.

Graph4 - Index trends by product origin



Source: BPE

Import prices have been on an upward trend since the beginning of 2022 (see chart above). In July 2022, prices of imported goods rose by 5.77% year-on-year, following an increase of 4.39% the previous month. The rise in prices of imported goods is explained first and foremost by the crisis in Ukraine and the economic sanctions imposed on Russia, which have disrupted global supply chains and caused shortages of essential products such as oil, gas and grain imported from Ukraine and Russia. Also, according to the BCEAO, prices of food products imported by UEMOA countries, expressed in CFA Francs, rose by 46.2% in May 2022, compared with the same period in 2021, following a 30.6% increase the previous month, driven by higher prices for wheat (+77.2%), oils (+54.0%), rice (+35.9%) and sugar (+28.5%). Over 70% of rice and all wheat consumed in Senegal is imported, with 64% of wheat imported from Russia and Ukraine. The situation in Mali (which has been subject to UEMOA and ECOWAS sanctions) and Guinea has also had an impact on the price of meat and certain fruits (bananas). Directly, imported goods account for almost a third of the consumer basket in Senegal, but indirectly they are driving up the price of local goods, as the costs incurred in purchasing inputs or intermediate goods are passed on in the price of processed products. Ultimately, imported inflation can account for most of the country's inflation (excluding the exchange rate), if external price rises are properly passed on.

Other imported consumer goods were affected by global trade disruptions, resulting in shortages and higher prices. The health crisis has led to soaring prices and scarcity of certain products, such as wood and plastics, amongst others. According to the ANSD, the rise in the price of inputs, particularly wood, has had an impact on the price of furniture and furnishings. This could explain the rise in prices of living room, dining room and office furniture (+4.3%), bedroom and bathroom furniture (+3.8%), and other household furniture and furnishings and repairs (+8.5%).

In addition, the war in Ukraine and rising energy costs have had a major impact on the availability and world prices of chemical fertilisers, on which Senegalese agriculture is heavily dependent. Whilst there are two local producers of phosphate fertilisers, Senegal imports most of its simple and complex fertilizers. The country's fertiliser imports are dominated by Russia (30.3%) and Ukraine (18.2%). Fertiliser prices have risen by almost 30% since the start of 2022, following last year's 80% increase. The price surge is due to a confluence of factors, including soaring input costs, supply disruptions caused by sanctions (Belarus and Russia) and export restrictions (China). Urea prices have surpassed their 2008 peaks, whilst phosphate and potash prices are approaching 2008 levels. The dynamic depreciation of the euro exchange rate (and, therefore, of the CFA franc) against the dollar is adding further pressure. Between September 1, 2021 and September 1, 2022, the euro lost 16.1% of its value against the dollar. According to BCEAO (note de conjoncture, July 2022), this weakening of the euro is explained by the difference in monetary policy stance between the European Central Bank (ECB) and the US Federal Reserve (FED), and by fears of an economic recession in Europe, against a backdrop of high inflation and growing uncertainty over the continuity of Russian gas supplies.

- **Local inflation**

According to graph 7, there is a strong positive correlation between the evolution of local product prices and that of the overall index. In July 2022, local product prices rose by 13.18% compared with the same period last year.

On the domestic front, the main determinants of food inflation are shocks to agricultural production, expansive fiscal policy and the margin behaviour of economic operators.

On the supply side, the poor performance of Senegal's cereal crop for the 2021/2022 season, with production down 4.4% due to early cessation of rainfall, has had an impact on domestic prices since the fourth quarter of 2021. Similarly, the lack of domestic supply in the fishing sector, faced with a situation of overexploitation of fish stocks, explains the upward trend in fresh fish prices. According to ANSD, industrial fishing production in 2021 was 204,312.9 tonnes, compared with 250,507 tonnes in 2020, a drop of 18.4%.

The constraints on supply came at a time when the country was experiencing a shock to demand, triggered by the Senegalese government's proactive policy of letting the budget deficit slide, in order to encourage rapid economic recovery following Covid-19, and to support household purchasing power through subsidies and tax exemptions. Additional measures were taken to increase government salaries and the wage bill (recruitment of young people), as well as to make emergency cash transfers to households, thus encouraging an increase in aggregate demand.

Faced with this rapid and almost universal increase in public spending in WAEMU countries (not covered by equivalent increases in tax and non-tax revenues), the BCEAO - anxious to counter persistent inflationary pressures - raised its key rates by 0.25 points from June 16, 2022. As a result, monetary policy is seeking to maintain its grip on fiscal policy and curb the zeal of WAEMU countries, including Senegal, which are increasingly issuing treasury bills to finance their budget deficits.

However, this rate hike has not yet had an impact, contrary to the conclusions of studies carried out on the subject (Nubukpo, 2002), which predict that changes in BCEAO lending rates have an immediate and lasting effect on inflation in the WAEMU zone and, consequently, in Senegal. And, thus, the negative effect on inflation is rapid, with the maximum impact observed from the end of the first quarter. This is something that is currently taking time to manifest itself.

The reason for this is that BCEAO's rate hike seems to have been too late and too timid. According to the IMF, at the start of 2022, BCEAO considered the rise in inflation to be a temporary phenomenon that did not call for an immediate tightening of monetary policy. It expected inflation to return to below 3% over the next 24 months, based on the fact that inflation remained concentrated on food products and that signs of transmission to other categories were not detected, partly due to administered prices. In addition, various indicators of underlying pressures (inflation expectations, wage growth) had not signalled any

feedback effects.

- **Margin behaviour**

An essential determinant of the inflation experienced in Senegal could be the high-margin policy practiced by certain companies and distributors, who are using the current uncertain situation that is conducive to anchoring inflationary expectations at a high level, to raise prices beyond the level justified by their rising costs. Indeed, in an inflationary environment, everyone knows that prices are going up; in other words, inflation feeds inflation. This is an opportunity for companies to pass on more than 100% of exposed cost increases. They can do so all the more since many sectors and sub-sectors in Senegal are still dominated by an excessive concentration of firms and sometimes by quasi-monopolies and/or duopolies, or by illicit agreements between sellers. Yet empirical work by economists shows that the number of firms and the distribution of market shares strongly determine margins and prices.

Margin behaviours can be properly understood by analysing the various trade channels and stages (importers/producers, wholesalers, semi-wholesalers, retailers) within each of them, in order to understand the strategy followed by each player since the inflationary crisis. At first sight, they can be approximated by studying the evolution of the gap between the inflation rate (in annual variation) of local products and that of imported consumer goods. This gap has been widening steadily since the beginning of 2022 and has been at unknown levels, since at least 2008. In addition, the median contribution of the inflation rate for local products (which represent around 70% of the typical basket) to the overall inflation rate is 84% over the first seven months of 2022, compared with 71% in 2021 and 78% in 2020. This reveals the practice of margin behaviour on the part of local players.

III Modelling the determinants of inflation

This section is devoted to modelling the determinants of inflation in Senegal. First, the model variables will be selected on the basis of an analysis of the potential factors influencing inflation. Next, the methodology and results obtained will be presented.

III.1 Modelling econometric steps

III.1.1 Choice of variables

To explain inflation dynamics, econometric modelling is carried out. In order to find the type of model that best fits the data, a series of statistical analyses and tests are carried out. The main choice is between a vector autoregressive model and a vector error correction model. The choice of one or the other is explained by the existence of a long-term relationship between the study variables. When the variables are co-integrated, the VECM model is preferred. Otherwise, a VAR model will be estimated. The model covers the following variables:

T Harmonised index of consumer prices (HICP) from ANSD;

T Price index for imported products: Given the significant weight of imports in Senegal's demand, the prices of imported products could play a significant role in explaining price fluctuations. This data was collected by ANSD;

T The industrial production index: This is a short-term indicator that measures changes in the production of industrial units operating in the country over a well-defined period. It is, therefore, supposed to give the evolution in volume of industrial production and present in a fairly representative way the movements observed within the industrial fabric. Data for this variable comes from BCEAO;

- T Money supply: This is the M2 monetary aggregate from the BCEAO database. This variable can represent a significant source of price fluctuation. As emphasised by monetary analysts, too much creation of this variable is a source of inflationary pressure in the long term. The relevance of money growth as a determinant of inflation has been tested in numerous empirical studies, especially in developed countries.

T Oil price: Data on this variable was collected from the World Bank. Given Senegal's dependence on oil imports, fluctuations in world oil prices can have a significant impact on the country's economy and price dynamics.

T FCFA/US exchange rate: This is the monthly series of the average exchange rate between the CFA Franc and the US Dollar, taken from the BCEAO database. Given the current

global economic situation, this variable will capture the effects of a potential exogenous factor.

T The average interest rate on loans granted by banks: Given that one of the main objectives of monetary policy is to ensure price stability, it would be important to include a monetary policy instrument in our analysis - hence, the choice of this variable.

III.1.2 Choice between SVAR and VECM

In order to find the type of model (between a VECM model and a SVAR model) that best fits the data, a series of analyses and statistical tests are carried out. These concern the analyses listed in the appendix. The graphical representation of the series, presented in the appendix, reveals that they are non-stationary. This was confirmed by the KPSS test and the ADF unit root test (see appendices for results). After an initial differentiation and considering the logarithm of the series, all the variables selected for this study become stationary. They are, therefore, integrated of order 1. After examining the cointegration (see table below), it turns out that the variables in the model do not maintain a stable long-term relationship. Consequently, the appropriate model is the vector autoregression (VAR) model on differentiated series. Specifically, the structural VAR model will be used.

Table 3 - Johansen cointegration test

	Test statistics	10%	5%	1%
$r \leq 6$	3.68	10.4	12.2	16.2
		9	5	6
$r \leq 5$	14.25	16.8	18.9	23.6
		5	6	5
$r \leq 4$	17.74	23.1	25.5	30.3
		1	4	4
$r \leq 3$	21.04	29.1	31.4	36.6
		2	6	5
$r \leq 2$	31.09	34.7	37.5	42.3
		5	2	6
$r \leq 1$	38.88	40.9	43.9	49.5
		1	7	1
$r=0$	54.71	46.3	49.4	57.8
		2	2	8

Source: BPE calculations

III.1.3 Model assumptions and specifications SVAR

A SVAR model with a recursive structure can be used to explain the short-term dynamics of inflation in Senegal. The recursive short-term relationship between variables in the SVAR model can be described by a linear system of equations. Following the work of Moriyama (2008) and McCarthy (2000), the recursive structure of the economy assumes that: (i) international oil prices (set on the international market) and the money supply (set by the central bank) are exogenous to the system (equation above) and, therefore, affect all disturbances to the average interest rate on loans granted by banks, the nominal exchange rate, industrial production, the price index of imported products and the Harmonised Index of Consumer Prices; (ii) shocks to the average interest rate on bank loans affect all variables in the system, with the exception of the price of oil and the money supply; (iii) exchange rate shocks affect disruptions to industrial production, the price index for imported products and the Harmonised Index of Consumer Prices; (iv) industrial production shocks affect disturbances in the imported product price index and the Harmonised Index of Consumer Prices; and (v) imported product price shocks affect disturbances in the Harmonised Index of Consumer Prices.

Consequently, the SVAR model is specified as follows:

The vector of variables is as follows:

$$X_{i,t} = (m2, pet, interet, tx, prod, imp, ihpc)$$

With m2 = Money supply, pet = Global oil price, interest = Average interest rate on bank loans, tx = Exchange rate, imp = Price of imported products, prod = Industrial production index, ihpc = Harmonised consumer price index.

The SVAR model is, therefore, specified as follows on the basis of the assumptions made:

$$m2_t = E_{t-1}m2_t + \epsilon_t^{m2}$$

$$pet_t = E_{t-1}pet_t + \epsilon_t^{pet}$$

$$interet_t = E_{t-1}interet_t + \lambda_1\epsilon_t^{m2} + \epsilon_t^{interet}$$

$$tx_t = E_{t-1}tx_t + \lambda_2\epsilon_t^{m2} + \lambda_3\epsilon_t^{pet} + \lambda_4\epsilon_t^{interet} + \epsilon_t^{tx}$$

$$prod_t = E_{t-1}prod_t + \lambda_5\epsilon_t^{m2} + \lambda_6\epsilon_t^{interet} + \epsilon_t^{prod}$$

$$imp_t = E_{t-1}imp_t + \lambda_7\epsilon_t^{pet} + \lambda_8\epsilon_t^{tx} + \lambda_9\epsilon_t^{prod} + \epsilon_t^{imp}$$

$$ihpc_t = E_{t-1}ihpc_t + \lambda_{10}\epsilon_t^{m2} + \lambda_{11}\epsilon_t^{pet} + \lambda_{12}\epsilon_t^{interet} + \lambda_{13}\epsilon_t^{tx} + \lambda_{14}\epsilon_t^{imp} + \lambda_{15}\epsilon_t^{prod} + \epsilon_t^{ihpc}$$

E is the conditional expectation operator and λ the impulse response coefficients. The restriction matrix is as follows:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \lambda_1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ \lambda_2 & \lambda_3 & \lambda_4 & 1 & 0 & 0 & 0 & 0 \\ \lambda_5 & 0 & \lambda_6 & 0 & 1 & 0 & 0 & 0 \\ 0 & \lambda_7 & 0 & \lambda_8 & \lambda_9 & 1 & 0 & 0 \\ \lambda_{10} & \lambda_{11} & \lambda_{12} & \lambda_{13} & \lambda_{14} & \lambda_{15} & 1 & 1 \end{pmatrix}$$

III.2 Model estimation results SVAR

III.2.1 Impulse response functions (IRFs)

The impulse response functions derived from the model's estimation enable us to determine the propagation of an exogenous shock on one variable over time and on the other variables. They reveal several findings:

T Following a shock, the overall price index returns to its initial trajectory approximately 6 months after the shock. A shock to the HICP, therefore, produces transitory effects that are not sustained over the long term.

T HICP reacts to its own shocks. A 1% rise in HICP has a positive effect on future HICP levels.

T Import prices have a strong impact on inflation. A sudden shock to imported product prices would cause a sharp rise in inflation: a 1% rise in imported product prices would generate a 0.27% fall, followed by a 0.44% rise in the HICP the following month. The effects remain positive, but the rate of increase gradually diminishes until the 6th month, when the effects of the shock dissipate.

T Following a 1% increase in the money supply, the effects on the HICP are almost nil the following month (graph below), but peak at 0.05% in month 2. The effects of this shock dissipate after the 5th month.

T A rise in the price of oil will immediately result in a slight fall in the HICP.

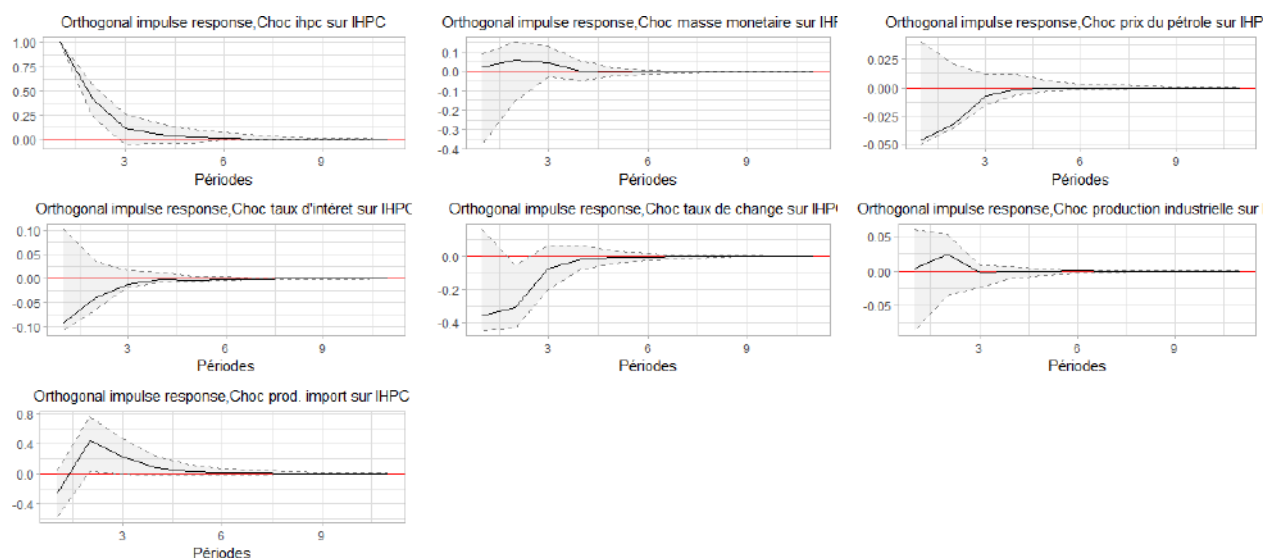
T A rise in industrial production would lead to an overall increase in the general price level. A 1% rise in the industrial production index translates the following month into a rise of around 0.0048% in the HICP. The effects of this shock cancel out around the 3rd month.

T An appreciation of the dollar against the euro leads to a fall in the IHPC. This fall would be 0.355% in the month following the shock.

T The interest rate causes the HICP to fall. Following a 1% rise in the average interest rate granted by banks, the HICP will fall by around 0.09% the following month. This decline

will continue in the following months, but at a slower pace.

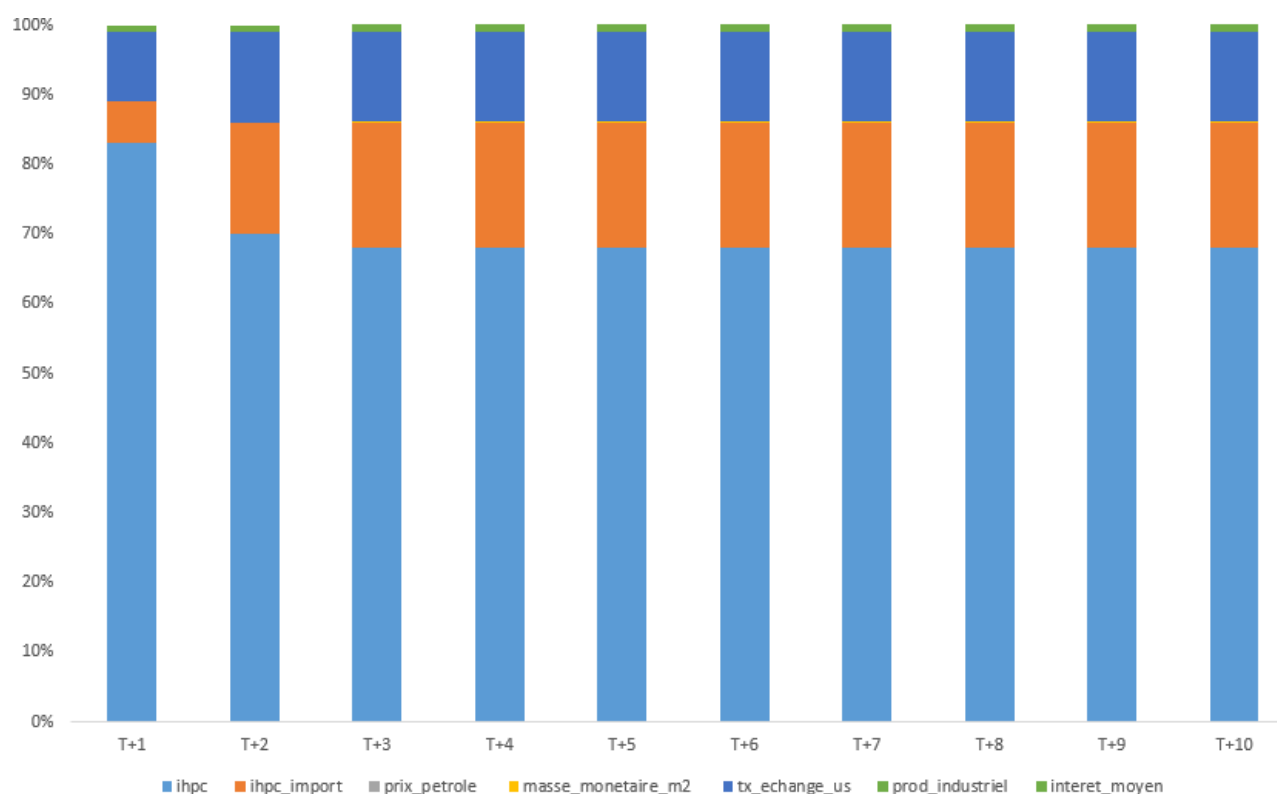
Graph5 - Impulse response functions



Source: BPE

III.2.2 Variance decomposition of the forecast error

The decomposition of the variance of the inflation forecast error reveals an important inertial component of inflation (past value of the price index) in explaining the current level of the index. Over 70% of the 10-month forecast error in Senegal's HICP is due to its own fluctuations. The 2nd most important factor, explaining fluctuations in the HICP forecast error, concerns innovations in the prices of imported products. These explain between 6% and 18% of HICP 10-month forecast error fluctuations. The remaining variables do not strongly influence HICP fluctuations.

Graph6 - Variance decomposition of forecast error

Source: BPE

Conclusion and policy implications

The aim of this study was to explain the dynamics of inflation in Senegal. A descriptive analysis revealed that it is the products in the "Food and non-alcoholic beverages" function that are driving the overall price level upwards. Between January and July 2022, this function recorded an average contribution of 90.89% to the rise in inflation.

A Structural VAR econometric model was estimated on monthly data, covering the period January 2015 - July 2022, to assess the dynamics of the Harmonised Index of Consumer Prices (HICP). The other variables in the empirical model used include various national macroeconomic indicators (industrial production index, money supply) and international indicators (oil price, import price index, USD/FCFA exchange rate). According to the results of the model, a 1% rise in the price of imported products would generate a 0.55% rise in the HICP the following month, whilst a 1% rise in industrial production generates very negligible effects from the second month following the increase. Similarly, the effects of the

money supply are weak: when it increases by 1%, it causes a negligible (if any) rise in the HICP the following month, but this rise reaches 0.03% in the 3rd month.

Moreover, over 75% of the observed price fluctuations are explained by their own past variations (inertia effect), and between 21.5% and 25.2% by the prices of imported products. The findings of this study are in line with those of Dembo Toé and Hounkpatin (2007), who used a VAR model to analyse the determinants of inflation in the UEMOA zone. Indeed, they showed that changes in the money supply have a significant but weak impact on inflation in the UEMOA. Moreover, they also highlighted the presence of a strong inertial component in inflation in the zone: around 80% of inflation forecast error in the UEMOA was due to its own innovations and around 10% to developments in imported inflation. This study also shows that inflation is not systematically a monetary phenomenon, as many economists maintain.

This study has limitations, which suggest directions for future research. One limitation is that the study focuses on the short-term dynamics of inflation. Future research could examine the long-term dynamics and the effects of structural changes on inflation. Another limitation is that the study assumes that the money supply is the main instrument of monetary policy. Future research could explore the role of other policy instruments, such as the policy rate and macroprudential measures, in influencing inflation.

Key implications emerge from these results for policymakers:

Import price stabilisation policy: Given the significant impact of import prices on the Harmonised Index of Consumer Prices (HICP), authorities could consider policies aimed at stabilising import prices. Such policies could include trade agreements or forward contracts on key imported products. Another way of reducing the impact of high inflation rates could be to lower trade restrictions, including import tariffs, quotas and other trade barriers (World Bank, 2022). These import restrictions increase the price of goods and these additional costs would be passed on to consumers.

Promoting domestic production: An increase in industrial production appears to have a negative, albeit very negligible, impact on the HICP. This suggests that policies to promote domestic industry could be beneficial for long-term price stability. Similarly, efforts to promote self-sufficiency or import substitution could help minimise the impact of price fluctuations on imported products. In order to reduce the transmission of world price fluctuations to domestic prices, the urgent need remains to develop national production (particularly of food and energy goods), by implementing an ambitious, coordinated programme of national sovereignty in targeted areas and ensuring that it is accompanied by appropriate financing and an effective monitoring-evaluation mechanism that is proactive, decentralised and inclusive. This remains the most important challenge, since Senegal's inflation is

mainly driven by foreign trade. Another way is to diversify energy and food supplies, giving priority to imports from the sub-region. In this respect, accelerating the implementation of the Continental Free Trade Area (ZLECAF) will undoubtedly contribute to controlling imported inflation. This economic integration will stimulate intra-regional trade in agricultural goods, foodstuffs, industrial goods and services.

Anti-inflationary market regulation policy: Given the strong inertial component of inflation, it cannot be contained in Senegal without a sound market regulation policy to prevent mark-up behaviour. In addition to pro-active monitoring of sectors, through intelligent surveillance of international and local markets and commercial practices, the State should more rapidly activate administered prices and reference prices or stores more quickly when the situation requires it, so as to curb any desire for an inflationary spiral very early on. It must also set up a real strategy of communication and consumer information on market conditions and on the most realistic prices. At the same time, it must establish a strong partnership with private actors and consumers to win the war against inflation together.

It must also set up a real communication strategy to inform consumers about market conditions and the most realistic prices. It must also set up a real strategy for communicating and informing consumers about market conditions and the most realistic prices. At the same time, it needs to establish a strong partnership with private players and consumers, so that together we can win the war against inflation.

Monetary policy to reduce inflationary expectations: The results of the study also show a significant but very weak impact of the money supply on the evolution of the general price level. As a result, the central bank must closely monitor price trends and be ready to raise rates, if inflation expectations drift upwards.

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Appendix

Harmonised index of consumer prices in WAEMU member states

It is mainly used to measure average price variations for household final consumption goods and services in the national economy.

It is used to calculate the inflation rate, which is one of the primary criteria for multilateral surveillance.

The theoretical scope of the price index is household final monetary consumption expenditure.

Household final monetary consumption expenditure covers final consumption expenditure:

- by resident households, regardless of nationality;
- on the country's economic territory;
- in monetary transactions ;
- for the acquisition of goods and services that directly satisfy individual needs;
- over the period studied.

It is calculated using the Laspeyres formula. The weights used correspond to the consumption structure of the base year 2014.

$$IHPC_t = \sum_{i=1}^n P_i * I_{it}$$

With P_i : weighting of consumption function i et I_{it} : index of consumption function i at period t. **Source: AFRISTAT**

1.1 Correlation analysis: methodology and results

To determine the products whose prices are most closely correlated with other products, we calculated an average correlation coefficient. For each given product, we assessed its correlation coefficient with the others. We then calculated the average of these coefficients for the product in question.

- **Consumption functions**

The study of product linkage highlights three types of product: those with a strong link to other products and a low weight in household budgets; those with a relatively weak link to other products and a low weight in household budgets; and those with both a high weight and a high link.

Food products represent high-consumption products with relatively high correlations. An increase in the price of these products leads, through their weight and link with other products, to an increase in the general price level. Products in the "Housing, water, gas, electricity and other fuels" function also have both a high correlation and a high weight.

Products in the "Furniture, household goods and routine household maintenance", "Transports" and "Miscellaneous goods and services" functions have low weights but record the highest correlations with other prices. An increase in the prices of these products will probably lead to an increase in the prices of other goods and, thus, to an increase in the general price level.

The products of the "Communication", "Education" and "Restaurants and Hotels" functions have both low weights and low correlations. These are services whose weight in household consumption is very low and which have no impact on trends in other products. An increase in the prices of these services will have very little effect on the general price level.

Table 4 - Correlations

Consumption functions	Correlation average	Correlation with ihpc	Weight
Food and wood products-of non-alcoholic sounds	.	390.74	4964
Alcoholic beverages, tobacco and Narcotics	0.32	0.48	49
Clothing and footwear Safe	0.3	0.64	730
Housing, water, gas, electricity and other fuels	0.35	0.68	1204
Furniture, household goods and routine household maintenance	0.46	0.86	502
Health	0.18	0.19	353
Transport	0.41	0.66	563
Communication	0.054	0.22	329
Leisure and culture	0.32	0.50	353
Teaching	0.099	0.02	194
Restaurants and Hotels	0.09	0.03	376
Miscellaneous goods and services	0.366	0.71	383

Source BPE (Data: ANSD)

• Principal Component Analysis of consumption functions

In order to analyse the various links that may exist between product prices in Senegal, a Principal Component Analysis (PCA) on the indices of the 12 consumption functions was carried out. This makes it possible to detect products that are similar in terms of price trends and that move at the same pace as inflation. In fact, the chronological nature of the data requires a more specific form of interpretation. As in all PCA, factors are linearly non-redundant variables that summarise all the variables under study. Here, each variable in the table is a time series, so the factors are time series that summarise the temporal evolution of all the variables.

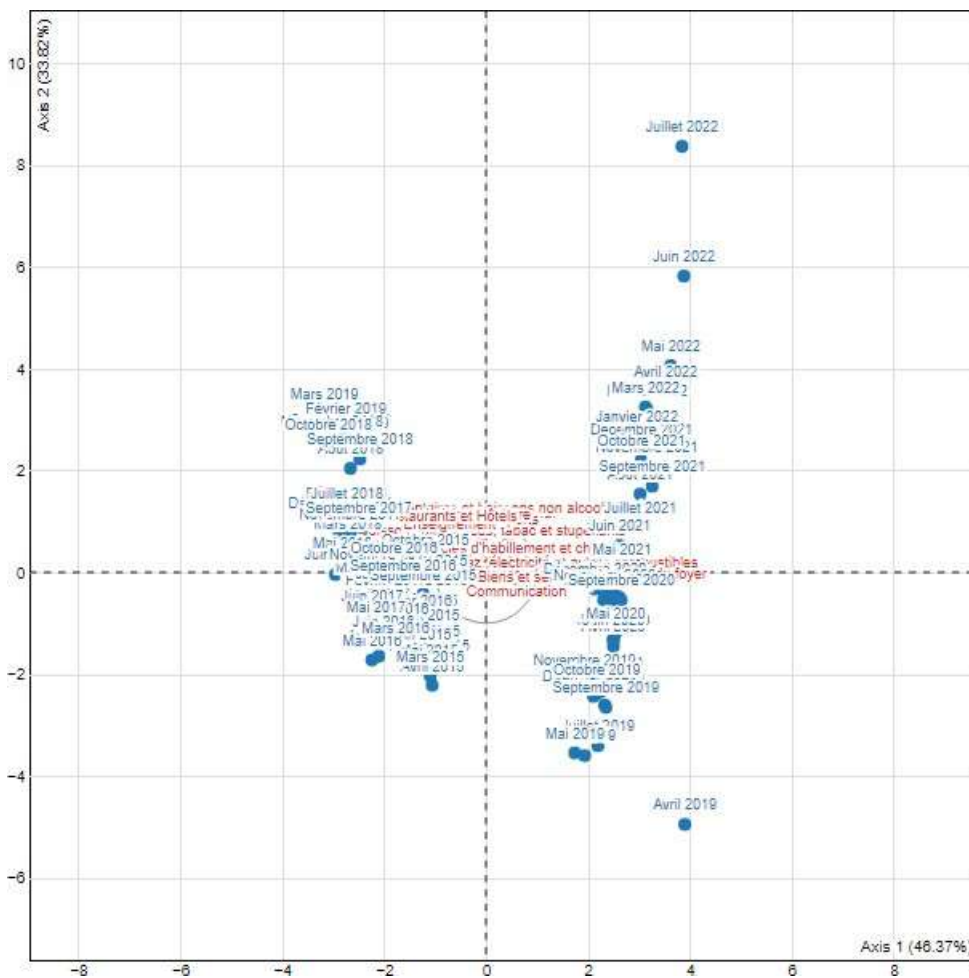
The dates of observation are taken as the individuals in the table, with the quantities observed as the variables. In this way, the cloud of individuals will reveal the temporal profile of the factors and through the cloud of variables we can then analyse the different variables in the table in terms of their correlations with these factors.

T Cloud of individuals:

From the cloud of individuals, we can see that the same months in the various years are very disparate on the graph.

This means that there is no similarity between the same months in different years: thus, there is no seasonality in the evolution of price levels, in other words, prices do not evolve according to specific periods or seasons of the year. The graph shows 2 main groups: the 1st covers the years 2015, 2016, 2017, 2018 and 2019, and the 2nd covers the years 2020, 2021 and 2022. In the 1st group, the factor coordinates show an upward trend between 2015 and 2019. Similarly, the 2nd group shows an upward trend between 2019 and 2022. This rise accelerated sharply from May 2022 onwards, reaching a peak in July 2022.

Graph7 - PCA - Individuals cloud

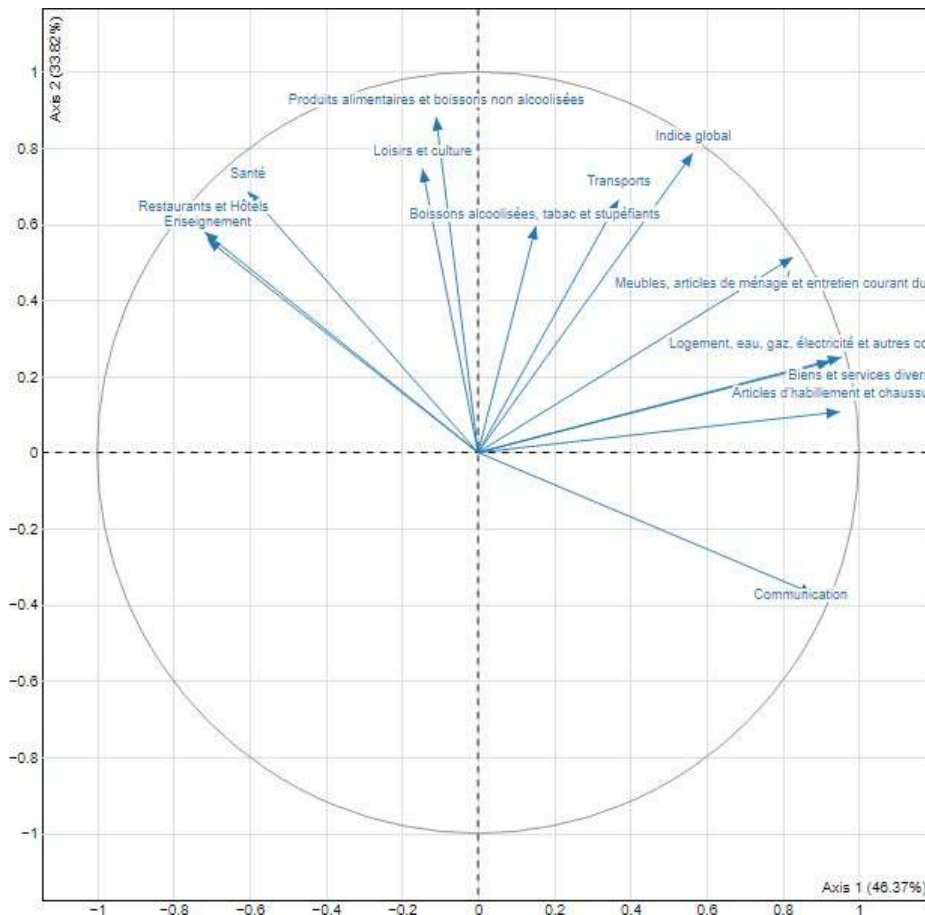


Source: BPE (Data: ANSD)

T Variable cloud:

The overall index is best represented in the plan. "Clothing functions and footwear", "Miscellaneous goods and services" and "Housing, water, gas, electricity" are highly correlated, with the prices of products in these consumption functions evolving broadly according to the profile of factor 1. Thus, prices for clothing and footwear, housing, water, gas and electricity, as well as the overall index, rose more or less continuously between 2015 and 2019, with a sharp drop in 2019, before starting a gradual rise that has become much more pronounced in recent months. Products in the "Transport" and "Furniture, household goods and routine household maintenance" groups are the most closely correlated with the HICP.

Graph8 - PCA - Variable cloud



Source: BPE (Data: ANSD)

- **Product analysis**

The table below shows the products with the highest average correlations with other products. If the price of these products were to rise, we would expect the price of other products to rise. However, despite being the highest correlations, they are still very low (below 0.4). In order to draw more convincing conclusions, we could also look at the correlations between these products and the HICP. It can be seen that, with the exception of the products "Powdered milk, Metal can or aluminium packaging", "SUPER" petrol at administered service stations" and "Retail wheat flour", all the other products having the highest correlations with the others are very strongly linked to the HICP (Results in Appendix). These products should, therefore, be monitored, as their evolution could provide sufficient information on the overall situation.

Table 5 - Highest average correlations

Varieties	Average correlation
Retail corn kernels	0,355
Retail sorghum	0.340
Vegetable oil pod 12.5 cl	0.323
Milk powder, tin or aluminium packaging	0.313
Vegetable oil	0.297
Retail millet grain	0.290
Unshelled, unroasted peanuts	0.275
Retail wheat flour	0.273
Shelled peanut	0.249
SUPER" petrol at managed service stations	0.249

Source: BPE (Data: ANSD)

Table 6 - Correlations with the highest ihpc

Varieties	Correlation with ihpc
Shelled peanut	0.925
Retail millet grain	0.881
Unshelled, unroasted peanuts	0.827
Vegetable oil	0.812
Retail corn kernels	0.802
Concrete reinforcing bar	0.798
Retail long grain rice	0.741
Retail sorghum	0.705
Vegetable oil pod 12.5 cl	0.680

Ordinary broken rice, retail	0.671
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Source: BPE (Data: ANSD)

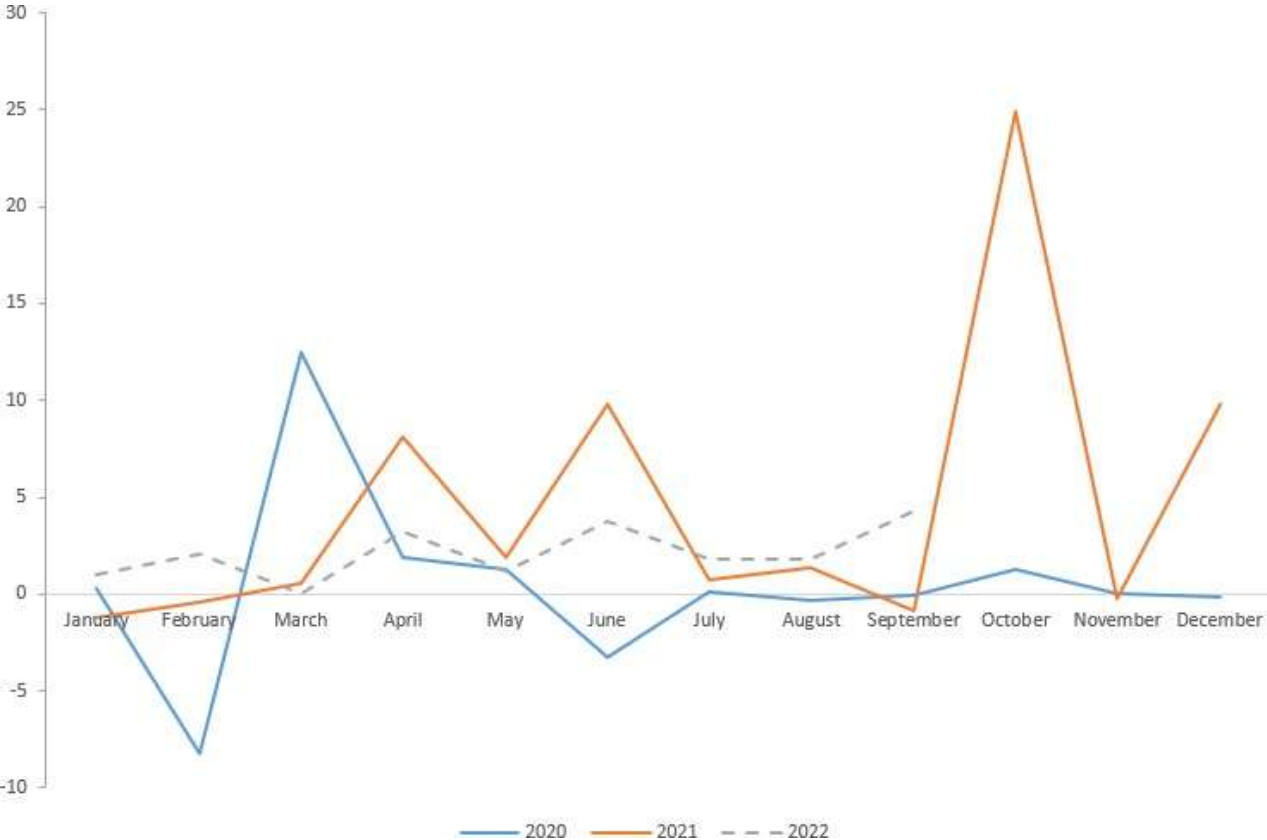
Contribution calculation results

Table 7 - Inflation-mitigating products (2020-2022)

Varieties	Average contributions
Cucumber	-0.02
Tapioca	-0.03
Fresh bell pepper	-0.20
Millet flour sold in bulk	-0..2
Carrots	-0.65
Retail long grain rice	-0.73

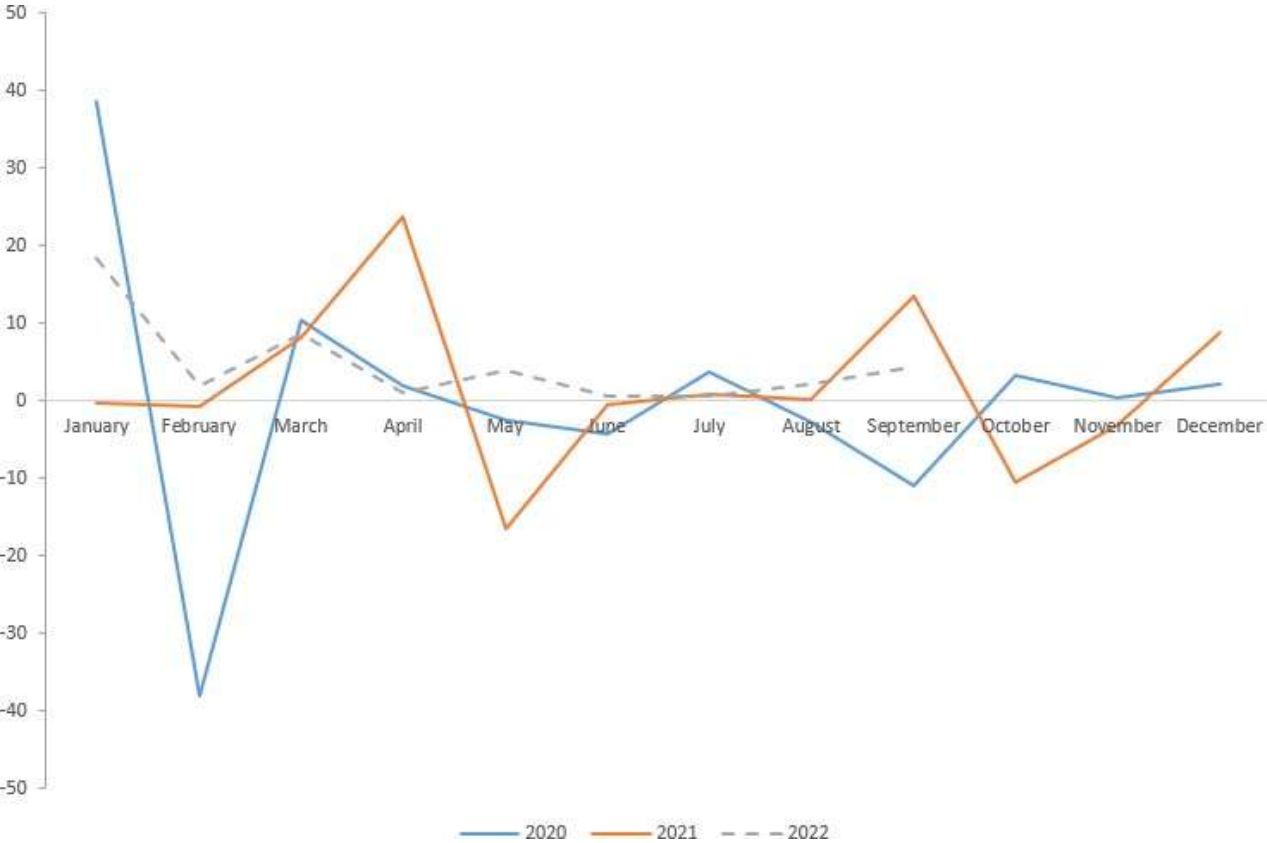
Source: BPE

Graph9 - Evolution of vegetable oil contributions



Source: BPE

Graph10 - Contributions of retail broken rice



Source: BPE

Econometric modelling

- **Modelling steps**

- 1. Chart analysis:**

The study of time series requires a series of visual examinations to detect the properties of the series (trend, seasonality, etc.). Ignoring this can lead to totally meaningless conclusions, commonly referred to as spurious modelling.

- 2. Stationarity analysis:**

Stationarity is an important concept in the study of time series. It refers to the temporal invariance of time series properties. In other words, if the process is stationary, its properties are not affected by a change of "time reference point": whether we look at point t or point $t+k$, the series will always behave in the same way.

- 3. Cointegration test:**

Cointegration theory is used to study non-stationary series in which one linear combination is stationary. Indeed, 2 variables $I(1)$, each non-stationary, are cointegrated if they evolve together in a stationary manner (equilibrium relationship). This makes it possible to identify the true relationship between several variables.

It is, therefore, important to test for the presence of cointegration in order to decide how to estimate the model (level or difference variable). Indeed, if the series are cointegrated, we use an error-correction model, otherwise we can use a VAR on the stationary variables in difference.

- 4. Model estimation:**

The choice of model is based on the results of unit root and cointegration tests. There are 2 main methods for estimating the parameters of a VAR model: the OLS (Ordinary Least Squares) method and the Maximum Likelihood method.

- 5. Model validation:**

The Maximum Likelihood estimation method and the coefficient significance tests are based on the assumption that the errors are Gaussian white noise, i.e., the errors are homoscedastic, non-autocorrelated and follow the normal distribution. So, before interpreting the results of the model, a few tests on the residuals must be carried out, in order to "validate the model".

- 6. Analysis/interpretation of results:**

Once the validity of the model has been verified, the results can be interpreted. For a

VAR model, we generally limit ourselves to interpreting the IRFs and the variance decomposition of the forecast error.

The VECM model assumes cointegration of the model series. Economically, this means that there is a stable long-term relationship between the variables.

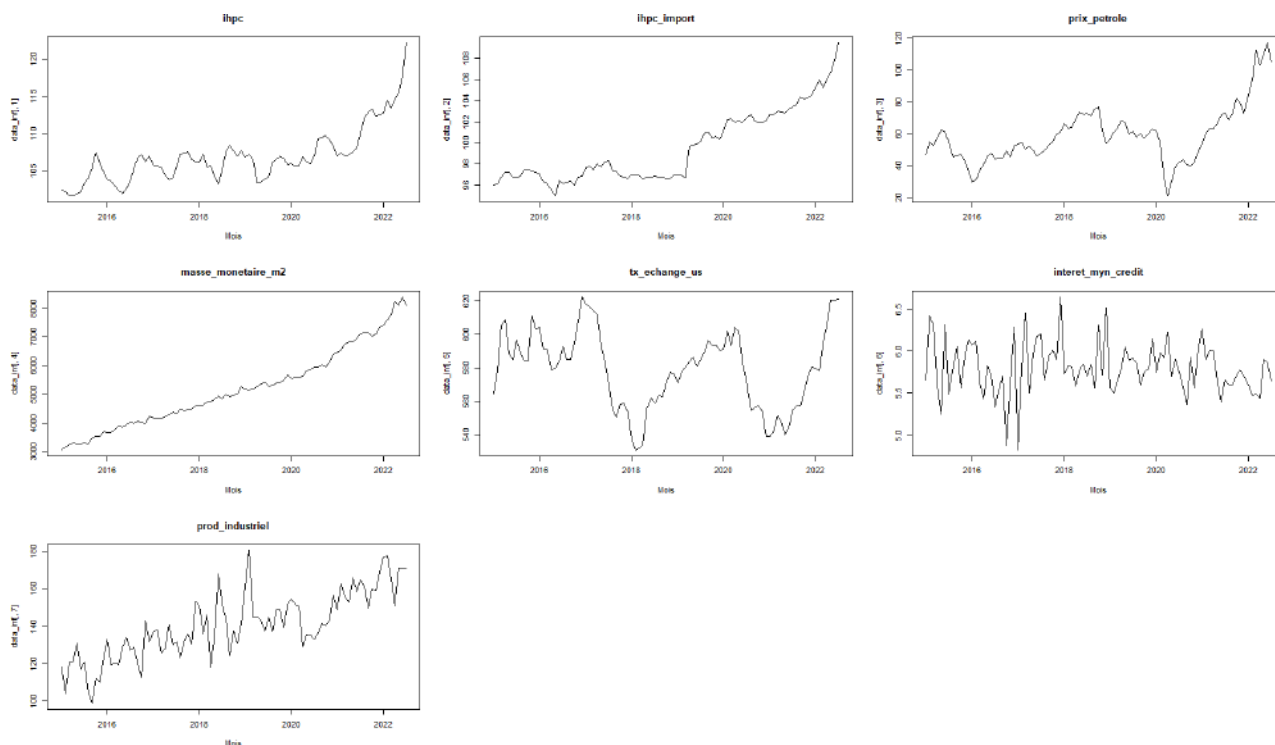
The VAR model measures the variation of a variable as a function of its past value and the past value of other factors.

Three main tools can be used through VAR models to analyse the impacts of economic policies:

- T Impulse response functions: These are simple and well-known tools for the quantitative study of the dynamic propagation of economic shocks. They will enable us to obtain an overall picture of Senegal's inflation response to an exogenous shock.
- T Forecast error variance decomposition: This approach will be useful for quantifying the interactions between the different variables. The aim is to calculate the contribution of each innovation to the variance of the error.
- T Forecasting: The future values of the variables in a VAR model can be estimated.

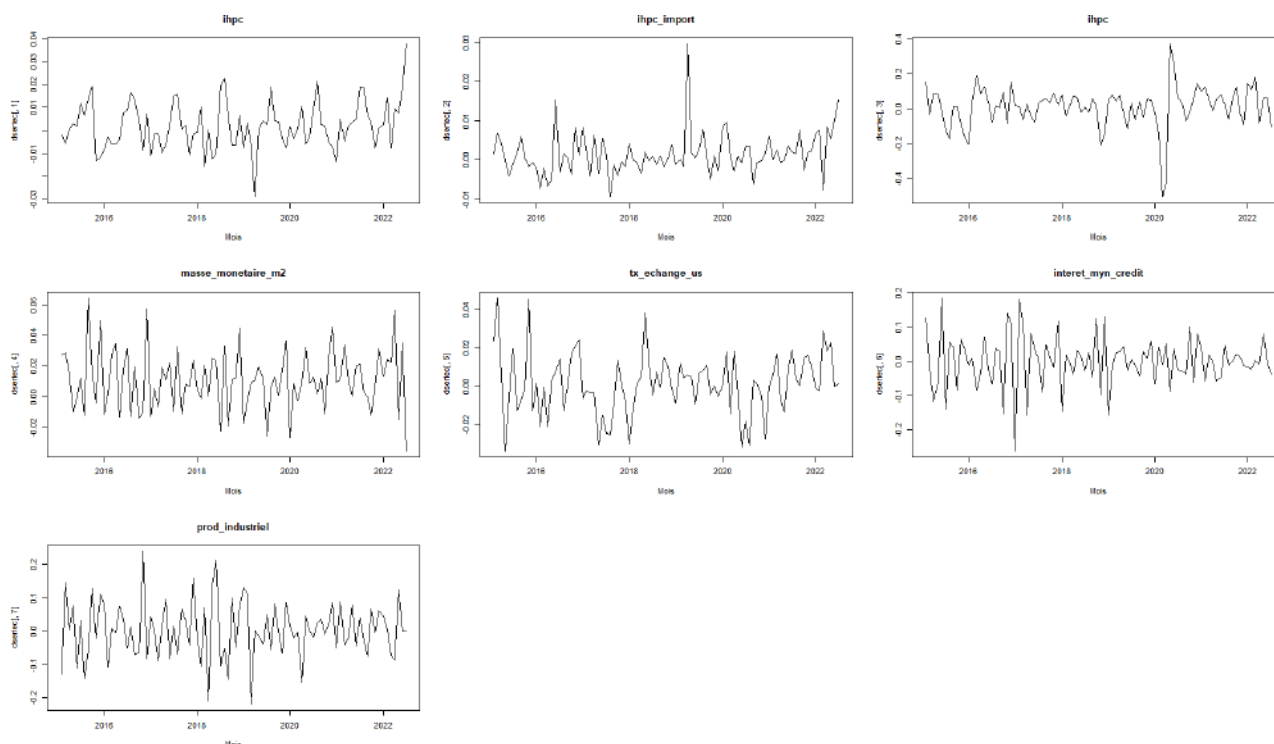
- Analysis results and statistical tests

Graph11 - Graphical representation of raw series



Source: BPE

FIGURE 12 - Graphical representation of transformed series



Source: BPE

Table 8 - Descriptive statistics for variables

	Min	Max	Q1	Median	Q3	Average	Standard deviation
IHPC	101.5	122.1	104.3	106.4	107.6	106.8	3.70
Price index for imported products	95.01	109.38	96.83	97.69	102.13	99.52	3.36
Oil prices	21.04	116.8	46.62	57.27	66.62	58.93	18.03
Money supply	3074	8394	4117	5008	5953	5181	1369..6
Exchange rates	531.2	622.2	558.4	580.9	593.5	578.8	23.28
Average interest rate	4.83	6.646	5.6	5.78	5.975	5.8	0.31
Industrial production index	98.9	180.33	129.11	137.64	151.6	140.35	17.87

Source: BPE

Table 9 - Stationarity and unit root tests on raw series

	Test	KPSSTes	Philips-Perron test
	t ADF		
IHPC	.01	0.9179	0.8093
IHPC_import	.01	0.9823	0.9882
Oil price	.01	0.7066	0.7282
Money supply M2	0.01877	0.99	0.9471
Exchange rate	.1	0.6901	0.5834
Industrial Production Index	0.01	0.217	0.5867
Interest rate	.1	0.1797	0.99

Source: BPE calculations

Table 10 - Stationarity and unit root tests on transformed series

	Test	ADF test	Philips-Perron test
	KPSS		
IHPC	0.1	0.01	0.01
IHPC_import	0.06379	0.01	0.01
Industrial production index	0.09875	0.01	0.01
Oil prices	0.1	0.01	0.01
Money supply M2	0.1	0.01	0.01
Exchange rates	0.1	0.01	0.01
Interest rates	0.1	0.01	0.01

Source: BPE calculations

Table 11 - Selecting the P order of the P = 1P = 2P = 3 model
AIC **-3.780006e+01** -3.776845e+01 -3.721370e+01

HQ **-3.716092e+01** -3.657007e+01 -3.545607e+01

SC **-3.621280e+01** -3.479236e+01 -3.284876e+01

FPE **3.847939e-17** 4.054582e-17 7.453937e-17

Source: BPE calculations

Table 12 - Non-autocorrelation test

	TestChi-squaredP	valueConclusion
Breusch-Godfrey LM test	86.608	0.1154 Non-autocorrelation
Portmanteau531	.99	0.5889 Non-autocorrelation

Source: BPE calculations

Table 13 - Residual normality test

	TestChi-squaredP	Value Jarques-Berra
testo	.32899	0.8483

Source: BPE calculations

Table 14 - Homoscedasticity test

	TestChi-squaredP	Value ARCH1404
	0.05903	.3

Source: BPE calculations



ABOUT EMANES

The Euro-Mediterranean and African Network for Economic Studies (EMANES) is a network of research institutions and think tanks working on socio-economics policy in Europe, the Mediterranean and Africa. EMANES is coordinated by the Euro-Mediterranean Economists Association (EMEA).

The research conducted by EMANES Researchers, Associates and Fellows aims to design sound and innovative socio-economic models that are inclusive, sustainable and employment creative, to devise new models for regional integration and to provide policy recommendations towards this goal.

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- Healthcare policy;
- Human capital development, education, innovation, skill mismatch and migration;
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- Finance, financial inclusion and the real economy;
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- Regional integration;
- Euro-Mediterranean economic partnership;
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