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A comparative analysis of inflation determinants in Morocco, Turkey, and Egypt using the Backward Elimination and Forward Regression Method

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Abstract: This paper examines the impact of internal and external factors on the inflation rate for three emerging economies, Morocco, Egypt and Turkey. Using annual data, covering the period (2009-2022) after two crises; international financial crisis 2008 and covid'19 crisis. In this study, we use backward elimination and forward regression as econometric methods.
According to our estimation results, the variables that have a significance influence (a degree of significance lower than 0.05) and thus a significant relationship with the inflation rate, namely unemployment rate, exportations and broad money (M3) for Morocco; Real effective exchange rate (REER), external balance, broad money (M3) and Households and NPISHs Final consumption expenditure for Egypt; Importations, key rate, REER and broad money (M3) for Turkey. Consequently, the inflation rate is affected, in the three countries, by internal and external factors. However, when applying the second method, new explanatory variables emerge for Morocco, such as imports, households and NPISHs final consumption expenditure, and exports for Turkey. Overall and upon its findings, it is worth noting that Turkey is the country most affected by inflation, followed by Egypt and, lastly, Morocco.

Keywords: Inflation; internal factor; external factor; backward elimination; forward; modeling.

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1. Introduction

Inflation is the persistent, general and self-sustaining increase in the prices of goods and services. It is a phenomenon that has been the subject of a wide range of empirical studies, particularly in recent years following the two crises that marked the beginning of the 21st century: the global financial crisis known as the Great Recession (2007-2008) and the Covid'19 health crisis (2020). The analyses carried out focus mainly on the internal and external factors that have the greatest impact on inflation, with a view to identifying them and ensuring price stability, the primary task of central banks.

Inflation is one of the main phenomena of the 20th century, which emerged after the First World War. Limited inflationary spikes were gradually followed by galloping inflation (double-digit inflation in the

1970s) and then by creeping inflation (a sustained and moderate rise in the general price level). Since the end of the eighties, inflation has been decelerating worldwide, becoming less persistent and less sensitive to supply shocks; from 10.4% in 1994, the inflation rate fell to 4.8% in 2007, before falling to 8.9% in 2008 as a result of the international financial crisis, and to 8% in 2022. This rise is the result of the recovery of economic activity after the Covid'19 health crisis and the Russian invasion of Ukraine, which led to sanctions against Russia that created "additional upward pressure on prices" [1].

The experience of individual countries shows that low inflation is essential for macroeconomic stability. In fact, high inflation is generally detrimental to this stability, mainly because of a fall in domestic savings due to deeply negative real interest rates, a fall in capital accumulation due to increased uncertainty, and a real appreciation of the exchange rate due to large inflation differentials with the country's main trading partners, which can have a negative impact on export competitiveness [2].
The analysis of inflation has been controversial between different schools of economic thought, in particular between Keynesianism (John N. Keynes) which emphasizes public spending to control the economy, and monetarism (Milton Friedman), which emphasizes controlling the money supply to control the economy. Monetarists believe in fighting inflation by adjusting the amount of money in circulation.

However, most central banks in many countries around the world face the problem of choosing the optimal monetary policy. Firstly, maintaining a stable exchange rate through foreign exchange intervention and key policies affects the money supply and balances the price level, which shows the need to avoid contradictions between exchange rate stability and the stability of the domestic economy. Secondly, monetary instruments affect inflation, unemployment, GDP growth, etc. (Mishkin, 2008) [3]. Therefore, it is necessary to determine this influence on financial and economic dynamics.

In this context, this paper focuses on examining inflation in Morocco, Egypt and Turkey over the period (2009-2022) in order to identify the main determinants of inflation in these economies. We would like to emphasize that the central question to which we seek to provide empirical answers is: **"What are the factors that most influence the level of inflation? Is there a common factor that influences inflation in all three countries?"**

To answer our research questions, we will review the general principles of inflation, provide an overview of the evolution of the inflation rate in the three countries and compare it with that of the euro area and the United States, and discuss the various trends and references that have carried out this type of analysis. Finally, we will present the results obtained, which will be discussed and explained with a view to better forecasting inflation.

2. Literature review

2.1 *Inflation: A General View*

In a market economy, which follows the law of supply and demand, the prices of goods and services rise or fall. Inflation occurs when prices rise across the board, not just for a few goods and services. When this happens, each unit of local currency buys fewer products over time. As a result, the value of the currency falls, leading to a decline in its purchasing power [4].

- Measuring and calculating inflation

Inflation is measured by the Consumer Price Index (CPI), which calculates the ratio of the cost of a basket of goods and services representative of household consumption in the current period to the cost of the same basket in the base (reference) period. The cost of the basket is based on quantities in the base year, but prices differ according to the year of calculation [5]. The aim of the CPI is to track changes in the cost of living over time.
The rate of inflation measured by the CPI is calculated as a year-on-year rate.

- **CPI= (Cost of Basket in Current Year / Cost of Basket in Base Year) ×100**

- **Inflation Rate= ((CPI in Year 2- CPI in Year 1)/CPI in Year 1) ×100**

- Causes of inflation:

Inflation can be caused by a variety of economic, social and structural factors. Some of the reasons for price rises are:

- Increased demand: If demand for goods and services increases faster than supply, prices will rise accordingly. This can happen, for example, when interest rates are low, stimulating demand for credit and consumption.
- Rising production costs: if the costs of raw materials, energy and taxes, which are all part of the cost of production, rise, companies may have to raise prices to maintain profit margins.
- Currency depreciation: if the value of the local currency falls in relation to that of other countries, imports become more expensive, which can lead to higher prices.
- If the amount of money in circulation increases faster than economic growth, this can lead to higher prices. This can happen when central banks print money to finance budget deficits, economic stimulus programs or wars.
- External factors: International events such as wars, economic sanctions and natural disasters can also cause prices to rise. For example, a drought that reduces agricultural production can lead to higher food prices.

It is important to note that these factors are not mutually exclusive and can often interact to influence inflation. For example, an increase in production costs may be caused by an increase in the price of raw materials due to a shortage caused by a natural disaster, leading to an increase in consumer prices [6].

2.2 *Theoretical approaches:*

The determination of inflation is commonly debated all over the world;
According to the classical approach, inflation is the result of an imbalance between the supply and demand of money. Based on this logic, money is neutral in the long term and has no effect on production and, of course, prices. It suggests that when demand exceeds supply, prices tend to rise, leading to an increase in production costs and a rise in prices. Similarly, a fall in demand leads to a fall in prices. So, the proposed solution to inflation is to ensure a balance between money supply and demand by limiting the growth of the money supply.

From the Renaissance onwards, Nicolaus Copernicus (1517) and Jean Bodin (1568) had pointed out the link between the quantity of money in circulation and the evolution of prices. Indeed, after the colonization of America and the introduction of gold, inflationary pressures emerged, particularly in Spain.

In the 19th century, the quantity theory of money was further developed by the British economist David Ricardo and Karl Marx, although he disagreed with Ricardo on many points because he believed that the quantity and the price of commodities are the determining elements and that the volume of money follows from them, was also a proponent of the quantity theory of money. This theory states that the general price level of goods and services is directly related to the quantity of money in circulation (i.e., the money supply), and that causality extends from money to prices.

The quantity theory of money was defended in the second half of the twentieth century, after it was reformulated in the 1910s by Irving Fisher [7], by a school of thought sometimes referred to as monetarism, of which Milton Friedman was a leading exponent. According to Friedman (1963) [8], "inflation is always and everywhere a monetary phenomenon, in the sense that it is and can only be caused by an increase in the quantity of money that is faster than the increase in output".

The monetarist theory believes that inflation is the result of an overexpansion of the money supply, which stimulates aggregate demand and consequently prices. This approach argues that the only way to control inflation is to regulate the money supply. It therefore recommends a monetary policy rigorously controlled by the central bank, which must ensure a balance between money supply and growth. To achieve this purpose, the central bank can raise interest rates, reduce the money supply and limit bank debt.

However, not all economists agree with this approach. In particular, the theory defended by John Maynard Keynes (1930) [9]. This British economist demonstrated that inflation is the consequence of aggregate demand exceeding aggregate supply. According to this theory, prices and output are

influenced by aggregate demand, which includes investment, public spending and consumption. To control inflation, this approach advocates government intervention, either by cutting public spending or by raising interest rates to dampen aggregate demand.

Phillips (1958) [10] and Branson (1975) [11] are among the first classic studies of the impact of inflation and monetary policy instruments on economic performance. The classic study by Phillips (1958) showed an inverse relationship between inflation and unemployment, as the result of the historical analysis of UK between 1867 and 1957. The Phillip's curve served as the basis for Keynesian policies until the 1970s, when it was called into question, particularly by the monetarist model. In 1975, Branson (1975) showed related theoretical results for the GNP deflator and the main instruments of monetary control.

Observers are increasingly inclined to declare the death of the Phillips curve, i.e. the flattening of its slope to zero for the US labor market, but this effect is still present for the wage Phillips curve. However, the analysis also reveals a significant difference between the price Phillips curve and the wage Phillips curve over the last few decades, with the wage Phillips curve becoming much less flat and retaining greater non-linearity. The results suggest that reports of the death of the Phillips curve may be greatly exaggerated (Hooper, Mishkin, & Sufi, 2020) [12].

A Moroccan empirical example is provided by LAHLOU Kamal and BENNOUNA Hicham (2022) [13], who analyze the determinants of inflation in Morocco over the last decade. The results of estimating the Phillips curve driven by external factors and the SVAR model with sign restriction showed that: (i) domestic demand has an increasingly weak influence on the evolution of inflation, (ii) the dynamics of inflation are mainly influenced by its past, (iii) given the acceleration of Morocco's integration into the international economy, the role of exogenous factors has been amply confirmed (6). Echcharfi-Loukili (2019) [14], investigated the leeway for monetary policy in Morocco from the perspective of the theory of the incompatibility triangle. The results of the simulation of three scenarios (the current exchange rate regime, informal steering of the exchange rate and pure inflation targeting) reveal the supremacy of the pure inflation targeting regime in comparison to the current exchange rate peg regime and a managed floating exchange rate regime.

Kuzheliev, Zherlitsyn, Rekunenko, Nechyporenko and Nemsadze (2020) [15] show for Ukraine that inflation does not affect fundamental economic indicators during periods of real GDP growth and quarterly CPI levels below 2%. Moreover, there are significant simultaneous regressions between real final consumption expenditure, the hryvnia exchange rate unemployment rate, and monetary policy instruments (amount of government bonds, international reserves, monetary aggregate M3 and discount rate) for periods when the quarterly CPI (consumer price index) is above 2%.

For Egypt, there are studies consider only the contribution of monetary policy to explaining inflation. (Sharaf, 2015 [16]; El Baz, 2014 [17]; Arbatli & Moriyama, 2011[18]; Helmy, 2010 [19]; and Youssef, 2007 [20]. Osama El-Baze (2014) [17] confirmed, through an empirical investigation, that inflation responds positively to exchange rate depreciation, output gap, domestic liquidity growth rate and world food prices. There are also some Egyptian studies that consider exogenous factors in determining inflation., but they do not involve monetary policies (Hosny, 2013 [21]; Al-Shawarby & Selim, 2012 [22]; as well as El-Sakka & Ghali, 2005 [23]).

As the review of empirical data for Egypt shows, the determinants of inflation are assessed from different angles, focusing either on external factors or on internal factors, but not on both at the same time.

From the Turkish studies, Öniş and Özmucur (1990) [24] find a considerable effect of devaluations on the domestic inflation rate. On the other hand, Rittenberg (1993) [25]; prove that the direction of causality between the exchange rate and the price level is from changes in the price level to changes in the exchange rate, thus demonstrating the validity of purchasing power parity for the Turkish economy.

However, Wijnbergen and Erol (1997) [26] find that the real exchange rate targeting policy would only have a moderate inflationary effect on the economy. Erol (1997) [27], Leigh and Rossi (2002) [28], Kesriyeli and Koçaker (1999) [29] and also Metin-Özcan, Berument and Neyaptı (2004) [30] provide evidence on the role of exchange rate depreciation on inflation. B. Akçay (1997) prove wage rises to be a crucial determinant of inflation dynamics. Moreover Umit Bulut (2017) [31] finds, 12 and 24 months

ahead expected inflation rate is positively related to past inflation rate, inflation target, output gap, USD/TL exchange rate.

3. Statement of inflation in Morocco, Turkey and Egypt

The graph below shows inflation trends in the 3 countries compared with the eurozone and the United States, their main economic partners. We note that Morocco's inflation curve perfectly follows that of the euro area and the United States, which will see an increase in 2022 as a result of the war in Russia and Ukraine and rising energy product prices. However, inflation in Morocco remains tame at between 1% and 2%.

Meanwhile, between 2009 and 2016, inflation in Egypt followed that of the euro area and the USA, with a remarkable rise in 2017 following the liberalization of the exchange rate which caused inflation to rise to 33% in July 2017, although it started to fall in 2018, reaching 3.1% in October 2019. As a result, the current account deficit fell to 2.4% of GDP in 2017/18 and 3.1% of GDP in 2019/2020 [32].

In the case of Turkey, which reached a record level of inflation in 2022 following the depreciation of the Turkish lira. Turkish inflation, which has been in double digits since 2019, was until last spring explained by Turkish leader Recep Tayyip Erdogan's determination to lower his central bank's interest rates at all costs. From August onwards, interest rates were cut on a monthly basis, bringing the key Turkish interest rate down to 9% in November, compared with 10.5% previously. This monetary policy had a severe impact on the Turkish lira. In October, it fell 36.7% against the euro year-on-year, having already fallen 44% in 2021 [33].

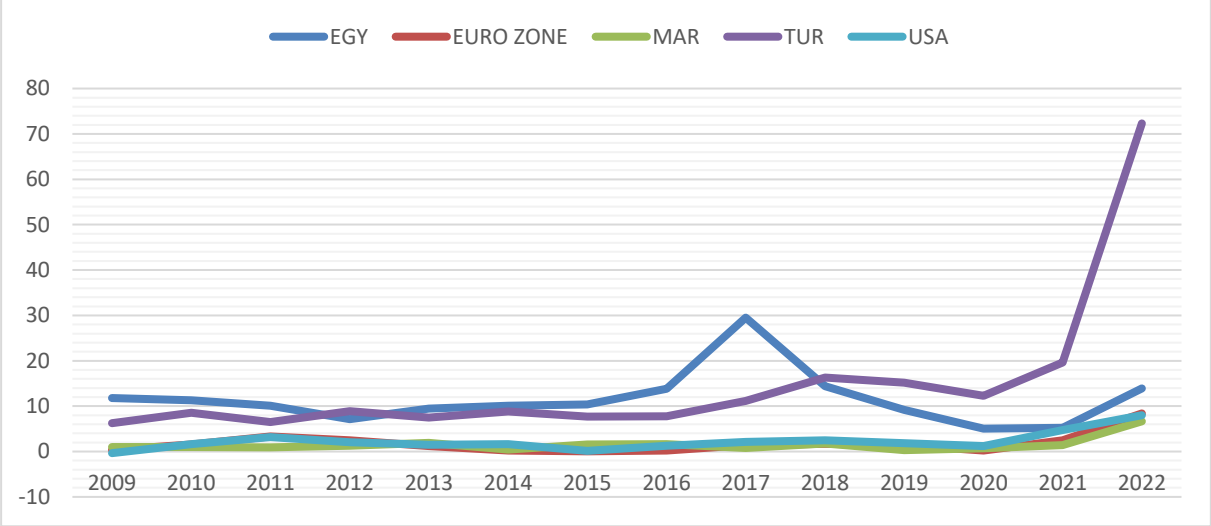

Figure 1. Evolution of inflation in Egypt, Morocco and Turkey

4. Modelling of inflation

4.1 *Work Methodology*

Our empirical approach is the Backward Elimination and Forward Regression Method for three countries: Egypt, Morocco and Turkey. The method was chosen for its ability to produce a concise and significant model. Backward elimination is a powerful technique that can improve prediction accuracy and aid in building better machine learning models.

The modelling was carried out independently for each country. It covered the period 2009 to 2022.

- Explanatory variables: In this statistical model, inflation is the dependent variable and the selected explanatory variables will be presented in the table below:

Table 1. Internal and external variables

Variables	Description
Inf	consumer price index, % to the previous year
INTERNAL FACTORS	
Rate	the key policy rate of the central bank (BAM, TCMB&CBE), %
M3	The amount of M3 monetary aggregate, LCU
consHs	Households and NPISHs Final consumption expenditure
Unemp	Unemployment %
EXTERNAL FACTORS	
REER	Real effective exchange rate
EXP	Exports of goods and services (current local currency units)
IMP	Imports of goods and services (current local currency units)
Ex.b	External Balance

These empirical results will be presented in statistical tables with their interpretations.

- Descriptive statistics: First, we present the descriptive statistics relating to the explanatory variables in Table 2 as follow:
- Hypotheses to test: Two hypotheses are to be tested by statistical modeling [34]:

H1: A significant relationship exists between inflation and internal & external factors.

H2: A number of variables may be important and influential in determining inflation.

$$Y = b_0 + b_1X_1 + \cdots + b_kX_k + \varepsilon, k = 8$$

Y = the variable to be explained (Inf)

- The variables of the problem: The variable to be explained and the explanatory variables adopted for the treatment of the problematic posed above is given as:

The explanatory variables:

X_1 = The key policy rate (key Rate)

X_2 = broad money (M3)

X_3 = Households and NPISHs Final consumption expenditure (consHs)

X_4 = Unemployment rate (Unemp)

X_5 = Real effective exchange rate (REER)

X_6 = Exports of goods and services (EXP)

X_7 = Imports of goods and services (IMP)

X_8 = External balance (Ex.b)

*b*i = Coefficients representing the linear combination of the predictor and the constant

ε = The error

The dependent variable is inflation. It is a dichotomous binary variable denoted “INF” such as:

INF = 0, if the inflation is not influenced by the explanatory variables.

INF = 1, if the inflation is influenced by the explanatory variables.

This makes it possible to highlight the degree of significance of the independent variables with respect to the dependent variable.

Table 2. Explanatory variables

	Variables	Mean	Std. Err. mean	Median	Std.dev	Skewness	Std. Err. skewness	Kurtosis	Std. Err. Kurtosis	Min	Max	Percentiles		
												25	50	75
EGYPT	Inf	11,51%	1,59%	10,22%	5,95%	2,24	0,597	6,82	1,154	5,04%	29,51%	8,64%	10,22%	13,83%
	Rate	10,91%	0,85%	9,43%	3,18%	1,355	0,597	0,595	1,154	8,25%	17,75%	8,75%	9,43%	12,35%
	REER	99,14	3,00	101,41	11,23	-1,02	0,60	1,52	1,15	73,02	117,20	95,36	101,41	105,70
	Exp	519,33	82,70	319,40	309,45	0,95	0,60	-0,33	1,15	257,60	1183,20	278,88	319,40	785,35
	Imp	806,00	129,73	534,30	485,39	0,57	0,60	-1,30	1,15	320,80	1717,20	390,03	534,30	1290,05
	Ex.b	-286,67	51,40	-233,05	192,32	-0,20	0,60	-1,73	1,15	-582,00	-56,50	-464,95	-233,05	-105,73
	M3	2906,80	546,20	2282,40	2043,69	0,97	0,60	0,10	1,15	866,70	7402,70	1135,43	2282,40	4313,00
	ConsHs	2893,04	514,50	2132,85	1925,10	0,67	0,60	-0,98	1,15	793,10	6471,80	1272,80	2132,85	4665,05
	Unemp	10,42%	0,63%	10,82%	2,37%	-0,172	0,597	-1,82	1,154	6,96%	13,15%	7,92%	10,82%	12,71%
MOROCCO	Inf	1,52%	0,42%	1,14%	1,57%	3,048	0,597	10,43	1,154	0,20%	6,66%	0,74%	1,14%	1,70%
	Rate	2,50%	0,16%	2,38%	0,61%	-0,197	0,597	-1,233	1,154	1,50%	3,25%	2,13%	2,38%	3,06%
	REER	99,02	0,65	98,81	2,43	0,91	0,60	1,22	1,15	95,38	104,82	97,06	98,81	100,38
	Exp	347,99	25,25	329,85	94,46	1,24	0,60	2,59	1,15	209,60	593,40	291,88	329,85	408,90
	Imp	456,69	28,85	432,05	107,96	1,47	0,60	3,80	1,15	298,70	751,50	401,48	432,05	519,15
	Ex.b	-108,69	5,83	-110,15	21,83	-0,64	0,60	0,51	1,15	-158,10	-78,70	-119,88	-110,15	-87,98
	M3	1202,86	68,80	1175,20	257,41	0,43	0,60	-0,80	1,15	856,00	1685,10	981,48	1175,20	1399,15
	ConsHs	624,31	32,11	642,50	120,14	-0,08	0,60	-1,00	1,15	438,80	830,10	506,23	642,50	716,03
	Unemp	9,94%	0,31%	9,45%	1,18%	1,26	0,597	0,085	1,154	8,91%	12,30%	9,09%	9,45%	10,60%
TURKEY	Inf	14,93%	4,54%	8,90%	17,00%	3,395	0,597	12,08	1,154	6,28%	72,31%	7,63%	8,90%	15,65%
	Rate	9,83%	1,19%	8,00%	4,46%	1,031	0,597	0,096	1,154	4,75%	19,42%	6,56%	8,00%	12,64%
	REER	91,88	5,68	100,39	21,25	-0,53	0,60	-1,04	1,15	54,34	121,91	73,14	100,39	108,48
	Exp	1172,24	387,17	591,50	1448,66	2,68	0,60	7,89	1,15	235,20	5686,60	369,73	591,50	1414,50
	Imp	1272,54	428,47	643,70	1603,19	2,88	0,60	9,02	1,15	235,70	6393,40	444,10	643,70	1382,05
	Ex.b	-100,31	49,70	-60,90	185,95	-2,97	0,60	10,21	1,15	-706,80	102,00	-105,95	-60,90	-14,78
	M3	2177,50	585,21	1341,70	2189,64	2,08	0,60	4,39	1,15	520,90	8330,90	766,98	1341,70	2754,95
	ConsHs	2178,21	558,85	1485,75	2091,04	2,62	0,60	7,75	1,15	619,60	8674,90	954,60	1485,75	2558,68
	Unemp	10,74%	0,44%	10,74%	1,64%	0,253	0,597	-0,566	1,154	8,15%	13,67%	9,61%	10,74%	12,12%

4.2 *Empirical Result :*

4.2.1 Selection of the optimal model:

We, at the present time, proceed to test the selection of the most significant explanatory variables in relation to the variable to be explained, using the method of eliminating non-significant variables at the 5% threshold, one by one, in order to make a successive correction to the proposed model. In this context, we apply the method of backward elimination and forward regression.

- The Backward Elimination method

The initial model adopted using the different variables that is supposed to be explanatory is given as follows in Table 3:

- Imports variable is the least significant for Egypt and Morocco, and Exports variable for Turkey. The SPSS software eliminate it directly before giving the initial model shown in the Table 3.
- The variable to be eliminated this time is the REER variable for Morocco, key rate for Egypt and external balance for Turkey. Then the new model is obtained in Annex 1.
- Then, we eliminate the variable external balance for Morocco, unemployment for Egypt and Households and NPISHs final consumption expenditure for Turkey. Hence the new model is in Annex 2.

- ❖ The variable to be eliminated now is key rate for Morocco, exports for Egypt and unemployment for Turkey. And the re-estimated model obtained for Morocco in Annex 3.
- ❖ Then the final consumption expenditure of households and NPISHs is eliminated only for Morocco, and no more variables are eliminated for Egypt and Turkey. Hence, the following and the last model adopted is given in Table 4.

In this new final model, the remaining variables for Morocco, unemployment, exports and M3; for Egypt, REER, external balance, M3, the final consumption expenditure of households and NPISHs; for Turkey, Imports, Key rate, REER and M3 are significant at the threshold of α=5%.This is the optimal model obtained by the backward regression method.

Table 3. The initial model adopted

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: MOROCCO					
	Non-standardized coefficients		Standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	-3,358	3,324	-1,3	-1,01	0,351
REER	0,035	0,141	0,054	0,246	0,814
EXP	0,046	0,017	2,765	2,635	0,039
Ex.b	-0,009	0,021	-0,118	-0,414	0,693
M3	-0,018	0,012	-2,911	-1,433	0,202
ConsHs	-0,012	0,012	-0,941	-1,049	0,335
Unemp	0,771	0,618	0,579	1,246	0,259
Multiple R	0,908		Mean dependent var	1,52%	
R-Squared	0,824		S.D. dependent var	1,57%	
Adjusted R-squared	0,619		Akaike info criterion	44,9	
S.E. of regression	0,97%		Bayesian info criterion	50,7	
R Square Change	0,824		Root mean square error	0,63	
F Change	4,022		Sumsquaredresid	5,6060	
Sig. F Change	0,055		Durbin-Watson stat	2,61	

Source: These estimates were prepared using SPSS

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: EGYPT					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	0,051	1,082	0,027	0,047	0,964
REER	-0,195	0,147	-0,369	-1,331	0,232
Exports	0,009	0,021	0,461	0,425	0,686
External balance	-0,051	0,045	-1,661	-1,137	0,299
M3	0,01	0,003	3,391	3,402	0,014
ConsHs	-0,016	0,008	-5,257	-2,065	0,084

Unemployment	0,507	0,627	0,202	0,809	0,449
Multiple R	0,934		Mean dependent var	11,51%	
R-Squared	0,873		S.D. dependent var	5,95%	
Adjusted R-squared	0,725		Akaike info criterion	77,7	
S.E. of regression	3,12%		Bayesian info criterion	83,5	
R Square Change	0,873		Root mean square error	2,04	
F Change	5,886		Sumsquaredresid	58,4204	
Sig. F Change	0,023		Durbin-Watson stat	2,92	

Source: These estimates were prepared using SPSS

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: TURKEY					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	0,307	0,171	0,08	1,79	0,124
REER	0,115	0,067	0,144	1,732	0,134
Imports	0,018	0,004	1,693	4,051	0,007
External balance	0,005	0,006	0,055	0,83	0,439
M3	-0,008	0,001	-0,976	-6,46	0,001
ConsR	0,003	0,003	0,361	0,885	0,41
Unemployment	0,228	0,232	0,022	0,983	0,364
Multiple R	0,999		Mean dependent var	14,93%	
R-Squared	0,998		S.D. dependent var	14,93%	
Adjusted R-squared	0,997		Akaike info criterion	45,1	
S.E. of regression	0,97%		Bayesian info criterion	50,9	
R Square Change	0,998		Root mean square error	0,638	
F Change	564,104		Sumsquaredresid	5,700	
Sig. F Change	0		Durbin-Watson stat	2,39	

Source: These estimates were prepared using SPSS

Table 4. The last model adopted

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: MOROCCO					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Exports	0,035	0,007	2,12	4,794	0,001
M3	-0,013	0,004	-2,134	-3,44	0,006
Unemployment	1,094	0,441	0,822	2,479	0,033
Multiple R	0,878		Mean dependent var	0,015214	
R-Squared	0,771		S.D. dependent var	1,57%	
Adjusted R-squared	0,703		Akaike info criterion	40,6	
S.E. of regression	0,0085		Bayesian info criterion	43,8	

R Square Change	-2%	Root mean square error	0,722
F Change	0,864	Sumsquaredresid	7,30
Sig. F Change	0,377	Durbin-Watson stat	2,95

Source: These estimates were prepared using SPSS

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: TURKEY					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	0,406	0,115	0,107	3,55	0,006
REER	0,094	0,049	0,117	1,896	0,09
Imports	0,02	0,001	1,86	19,768	0
M3	-0,007	0,001	-0,856	-6,884	0
Multiple R	0,999		Mean dependent var	14,93%	
R-Squared	0,998		S.D. dependent var	17,00%	
Adjusted R-squared	0,997		Akaike info criterion	45,6	
S.E. of regression	1%		Bayesian info criterion	49,4	
R Square Change	0		Root mean square error	0,804	
F Change	1,861		Sumsquaredresid	9,04	
Sig. F Change	0,21		Durbin-Watson stat	2,83	

Source: These estimates were prepared using SPSS

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: EGYPT					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
REER	-0,248	0,09	-0,469	-2,762	0,022
External balance	-0,05	0,016	-1,626	-3,077	0,013
M3	0,01	0,003	3,334	3,716	0,005
ConsR	-0,015	0,003	-4,87	-4,423	0,002
Multiple R	0,916		Mean dependent var	11,51%	
R-Squared	0,839		S.D. dependent var	5,95%	
Adjusted R-squared	0,768		Akaike info criterion	75	
S.E. of regression	3%		Bayesian info criterion	78,9	
R Square Change	-0,018		Root mean square error	2,30	
F Change	0,982		Sumsquaredresid	73,9	
Sig. F Change	0,351		Durbin-Watson stat	2,71	

Source: These estimates were prepared using SPSS

Table 5. Forward regression method

	EGYPT	MOROCCO	TURKEY
	Inf		
Inf	1,00000	1,00000	1,00000
Rate	0,67143	-0,33960	0,32982
M3	-0,00144	0,49500	0,90660
ConsHs	-0,04605	0,45721	0,96357
Unemp	0,19747	0,40774	0,00022
REER	-0,69535	-0,20253	-0,67341
EXP	0,04694	0,70423	0,96823
IMP	0,10142	0,75649	0,97724
Ex.b	-0,18046	-0,69355	-0,88229

- Forward Regression method

The Forward regression consists in starting with no variable and incrementally adding each new explanatory variable, testing for statistical significance using the correlation coefficient. The method only takes into consideration variables that have a strong correlation with the dependent variable, which in our case is inflation.

Table 5 shows the correlation coefficients that link the dependent variable to the independent variables. The method that is used leads us to use the highest correlation coefficient that is recorded with the inflation (Y). The highest coefficient correlation we have selected is the variable “REER” for Egypt, “Imports” for Morocco & Turkey.

In Table 6, we obtain a new model with the selected variable.
As far as the forward method is concerned, the variables "imports" and "final consumption expenditure of households and NPISHs" for Morocco, "exports" for Turkey, despite the fact that were eliminated by the backward method because they were not statistically significant, were selected by the forward method because they obtained the highest correlation with the variable to be explained. This happened just after we had assumed that the addition of this variable was significant, which means that they are significantly correlated with the inflation.

Table 6. The new model with the explanatory variable selected

Dependent Variable: Inflation					
Method: Least Squares					
Date: 14-DEC-2023 Time: 19:55:31					
No. of lines: 14					
Country: MOROCCO					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Imports	0,021	0,005	1,471	4,702	0,001
consHs	-0,011	0,004	-0,822	-2,628	0,024
Multiple R	0,859		Mean dependent var	1,52%	
R-Squared	0,737		S.D. dependent var	1,57%	
Adjusted R-squared	0,689		Akaike info criterion	40,6	
S.E. of regression	0,87%		Bayesian info criterion	43,1	
R Square Change	0%		Root mean square error	0,774	
F Change	6,904		Sumsquaredresid	8,39	
Sig. F Change	0,024		Durbin-Watson stat	1,81	

Source: These estimates were prepared using SPSS

Dependent Variable: Inflation					
Method: Least Squares					
Date: 14-DEC-2023 Time: 19:55:31					
No. of lines: 14					
Country: TURKEY					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Imports	0,009	0,003	0,895	3,156	0,01
M3	-0,009	0,001	-1,115	-10,815	0
Exports	0,014	0,004	1,17	3,383	0,007
Multiple R	0,999		Mean dependent var	14,93%	
R-Squared	0,997		S.D. dependent var	17,00%	
Adjusted R-squared	0,996		Akaike info criterion	45,5	
S.E. of regression	1,02%		Bayesian info criterion	48,7	
R Square Change	0,003		Root mean square error	0,861	
F Change	11,446		Sumsquaredresid	10,4	
Sig. F Change	0,007		Durbin-Watson stat	2,90	

Source: These estimates were prepared using SPSS

Dependent Variable: Inflation					
Method: Least Squares					
Date: 14-DEC-2023 Time: 19:55:31					
No. of lines: 14					
Country: EGYPT					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
REER	-0,368	0,11	-0,695	-3,352	0,006
Multiple R	0,695		Mean dependent var	11,51%	
R-Squared	0,484		S.D. dependent var	5,95%	
Adjusted R-squared	0,44		Akaike info criterion	85,4	
S.E. of regression	4,45%		Bayesian info criterion	87,3	
R Square Change	0,484		Root mean square error	4,12	
F Change	11,234		Sumsquaredresid	237	
Sig. F Change	0,006		Durbin-Watson stat	1,10	

4.2.2 Analysis of results:

Overall, the results obtained show that the explanatory variables, among the eight variables, are significant at the 5% level, namely the unemployment rate (internal factor), exports (external factor) and the M3 money supply (internal factor) for Morocco, the REER (external factor), the external balance (external factor) and the M3 money supply (internal factor) for Egypt, the imports (external factor), the policy rate (internal factor), the REER (external factor) and the M3 money supply (internal factor) for Turkey. The results show that M3 money supply is the only explanatory variable that is statistically significant for the three countries studied. This partially validates the monetarist approach, which considers the quantity of money in circulation as a crucial factor in determining inflation.

The method used is based on the optimal model and backward elimination, which is the process of eliminating any explanatory variable that is not statistically significant. This means that the remaining variables, which are both internal and external factors, have an impact on inflation. In other words, these variables explain and predict inflation, and their effects on the perspective can be proved.

On the other hand, the forward regression method gave us a new result for Morocco, namely the "imports" and " Households and NPISHs Final consumption expenditure ", and a new variable for Turkey, namely "exports".

For Morocco, the two models produced different results, indicating that inflation prediction is based on multiple criteria. This may be due to the complex nature of inflation and governance, which is a qualitative variable that cannot be measured. Morocco has managed to keep inflation under control in recent years, from 2009 and after the international financial crisis, inflation did not exceed the 2% target set by the central bank until 2022, when it reached 6.66% after the covid'19 crisis. For Egypt, the common explanatory variable yield by the both model is REER. This is expected as the Egyptian economy relies heavily on three sources of income: remittances from the diaspora, tourism, and royalties from the use of the Suez Canal [35]. In the case of Turkey, the two models commonly use imports and M3 as explanatory variables for inflation. This is because hydrocarbons dominate Turkish imports, particularly since Russia became its primary supplier alongside China and Germany. The Turkish economy has been affected by the increase in energy prices since the end of the COVID-19 crisis, which has been amplified by the conflict in Ukraine.

We conclude that there is a significant relationship between inflation and the internal and external factors included in our modeling, and that certain independent variables can affect and predict inflation. Consequently, we confirm the two hypotheses (H1) and (H2) that have been tested and verified by modeling.

5. Conclusion

Inflation is a complex and peculiar phenomenon that has harmful consequences on the economy and can be the cause of economic instability, as is currently the case in Turkey. In this article, we have tried to highlight the factors that can explain inflation in order to make predictions and perspectives aimed at controlling inflation and ensuring a certain equilibrium in the market. This is attempted through the two chosen statistical modeling methods, Backward Elimination and Forward Regression, carried out on the SPSS software, which can lead to different results, proposing new models or confirming old ones. The objective of this empirical study is to select the explanatory variables that predict inflation and to interpret the nature of inflation fluctuation in different countries according to a reduced and significant model.

The results show that the factors explaining inflation are often not identical, depending on each country's monetary and economic policy and its behavior at the time of crisis. Thus, the results of the empirical analysis prove this, since the M3 money supply is the only explanatory variable, among the eight analyzed, that exerts a certain influence for all three countries, while the other explanatory variables are different between Morocco, Egypt and Turkey. However, it is eminent to note that the explanatory variables retained by the models, such as money supply, unemployment rate, exports, imports, RRSP, policy rate and Households and NPISHs Final consumption expenditure, represent influential instruments on the level of inflation. Moreover, light must be shed on the case of turkey in particular, this situation is atypical and requires special attention, as it is a relatively strong economy and is witnessing high inflation, which according to our study is more explained by external factors, proving the existence of implicit factors that can induce a hidden field in the econometric modeling of inflation.

As we move forward, it is imperative to recognize the significance of these influential variables in shaping inflation levels. The implications of our findings extend beyond statistical models, emphasizing the need for tailored economic policies that consider the distinctive characteristics of each country. By understanding the multifaceted nature of inflation, policymakers can implement targeted strategies to mitigate its impact and contribute to sustained economic stability.

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Annex. 1. Elimination of the REER for Morocco, key rate for Egypt and external balance for Turkey and the re-estimation of the equation

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: MOROCCO					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	-3,309	3,088	-1,281	-1,072	0,319
EXP	0,046	0,016	2,747	2,82	0,026
Ex.b	-0,007	0,018	-0,093	-0,374	0,719
M3	-0,017	0,011	-2,808	-1,519	0,173
ConsHs	-0,013	0,011	-0,999	-1,241	0,255
Unemp	0,769	0,575	0,578	1,337	0,223
Multiple R	0,907		Mean dependent var	0,015214	
R-Squared	0,823		S.D. dependent var	1,57%	
Adjusted R-squared	0,67		Akaike info criterion	43,2	
S.E. of regression	0,90%		Bayesian information criterion	48,2	
R Square Change	-0,002		RMSE: root mean square error	0,636	
F Change	0,06		Sumsquaredresid	5,662	
Sig. F Change	0,814		Durbin-Watson stat	2,57	

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: EGYPT					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
REER	-0,196	0,135	-0,37	-1,447	0,191
EXP	0,01	0,01	0,505	0,973	0,363
Ex.b	-0,053	0,023	-1,718	-2,333	0,052
M3	0,01	0,003	3,399	3,747	0,007
ConsHs	-0,017	0,005	-5,348	-3,52	0,01
Unemp	0,517	0,549	0,206	0,942	0,378
Multiple R	0,934		Mean dependent var	11,51%	
R-Squared	0,873		S.D. dependent var	5,95%	
Adjusted R-squared	0,764		Akaike info criterion	7,57	
S.E. of regression	2,89%		Bayesian information criterion	80,8	
R Square Change	0		RMSE: root mean square error	2,04	
F Change	0,002		Sumsquaredresid	58,44	
Sig. F Change	0,964		Durbin-Watson stat	2,90	

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: TURKEY					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	0,408	0,117	0,107	3,478	0,01
REER	0,137	0,06	0,171	2,294	0,055
IMP	0,016	0,004	1,539	4,204	0,004
M3	-0,007	0,001	-0,906	-7,405	0
ConsHs	0,003	0,003	0,41	1,039	0,333
Unemp	0,253	0,225	0,024	1,125	0,298
Multiple R	0,999		Mean dependent var	14,93%	
R-Squared	0,998		S.D. dependent var	17,00%	
Adjusted R-squared	0,997		Akaike info criterion	44,7	
S.E. of regression	0,95%		Bayesian information criterion	49,8	
R Square Change	0		RMSE: root mean square error	0,674	
F Change	0,688		Sumsquaredresid	6,353	
Sig. F Change	0,439		Durbin-Watson stat	2,31	

Annex. 2. Elimination of the external balance for Morocco, unemployment for Egypt and households and NPISHS final consumption expenditure for Turkey and the re-estimation of the equation

Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines :14					
Country: MOROCCO					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	-3,222	2,909	-1,248	-1,108	0,3
EXP	0,048	0,014	2,913	3,554	0,007
M3	-0,018	0,01	-2,924	-1,698	0,128
ConsHs	-0,013	0,01	-1,015	-1,335	0,219
Unemp	0,834	0,518	0,627	1,611	0,146
Multiple R	0,905		Mean dependent var	0,015214	
R-Squared	0,819		S.D. dependent var	1,57%	
Adjusted R-squared	0,706		Akaike info criterion	41,3	
S.E. of regression	0,85%		Bayesian information criterion	45,8	
R Square Change	-0,004		RMSE: root mean square error	0,642	
F Change	0,14		Sumsquaredresid	5,776	
Sig. F Change	0,719		Durbin-Watson stat	2,62	

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: EGYPT					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
REER	-0,158	0,128	-0,298	-1,232	0,253
EXP	0,01	0,01	0,51	0,991	0,351
Ex.b	-0,062	0,02	-2,017	-3,056	0,016
M3	0,01	0,003	3,403	3,777	0,005
ConsHs	-0,018	0,004	-5,783	-4,025	0,004
Multiple R	0,926		Mean dependent var	11,51%	
R-Squared	0,857		S.D. dependent var	5,95%	
Adjusted R-squared	0,767		Akaike info criterion	75,4	
S.E. of regression	2,87%		Bayesian information criterion	79,9	
R Square Change	-0,016		RMSE: root mean square error	2,17	
F Change	0,887		Sumsquaredresid	65,84	
Sig. F Change	0,378		Durbin-Watson stat	2,91	

Dependent Variable: Inflation					
Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: TURKEY					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
Key rate	0,371	0,112	0,097	3,303	0,011
REER	0,099	0,047	0,124	2,088	0,07
IMP	0,02	0,001	1,907	19,814	0
M3	-0,007	0,001	-0,898	-7,318	0
Unemp	0,301	0,221	0,029	1,364	0,21
Multiple R	0,999		Mean dependent var	14,93%	
R-Squared	0,998		S.D. dependent var	17,00%	
Adjusted R-squared	0,997		Akaike info criterion	44,7	
S.E. of regression	0,96%		Bayesian information criterion	49,2	
R Square Change	0		RMSE: root mean square error	0,724	
F Change	1,08		Sumsquaredresid	7,33	
Sig. F Change	0,333		Durbin-Watson stat	2.76	

Annex. 3. Elimination of the key rate for Morocco, and the re-estimation of the equation

Method: Least Squares					
Date: 09-DEC-2023 Time: 15:49:42					
No. of lines: 14					
Country: MOROCCO					
	Non-standardized coefficients		standardized coefficients	t-Statistic	Sig.
Variables	B	Std. Error	Beta		
EXP	0,036	0,007	2,147	4,812	0,001
M3	-0,008	0,006	-1,38	-1,348	0,211
ConsHs	-0,008	0,009	-0,641	-0,93	0,377
Unemp	0,835	0,525	0,627	1,591	0,146
Multiple R	0,89		Mean dependent var	0,015214	
R-Squared	0,791		S.D. dependent var	1,57%	
Adjusted R-squared	0,698		Akaike info criterion	41,3	
S.E. of regression	0,86%		Bayesian information criterion	45,2	
R Square Change	-0,028		RMSE: root mean square error	0,690	
F Change	1,227		Sumsquaredresid	6,662	
Sig. F Change	0,3		Durbin-Watson stat	2,54	