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Higher banknotes and inflation: A myth or a reality? Evidence from Syria

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ABSTRACT

Before the onset of the Syrian crisis in 2011, the exchange rate of the Syrian pound (SP) to the USD was SP45 to USD1. The Syrian pound kept depreciating until it reached SP3500 to USD1 in 2021. The constant depreciation in the value of the Syrian pound led to unprecedented high levels of inflation. This pushed the monetary authorities to introduce higher banknotes, the SP2000 and the SP5000 to facilitate the conduct of daily transactions. The issuance of higher banknotes triggered public concerns regarding the inflationary impact of these banknotes. Moreover, rumors are now circulating that the SP10000 note has already been printed and will be put into circulation soon to address the constant depreciation of the Syrian pound (SP15000=USD1 in 2024). This study aims at investigating the impact of higher banknotes on the level of inflation in Syria between 2011 and 2021. The study utilized structural break tests such as the Zivot and Andrews and the Lee and Strazicich to examine whether putting higher banknotes into circulation led to structural breaks in the series of inflation. The results obtained conclusively revealed that putting higher banknotes into circulation did not cause a structural break in the series of inflation. Accordingly, the findings cannot support the view that issuing higher banknotes leads to higher inflation. This implies that the monetary authorities in Syria should not keep postponing the issuance of higher banknotes out of inflationary concerns.

Contribution/Originality: Previous studies that examined the impact of issuing higher banknotes on inflation utilized intervention analysis, price modelling, ATM withdrawals, and time series models. The originality of this study lies in the use of structural break tests in examining the impact of higher banknotes on inflation.

1. INTRODUCTION

Syria was experiencing a rapid growth in its gross domestic product (GDP), a rise in its financial and services sectors, a notable growth in its domestic industries and a good stock of grains before the onset of the conflict in 2011. More than twelve years in the Syrian conflict resulted in severe destruction to the economy of Syria. Aleppo, the economic capital of Syria was subject to severe destruction (Karklis, 2016).

The government lost control over the north of Syria, the host of oil and grain fields. Syria not only lost the exports and oil income but also the main lands that used to supply the country with grain and other agricultural products. Moreover, closing the borders with the neighboring countries destroyed the ability of the coastal part of Syria to export olives and lemons, the main agricultural products of this area. The loss of resources, combined with the huge war expenses that Syria had to undertake led to a severe deterioration in the value of the pound, the Syrian

currency. To get a better understanding of the depreciation that the pound is facing, it is interesting to know that the pound in the pre-conflict period was SP45=USD1 compared to its current value which is SP11000=USD1.

The high levels of inflation that Syria is experiencing made it very troublesome for Syrians to carry on their daily transactions[1]. To understand the situation better, one needs to know that the highest pre-crisis banknote, SP1000 was issued in 1997 when the exchange rate was SP50-52 to USD1. During the crisis, two higher banknotes were issued, the SP2000 in 2017 and the SP5000 in 2021. Currently, the highest note in circulation, SP5000 cannot buy a bottle of Coca Cola.

Accordingly, Syrians have to carry with them a considerable amount of notes to perform their daily transactions. If inflation persists in increasing, the need for higher banknotes is inevitable. Had the e-payment system been more developed[2], the scenario might have been less severe. However, with almost a full reliance on cash, the problem of high inflation is complicating the daily transactions for Syrians. A solution or a curse for this might be issuing higher denominations of banknotes.

The literature highlighted several advantages of issuing higher banknotes. This includes efficient conduct of transactions, lower carrying and management expenses, lower production costs, less spending, and protection of the national identity (Hyunjung, 2019; Manikowski, 2017). Despite these advantages, issuing a higher note could raise many concerns and could be faced with reluctance from the public and the monetary authorities. South Korea, for example, kept its highest denomination, 10000 won, for 36 years and was reluctant to issue a higher note despite the fact that the consumer price index increased 14 times during this period and the GDP increased 209 times (Hyunjung, 2019).

Furthermore, several countries are eliminating their higher notes. For example, Canada stopped printing the $1000 note in 2000 and started to withdraw it from circulation. This came as an attempt to fight money laundering and organized crime (Bank of Canada website). Similarly, to stop money laundering, Singapore stopped the printing of the $10000 note in 2014 and started to withdraw it from circulation (https://www.todayonline.com/singapore/singapore-stop-issuing-s10000-notes). In 2016, the European Central Bank decided to halt the production of the 500 note and to remove it from the Europa series as this note is believed to be facilitating illegal activities (ECB website).

One of the main concerns of issuing a higher note is that it facilitates drug dealing, organized crimes, money laundering and other illegal activities. In addition, higher notes are more susceptible to forgery. Another concern when it comes to issuing higher banknotes is inflation. Franses (2006) suggested that issuing higher banknotes might lead to higher levels of inflation as it affects the expectations about future levels of inflation. Inflationary expectations could be self-fulfilling.

It is noteworthy that the efficiency of the denomination structure should be the main point to consider when analyzing the elimination or the issuance of higher notes. As per the case of Syria, Ismaiel and Al-Ahmad (2023) reported that the SP10000 should have been issued since 2020 and the SP20000 should not be pushed beyond the year 2024. Accordingly, the question is why the Syrian monetary authorities are delaying the issuance of higher notes.

The monetary authorities are facing a trade-off between the efficient conduct of transactions with the protection of the national identity and the possible higher levels of inflation with the facilitation of illegal activities. In fact, even when issuing higher notes is justified by the denomination structure, inflationary concerns might arise. This especially holds if inflation levels are already high. The concern is that it is not easy to stop a cycle once it starts.

That is to say, if the inflation continues to increase, the need for higher banknotes will increase. Issuing higher banknotes might also lead to higher levels of inflation as it affects the expectations about future inflation (Franses, 2006). This is usually followed by redenomination, removing zeros from the currency in an attempt to control

[1] The year-to -year inflation in August 2020 was 139.46% compared to 3.9% in August 2011 (before the crisis) (Inflation reports, Central Bank of Syria).

[2] The sanctions imposed on Syria, the destruction of the infrastructure, and the lack of electricity are complicating the reliance on E-payment.

inflation. This vicious cycle of inflation, higher denominations, and redenomination was experienced in several countries such as Zimbabwe, Venezuela, and Turkey.

This study aims to examine the impact of introducing higher denominations of the Syrian pound on the inflation level in Syria during 2011-2021. The study contributes to the limited empirical evidence that examined the impact of issuing higher notes on inflation. Unlike previous studies that utilized intervention analysis, price modelling, Automated Teller Machine (ATM) withdrawals, and time series models, to investigate the relationship between the two variables, the current study utilizes tests of structural breaks applied to the inflation series. We believe that this methodology would be more able to detect the impact of issuing higher notes on inflation. The outcomes of the study are expected to be important for policymakers and the public as well.

The rest of the paper is organized as follows: section two discusses the theoretical and empirical relationship between higher banknotes and inflation, section three explains the data collection process and the methodology used, section four discusses the findings and section five provides the concluding remarks of the study.

2. REVIEW OF THE LITERATURE

2.1. The Relationship between Issuing Higher Banknotes and Inflation: A Theoretical Framework

Chen (1976) highlighted three effects on the real demand for money that could result from improving the size mixture of money. Those are the efficiency, the substitution, and the income effect. With the more efficient money, people would need fewer real units of this money to carry on a certain transaction. Therefore, the real demand for money would decrease. This is what Chen called the efficiency effect. On the other hand, money would be more attractive due to the improvement on the size structure of money. Accordingly, people would substitute money and holding money for bartering and holding other assets. This is called the substitution effect and it causes the demand of real cash balances to increase.

In addition, the saving of labor with other real resources that result from the increase in the use and efficiency of money would result in an increase in the real flow of income. This would boost the demand for money as a result of the positive income effect. He also added another contractionary force that results from the improvement of the size mixture of money, and is related to the fractional reserve banking system. He argued that the better mixture would cause the currency-to-deposit ratio to rise which would lead to a decrease in the money multiplier. As the nominal quantity of the high-powered money is unchanged, there will be a decline in the nominal stock of money which can be called "the tight money effect".

He highlighted that to be inflationary, the improvement on the currency denomination should have an efficiency effect that outweighs the three other effects combined (substitution, income and tight money). However, he pointed out that the historical evidence indicates that the efficiency effect does not outweigh the substitution effect. He highlighted that even though the efficiency effect might have increased in the past decades, there was a decline in the income velocity of money. This made him conclude that the substitution effect outweighs the efficiency effect.

2.2. The Relationship between Issuing Higher Banknotes and Inflation: An Empirical Framework

Despite the importance of the topic, very limited research empirically addressed the impact of higher banknotes on inflation. Hobijn, Franses, and Ooms (2004) investigated the reasons why the general price index did not increase following the introduction of the euro whereas the prices in some industries, restaurants and cafes, experienced a rise compared to their pre-euro level and none EU countries.

The authors examined how well four sticky price models do in explaining the blip in the price inflation of restaurant and cafe in Europe in January 2002. They attributed the blip in the price inflation to what they called "the horizon effect". Namely, due to sticky prices, the prices that firms set before the adoption of the euro were not really reflective of the expected increase in marginal costs following the adoption of the euro. Firms know that once they adopt the euro, they can adjust their prices up so that the new prices will reflect the increases in future costs. The

authors concluded that the higher denominations might have a significant impact on inflation in economies that are characterized by relatively sticky prices and high inflation rates. This contradicted the previous belief in the neutral monetary impact of issuing higher denominations. Franses (2006) examined the dynamic causality between higher banknotes and inflation over 40 years for 59 countries. Applying a vector autoregressive of order 1 model, he documented that higher banknotes are a result of high inflation but he could not find evidence in favor of higher banknotes leading to inflation. Angelini and Lippi (2006) examined whether the introduction of the euro had an inflationary impact. They examined the cash withdrawals from ATM machines rather than relying on official numbers related to inflation. They argued that the alleged higher inflation should have led to more cash withdrawals from ATMs. The authors highlighted that people felt the sting of inflation after the adoption of the euro although the statistics did not support the claim that the introduction of the euro caused higher inflation.

Overall, the authors could not find evidence that support the presence of an inflationary effect following the introduction of the euro. They attributed the higher inflation that was perceived after the euro was introduced to psychological factors (Traut-Mattausch, Schulz-Hardt, Greitemeyer, & Frey, 2004) and revisions of prices in some industries (Deutsche Bundesbank, 2004). Egbuna and Obikili (2013) examined the effect of introducing higher banknotes on the inflation level in Nigeria. They utilized intervention analysis to assess the impact of a discrete change in inflation that results from introducing a new banknote. Their results revealed that the introduction of higher banknotes did not have any impact on inflation. However, it caused a short-lived increase in food prices that was noted only in the two months following the introduction of the note. They attributed this to the effect of money illusion where the introduction of the higher note does not have a real effect on the level of inflation. On the contrary, it is the changes in inflation expectations which follow the introduction of the higher note that lead to higher inflation.

Taiwo, Ogunwale, and Afieroho (2016) examined the effect of higher currency banknotes on the Nigerian economy. Applying a vector error correction mechanism and a vector autoregressive analysis they reported that the currency denominations, measured by the introduction of higher notes, are not affected by shocks in fiscal deficit, broad money supply and inflation. Alternatively, shocks in currency denominations seem to affect inflation through their impact on fiscal deficit and broad money supply. They also highlighted that the introduction of the higher currency notes caused the removal of smaller units from the currency structure and resulted in a rounding up of prices. They recommended keeping lower denominations in circulation rather than higher ones to avoid increasing the level of inflation. Moyo and Dunga (2020) examined the effect of introducing higher banknotes on inflation in Malawi. Using monthly data between 1990 and 2017 and applying a vector autoregressive model, an ordinary least square (OLS) regression and a Granger causality, they reported that inflation and the introduction of higher currency denominations have bidirectional causality. More specifically, they reported that some of the higher notes led to higher levels of inflation. They suggested that the introduction of higher denominations should be done strategically whereby the higher notes' proportion is less than the proportion of smaller ones. This would help in avoiding the inflationary expectations of the public when a higher note is introduced. Ngwende (2023) discussed the potential impact of issuing higher banknotes on inflation in Malawi. He highlighted that there are diverse views about the impact of the issuance of higher notes on inflation. While the literature suggests that issuing higher banknotes will not lead to higher inflation, researchers (mainly Moyo and Dunga, 2020) revealed that there was an increase in inflation after the introduction of higher notes. Ngwende (2023) utilized the quantity theory of money to identify the events that could lead to higher inflation. He revealed that the period in which issuing higher banknotes led to higher inflation was characterized by higher public spending, further introduction of value added tax (VAT) and the increase in edible oil and fertilizer prices resulting from the spread of COVID-19.

Accordingly, he recommended the issuance of a higher note if needed, but this should be combined with disciplined fiscal policies so that the government does not have to increase the VAT, and the use of monetary policy tools to control inflation. The review of the literature on the impact of introducing higher notes on inflation does not provide a clear-cut answer. The results seem to be sensitive to several country specific issues. This includes sticky

prices and price revision, psychological factors, the proportion of higher notes to that of smaller notes, and the rounding up of prices. In addition, the results seem to be sensitive to the methodology used. While some authors utilized intervention analysis, price modelling and ATM withdrawals, others utilized Granger causality, vector auto regressive models and error correction mechanisms.

The distinctive contribution of this study lies in the different methodologies that it utilized. The study made use of the structural break tests to examine the impact of issuing higher banknotes on inflation. More specifically, the study proposes that if issuing higher banknotes leads to higher levels of inflation, then the issuance of higher banknotes should result in a structural break in the inflation series.

This study is the first to utilize structural break tests in examining the impact of higher banknotes on inflation.

The following section explains the data collection process and the methodology utilized to examine the impact of higher banknotes on inflation in Syria:

3. DATA AND METHODOLOGY

3.1. Data

Before the issuance of the SP2000 note in 2015, the highest denomination, SP1000 was issued in 1997. Nevertheless, there are two reasons for limiting our analysis to the period Jan 2011- Dec 2021. First, we are more interested in the inflation that took place during the Syrian crisis, which started in 2011. Second, the base year for inflation is different for the period before 2011. Therefore, we preferred to set the beginning of the time period as January 2011.

We could not go beyond December 2021 due to limitations in data availability of the inflation series.

This study utilizes monthly time series data of the inflation rate. Two series for inflation are used, the first series (Infmonth) is measured as the change in the consumer price index (CPI), (base year 2010=100) compared to the previous month in the same year. It covers the period (2011:02-2021:12). The second series (InfYOY) is measured as the change in CPI (2010=100) compared to the same month last year. It covers the period (2012:01-2021:12).

Data of the CPI were obtained from the Central Bank of Syria (CBS) website for the period (2011:01-2020:08), and from the Central Bureau of Statistics (CBSSYR) website for the period (2020:09-2021:12). The dates of putting the higher notes into circulation were identified from the Central Bank of Syria website. Figure 1 shows the two series of inflation rates in the examined period.

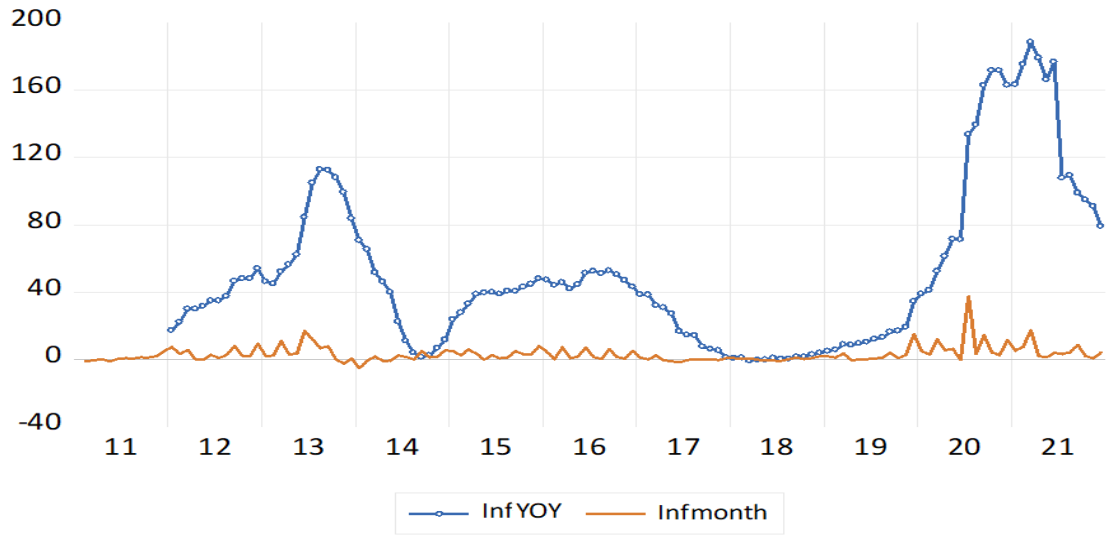

Figure 1. Evolution of the inflation rate series.

Source: EViews output based on CBS and CBSSY data.

3.2. Methodology

Studies that examined the impact of currency structure on inflation used different methodologies. This ranged from intervention analysis, price modelling, ATM withdrawals to time series models (Ganger causality, vector auto regressive models and error correction mechanism).

The current study applied a new approach, testing for structural breaks in the inflation series to examine the impact of higher banknotes on inflation. We postulate that if the issuance of higher banknotes leads to higher inflation, then one should expect a structural break in the inflation series in the month in which the higher banknote is introduced. In applying this approach, we were guided by Zídek and Chribik (2015) who examined the impact of currency redenomination on inflation in Turkey. The authors limited their analysis though to the Chow test to examine the structural break of the inflation series. In contrast to Zídek and Chribik (2015) this study utilizes a variety of unit root structural break tests to examine the structural break in the inflation series that might have been caused by the introduction of the higher banknote.

Applying unit root tests with structural breaks allows us to explore whether the introduction of the 2000 and 5000 notes caused structural breaks in the inflation series and thus had a significant impact on the inflation rates. Structural breaks are included to detect the presence of breaks in level and trend. If the tests reveal the presence of breaks, then the question arises as to whether the breaks coincide with the dates at which the higher notes were introduced. Moreover, we aim to test whether the inflation series is stationary, utilizing unit root tests with and without structural breaks. This allows us to verify whether the outcomes of the unit root test are affected by the identification of breaks in the data.

If the inflation series is stationary, then the impact of shocks on the inflation rates is transitory. In contrast, if inflation rates are nonstationary, then the impact of shocks on the inflation rates is a long- run one. If inflation rates are stationary around breaks, then the series is described as a trend-break stationary series; a series whereby the structural break suggests an infrequent permanent change at its level and/or its trend (Hassan, 2013).

To examine whether the inflation rate series is stationary, the conventional Augmented Dickey-Fuller (ADF) unit root test is first applied. To account for the structural breaks in the data, the Zivot and Andrews's (2002) test which endogenously captures one structural break in the series, and the minimum Lagrange Multiplier (LM) unit root tests with one and two structural breaks as proposed by Lee and Strazicich (2004) and Lee and Strazicich (2003) are applied.

3.3. The ADF Test

The ADF test postulated by Said and Dickey (1984) became one of the most commonly used unit root tests in the literature.

The test can be run using different models as shown in Equations 1-3.

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \boldsymbol{\varepsilon}_t \qquad (1)$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \varepsilon_t \qquad (2)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \delta Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \varepsilon_t \qquad (3)$$

Where Yt stands for the independent variable (inf), ΔY_t is the first difference of the variable, β_1 is the intercept, T is the deterministic trend, β_2 stands for the estimated coefficient for the deterministic trend, δ *and* ρ_i are the coefficients that will be estimated. K stands for the lag's length and ε_t is a white noise error term.

The ADF test tests the null hypothesis that the series has a unit root and is not stationary. A rejection of the null in Equations 1, 2 and 3 implies that the series is stationary with zero mean, mean stationery and trend stationary, respectively.

The ADF test does not account for structural breaks in the series. Perron (1989) reported that when structural breaks in the data are accounted for, one might draw a different conclusion about the null hypothesis of unit root. Accounting for structural breaks led to more rejection of the unit root hypothesis. A major issue with the structural

break test developed by Perron is that the test specifies the break exogenously, i.e., based on previous knowledge of the time of the break. This could cause data mining (Christiano, 1992) and might lead to more rejection of the null hypothesis (Zivot & Andrews, 2002). Zivot and Andrews (2002) have developed their test to allow for a structural break that could be endogenously determined.

3.4. The Zivot and Andrews (2002) Test

Unlike the Perron test which requires a pre knowledge of the date of the structural break, Zivot and Andrews's (2002) test endogenously estimates the structural break in the data. Three models are proposed to estimate this test. Equation 4 allows for a one-time shift in the intercept. Equation 5 allows for a one-time structural break in the trend while Equation 6 allows for a break in both the intercept and the trend (Al-Ahmad & Ismaiel, 2016; Narayan & Smyth, 2004):

$$\Delta Y_t = \beta_1 + \beta_2 T + \theta\, DUt + \delta Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \boldsymbol{\varepsilon}_t \quad (4)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \gamma DTt + \delta Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (5)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \theta\, DUt + \gamma DTt + \delta Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \varepsilon_t \quad (6)$$

DUt is a dummy variable that identifies a structural break in the intercept at time TB; if t is greater than TB, then DUt is set equal to one, otherwise, it is equal to zero. DTt is a dummy variable that captures the trend function's change in slope; *DTt is equal to t-TB* when *t is greater than TB*, otherwise, it takes the value of zero. *TB* reflects the time of the break occurrence. Following Glynn, Perera, and Verma (2007) we choose the break date that has the lowest one-sided t-statistic for the Augmented Dickey Fuller unit root δ.

The three models test the same null hypothesis that δ is equal to zero which suggests that there is a unit root with a drift in the series but there are no structural breaks. On the other hand, the alternative hypothesis δ is less than zero and suggests that the series is a breakpoint stationary with one structural break that takes place at unknown point in time (Narayan & Smyth, 2007; Waheed, Tasneem, & Ghauri, 2006).

3.5. The Lee and Strazicich Tests

Although the Zivot and Andrews (ZA) test accounts for the presence of an exogenous break in the time series, many economic time series appear to have more than one structural break (Ben-David & Papell, 1998). Ignoring these breaks would entail a loss of power when conducting the test. To address this issue, Lumsdaine and Papell (1997) (hereafter LP) extended the ZA test to include two structural breaks.

Nevertheless, the LP and ZA tests appear to be facing another critical issue. They presume no breaks under the null. They use this assumption to derive their critical values. However, if structural breaks occur under the null, the tests become invalid. A rejection of the null does not necessarily suggest a rejection of a unit root by itself. Instead, it suggests a rejection of a unit root without a break (Lee, List, & Strazicich, 1998). Nunes, Newbold, and Kuan (1997) and Lee et al. (1998) illustrated that when no structural breaks are assumed under the ZA null, the ZA test statistic diverges and causes a spurious rejection of the null if the data has a break. After investigating the reasons behind the spurious rejection, Lee and Strazicich (2003) found that the selection of the break point in the ZA test is most often where the bias is maximized. They also documented that the two-break LP unit root test faces the same problems of bias and spurious rejections.

To address the issue of bias and false rejection that the LP and ZA tests faced, Lee and Strazicich (2003) developed their two-break test that is built on the Lagrange Multiplier (LM) unit root test proposed by Schmidt and Phillips (1992). In their two-break LM test, there is no need to assume that the null hypothesis has no breaks. In addition, the test is not subject to bias and false rejections. The test maintains its validity even when there is misspecification in the breaks' number under the null (Lee & Strazicich, 2003) Accordingly, the LM two-break tests are applied.

The two-break minimum LM unit root test statistic can be obtained from the regression below.

$$\Delta y_t = \delta' \Delta Z_t + \phi S_{t-1} + u_t \quad (7)$$

$$S_t = y_t - \psi_x - Z_t \tilde{\delta}$$

t= 2,…T, T and $\tilde{\delta}$ are coefficients from regressing Δy_t on Δz_t; $\widetilde{\psi_x}$ is the restricted maximum likelihood equation (MLE) of ψ_x $(\psi + X_0)$ given by $y_1 - Z_1 \tilde{\delta}$.

Since the error terms could be correlated, augmented terms ΔS_{t-j}, j=1,…,k could be added to the test equation to correct for the autocorrelation. The null hypothesis of the unit root test is described by $\phi = 0$

Lee and Strazicich (2004) proposed an LM unit root test with one structural break. The LM one-break test is also not affected by the size distortions whereby the unit root null hypothesis is rejected too often. Thus, it is free from the spurious rejection of the null.

Lee and Strazicich (2004) suggested that combining their one and two LM tests would enable researchers to accurately specify the right number of breaks in their unit roots.[3] Following Hassan (2013) we begin by applying the two-break unit root test. If only one level and /or trend break is significant, then we utilize the one-break test.

4. RESULTS AND DISCUSSION

Table 1 displays the results of the Augmented Dickey-Fuller (ADF) test for the two series of inflation. As revealed in the table, the t-statistics for both series (Infmonth and InfYOY) are less than the critical t-values of the test.

Accordingly, we fail to reject the null hypothesis that inflation has a unit root and is not stationary. However, according to Perron (1989) failure to account for structural breaks in the data might cause less rejection of the unit root hypothesis. When structural breaks are taken into account, the test leads to more rejection of the null.

Table 1. The results of the ADF test.

Series	Intercept	Intercept and trend
Infmonth	-2.50 (6)	-2.48 (6)
InfYOY	-1.64 (12)	-1.67 (12)

Note: The lag length of the tests is reported in brackets. The optimal lag length of the ADF test was selected based on the modified AIC (MAIC). The critical values for ADF test are -3.43 (1%) and -2.88 (5%) for the model with a constant; and -4.03 (1%) and -3.45 (5%) for the model with a constant and a trend.

Table 2 displays the results of the Zivot and Andrews (2002) test applied to the two series of inflation. The results indicate that the unit root null hypothesis could not be rejected for the first series of inflation (Infmonth). This holds for the series with the trend and without the trend.

However, for the second series of inflation (InfYOY), the unit root null hypothesis was rejected at the 1% level of significance, for the two series, with and without the trend. The alternative hypothesis is that the series is a breakpoint stationary that has a one-time break.

The date of the break, May 2020 in the model with the intercept and June 2018 in the model with the intercept and the trend, does not match with the dates of introducing the higher banknotes which are 2017 for the S.P 2000 and 2021 for the S.P5000.

[3]See Lee and Strazicich (2003) and Lee and Strazicich (2004) for further details on the one- and two-break LM unit root tests.

Table 2. The results of the Zivot and Andrews test.

Series	Break in	Break date year: Month	θ coefficient (t-statistics)	γ coefficient (t-statistics)	Δ (t-statistics)	lag k	Critical values
Infmonth	Intercept	2019:10	7.06 (3.54)		-4.33	8	-5.34(1%) -4.8(5%)
	Intercept and trend	2020:5	12.99 (4.22)	-0.75 (-3.50)	-4.21	8	-5.57 (1%) -5.08 (5%)
InfYOY	Intercept	2020:05	29.68 (4.87)		-6.50**	8	- 5.34(1%) -4.8(5%)
	Intercept and trend	2018:06	-10.02 (-2.16)	1.104 (3.87)	-5.49**	8	- 5.34(1%) -4.8(5%)

Note: Reported in brackets are the t-statistics. The null hypothesis is that δ =0. θ is the coefficient of the break in the intercept. γ is the coefficients of the break in trend. ** indicates significance at the 1% level of significance. Guided by Lumsdaine and Papell (1997) and Ben-David and Papell (1998), we assumed the Kmax to be equal to eight.

Table 3. The results of Lee and Strazicich two-break unit root test.

Series	Break in	Break date	θ coefficient (t-statistics)	γ coefficient (t-statistics)	ω coefficient (t-statistics)	ψ coefficient (t-statistics)	S{1} coefficient (t-statistics)	Lag k	Critical values
Infmonth	Intercept	2019:11 2020:05	12.65 (2.78)		-14.50 (-3.04)		-0.87 (-5.2)**	4	-4.10(%1) -3.6(5%)
	Intercept and trend	2012:12 2020:06	-7.18 (-1.94)	2.69 (2.53)	56.12 (12.74)	-15.45 (-8.08)	-0.99 (-8.07)**	7	-5.93 (%1) -5.37(5%)
Series	Intercept	2013:06 2014:05	22.77 (2.33)		-7.07 (-0.73)		-0.11 (-4.39)**	8	-4.01(%1) -3.59(5%)
	Intercept and trend	2018:02 2020:05	3.12 (0.36)	-13.67 (-4.37)	-22.77 (-2.45)	18.18 (4.21)	-0.36 (-7.92)**	8	-6.06(%1) -5.41(5%)

Note: The coefficient of S {1} tests for the unit-root. The t-statistic are reported in brackets. θ is the coefficient of the first break in the intercept, γ is the coefficient of the first break in the trend. ω is the coefficients of the second break in the intercept and ψ is the coefficients of the second break in the trend. ** indicates significance at the 1% level of significance. The general- to- specific method is utilized to determine the optimal lag length. Kmax is set to equal eight.

The results of Lee and Strazicich's two-break test reported in Table 3 reveal that the null hypothesis, the series has a unit root cannot be accepted. This holds for the two series of inflation, Infmonth and InfYOY. Accordingly, one can conclude that the inflation series is stationary. More specifically, inflation seems to be a trend-break stationery series that is only temporarily affected by shocks.

The dates of the structural breaks for each series, Infmonth and InfYOY both with intercept and with intercept and trend are inconsistent with the dates of introducing the higher notes, SP2000 and SP5000. This again confirms that the introduction of the higher banknotes did not cause a structural break in the inflation series.

As highlighted earlier, if the two-break unit root test reveals that only one level and/or trend break is significant, then we utilize the one-break test. Unreported results reveal that only one level and/or trend break is significant for each of the two series, Infmonth and InfYOY. Accordingly, we apply the one-break test. Results of the Lee and Strazicich one- break test are reported in Table 4.

Consistent with the results of the Lee and Strazicich two-break test, the results of the Lee and Strazicich one break test reported in Table 4 reveal a rejection of the null hypothesis of unit root. This implies that the two series of inflation, Infmonth and InfYOY are stationary.

As is the case with the Lee and Strazicich two-break test, the timing of the breaks reported in the Lee and Strazicich one break test seems to be sensitive to the series chosen, Infmonth versus InfYOY. Nevertheless, once again, it appears that the timing of the breaks does not coincide with the dates at which the 2000 and 5000 notes were introduced.

One breakthrough attracted our attention, the 2019 break in the monthly series of inflation (Infmonth). This break corresponds with the year of printing the 5000 notes. We investigated further whether the exact date of printing the 5000 note was known to the public. We were not able to find any relevant information related to the exact months in which the 5000 was printed. Accordingly, it is highly unlikely that the break is caused by the printing out of the note.

Table 4. The results of the Lee and Strazicich one- break unit root test.

Series	Break in	Break date	θ coefficient (t-statistics)	γ coefficient (t-statistics)	S{1} coefficient (t-statistics)	lag k	Critical values
Infmonth	Intercept	2019:08	2.24 (0.51)		-0.54 (-4.13)**	2	-4.001(1%) -3.4(5%)
	Intercept and trend	2020:06	53.34 (12.37)	-15.07 (-7.58)	-0.84 (-7.33)**	7	-4.56(1%) -4.007(5%)
Series	Intercept	2013:06	22.75 (2.41)		-0.10 (-4.34)**	8	-3.99(1%) -3.39(5%)
	Intercept and trend	2018:02	-4.40 (-0.49)	-0.54 (-0.30)	-0.17 (-5.24)**	8	-4.69 (1%) -4.15(5%)

Note: The coefficient of S{1} tests for the unit-root. θ is the coefficient of the first break in the intercept, γ is the coefficients of the first break in the trend. The general-to-specific GTOS method is used to determine the optimal lag length. Kmax is set to be equal to eight. ** indicates significance at the 1% level of significance.

Overall, the examination of the break dates obtained when applying the three tests provides an interesting finding regarding the impact of higher banknotes on inflation. More specifically, none of the identified breaks corresponds with any of the dates of putting the higher notes into circulation (neither the 2000 nor the 5000). This implies that the issuance of the higher banknotes, the 2000 and 5000 has not caused a structural break in the inflation series. Accordingly, the debated impact of higher banknotes on inflation seems not to be valid in Syria.

As a sensitivity analysis, we re-run the tests using the CPI variable instead of inflation. Results not reported for brevity reasons were consistent with the ones obtained when the inflation series is used. More precisely, putting higher banknotes into circulation did not cause a structural break in the inflation series. Thus, issuing higher banknotes do not lead to higher levels of inflation. This holds regardless of the variable used to measure inflation.

The findings have important implications for policymakers and the public in general and for Syria in particular.

While the results could not confirm the inflationary impact of the higher note, introducing higher notes should be done with caution. Few issues need to be taken into account so that the higher note does not have an inflationary impact when it is put into circulation.

Firstly, when introducing a higher note, the government needs to meet the demand for smaller notes/coins, if this is not done, people will experience "trivialization". Trivialization occurs when the public starts to round up prices as the small denominations of the currency are not available. Pambudi, Juanda, and Priyarsono (2014) reported that trivialization was observed in Ghana where the inflation rate kept increasing at 5% per year following the redenomination of the currency. Similarly, Egbuna and Obikili (2013) reported that the introduction of the higher currency notes in Nigeria resulted in the removal of the smaller notes and a rounding up of prices. If the payment system is mainly reliant on cash, which is the case in Syria, we believe that trivialization is more likely to occur if the government does not secure the availability of smaller notes/coins.

Secondly, it is of great importance to educate the public about the higher note and its neutral impact on prices (from a theoretical and empirical background). This is a very important step as expectations of inflation could be a main driver of inflation.

Thirdly, the government needs to protect consumers from potential abuse or price revision by retailers such as the one that took place after the introduction of the euro. The government could adopt a hotline to report potential abuse of price revision that could lead to inflation.

5. CONCLUSION

The crisis that hit Syria in 2011 caused a severe depreciation in the Syrian pound. This combined with the fact that the payment system in Syria is largely reliant on cash complicated the conduct of daily transactions in Syria. The Syrian monetary authorities responded to this by issuing two higher notes the SP2000 in 2017 and the SP5000 in 2021, with an almost 20 years gap from the last highest currency, the SP1000 issued in 1997. A recent study by Ismaiel and Al-Ahmad (2023) reported that the SP10000 should have been issued since 2020 and the SP20000 should be issued by the year 2024 at the latest.

This study aimed at examining the impact of issuing higher banknotes on inflation. Unlike previous research that utilized intervention analysis, price modelling, ATM withdrawals and time series models, this study examined whether the introduction of the higher banknotes, the SP2000 and SP5000, caused a structural break in the inflation series between 2011-2021. Applying the Zivot and Andrews (2002) and Lee and Strazicich (2004) structural break tests, the findings confirmed that the introduction of higher notes did not cause a structural break in the inflation series. This holds regardless of how inflation is measured.

The findings have important implications and recommendations for policymakers in general and for Syria in particular. If the currency structure suggests issuing higher notes as is the case for Syria (Ismaiel & Al-Ahmad, 2023), then the authorities need not postpone this out of fears of inflation. Nevertheless, the issuance of higher notes should be accompanied by 1- ensuring that the lower notes or coins are available to the public to avoid trivialization impact. 2-timely communication with the public to manage their expectations about future inflation to avoid inflation that might be driven by expectations about future inflation. 3- exercising more supervision on retailers to prevent them from abusing consumers by price revision and rounding up of prices.

Future research could utilize a longer data set to investigate the relationship between higher banknotes and inflation, should a higher banknote be introduced in Syria in the future. It could also examine the relationship between the two variables across different countries as the current literature is limited to a few numbers of countries.

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REFERENCES

Al-Ahmad, Z., & Ismaiel, L. (2016). Testing the PPP using unit root tests with structural breaks: Evidence from politically unstable Arab countries. *International Journal of Business, Economics and Management*, *3*(12), 173-187. https://doi.org/10.18488/journal.62/2016.3.12/62.3.173.187

Angelini, P., & Lippi, F. (2006). Did inflation really soar after the Euro cash changeover? Indirect evidence from ATM withdrawals. *International Journal of Central Banking*, *3*(4), 1-22.

Ben-David, D., & Papell, D. H. (1998). Slowdowns and meltdowns: Postwar growth evidence from 74 countries. *Review of Economics and Statistics*, *80*(4), 561-571.

Chen, C.-n. (1976). Currency denominations and the price level. *Journal of Political Economy*, *84*(1), 179-183.

Christiano, L. J. (1992). Searching for a break in GNP. *Journal of Business & Economic Statistics*, *10*(3), 237-250.

Deutsche Bundesbank. (2004). *The Euro and prices two years on.* Retrieved from https://www.bundesbank.de/resource/blob/706408/6208776382f91d5b3f592430e7e37992/mL/2004-01-euro-prices-data.pdf

Egbuna, N. E., & Obikili, N. (2013). The introduction of higher banknotes and the price level in Nigeria: An empirical investigation. *International Journal of Economics and Finance*, *5*(1), 105-111. https://doi.org/10.5539/ijef.v5n1p105

Franses, P. H. (2006). Empirical causality between bigger banknotes and inflation. *Applied Economics Letters*, *13*(12), 751-752. https://doi.org/10.1080/13504850500424926

Glynn, J., Perera, N., & Verma, R. (2007). Unit root tests and structural breaks: A survey with applications. *Journal of Quantitative Methods for Economics and Business Administration*, *3*(1), 63–79.

Hassan, A. K. (2013). Is Malaysia's current account balance sustainable? Evidence from inter-temporal solvency model. *International Journal of Business and Society*, *14*(2), 207-220.

Hobijn, B., Franses, P. H., & Ooms, M. (2004). Generalizations of the KPSS-test for stationarity. *Statistica Neerlandica*, *58*(4), 483-502. https://doi.org/10.1111/j.1467-9574.2004.00272.x

Hyunjung, B. S. (2019). *Korea's largest bills dominate cash market: BOK. The Korea Herald.* Retrieved from https://www.koreaherald.com/article/2028039

Ismaiel, L., & Al-Ahmad, Z. (2023). A D-metric analysis of the denomination structure of the Syrian pound. *Syrian Journal for Science and Innovation*, *1*(3), 1-10.

Karklis, L. (2016). *The destruction in Aleppo after five years of fighting the Washington post.* Retrieved from https://www.washingtonpost.com/graphics/world/destruction-of-aleppo/

Lee, J., List, J., & Strazicich, M. (1998). *Spurious rejections with the minimum unit root test in the presence of a structural break under the null.* Working Paper, Department of Economics, University of Central Florida. Retrieved from http://www.upo.es/RevMetCuant/art34.pdf

Lee, J., & Strazicich, M. C. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. *Review of Economics and Statistics*, *85*(4), 1082-1089. https://doi.org/10.1162/003465303772815961

Lee, J., & Strazicich, M. C. (2004). *Minimum LM unit root test with one structural break. Unpublished Manuscript, Appalachian State University* Retrieved from https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fecon.appstate.edu%2FRePEc%2Fpdf%2Fwp0417.pdf;h=repec:apl:wpaper:04-17

Lumsdaine, R. L., & Papell, D. H. (1997). Multiple trend breaks and the unit-root hypothesis. *Review of Economics and Statistics*, *79*(2), 212-218. https://doi.org/10.1162/003465397556791

Manikowski, A. (2017). Analysis of the denomination structure of the polish currency in the context of the launch of the new 500 zloty banknote. *Bank i Kredyt*, *48*(5), 495-530.

Moyo, D., & Dunga, H. M. (2020). The introduction of higher banknotes and inflation in Malawi: A test of bi-causality. *African Journal of Business & Economic Research*, *15*(1), 137-163. https://doi.org/10.31920/1750-4562/2020/15n1a6

Narayan, K. P., & Smyth, R. (2004). Is South Korea's stock market efficient? *Applied Economic Letters*, *11*(11), 707-710. https://doi.org/10.1080/1350485042000236566

Narayan, P. K., & Smyth, R. (2007). Are shocks to energy consumption permanent or temporary? Evidence from 182 countries. *Energy Policy*, *35*(1), 333-341. https://doi.org/10.1016/j.enpol.2005.11.027

Ngwende, A. (2023). *Higher note value whats next. MSc Agri. Applied Econ, BBA.* Retrieved from https://www.researchgate.net/publication/374741101?channel=doi&linkId=652cb6e706bdd619c4948f17&showFulltext=true

Nunes, L., Newbold, P., & Kuan, C. (1997). Testing for unit roots with breaks: Evidence on the Great Crash and the unit root hypothesis reconsidered. *Oxford Bulletin of Economics and Statistics*, *59*, 435-448. https://doi.org/10.1111/1468-0084.00076

Pambudi, A., Juanda, B., & Priyarsono, D. S. (2014). The determining factors of currency redenomination success: Experimental and historical approach. *Bulletin of Money Economics and Banking*, *17*(2), 155-181.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Journal of the Econometric Society*, *57*(6), 1361–1401. https://www.jstor.org/stable/1913712

Said, S. E., & Dickey, D. A. (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika*, *71*(3), 599-607. https://doi.org/10.1093/biomet/71.3.599

Schmidt, P., & Phillips, P. C. (1992). LM tests for a unit root in the presence of deterministic trends. *Oxford Bulletin of Economics and Statistics*, *54*(3), 257-287. https://doi.org/10.1111/j.1468-0084.1992.tb00002.x

Taiwo, J. N., Ogunwale, O., & Afieroho, E. (2016). Introduction of higher currency notes in Nigeria and the dynamics of inflation (1980-2014). *Basic Research Journal of Business Management and Accounts*, *5*(4), 42-60.

Traut-Mattausch, E., Schulz-Hardt, S., Greitemeyer, T., & Frey, D. (2004). Expectancy confirmation in spite of disconfirming evidence: The case of price increases due to the introduction of the Euro. *European Journal of Social Psychology*, *34*(6), 739-760. https://doi.org/10.1002/ejsp.228

Waheed, M., Tasneem, A., & Ghauri, S. P. (2006). *Structural breaks and unit root: evidence from Pakistani macroeconomic time series. MPRA Paper 1797, University Library of Munich, Germany*

Žídek, L., & Chribik, M. (2015). Impact of currency redenomination on inflation case study Turkey. *Asian Economic and Financial Review*, *5*(6), 908-914. https://doi.org/10.18488/journal.aefr/2015.5.6/102.6.908.914

Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business & Economic Statistics, 20*(1), 25-44. https://doi.org/10.1198/073500102753410372

WEB SITES:

Bank of Canada website, https://www.bankofcanada.ca/

European Central Bank (ECB) website, https://www.ecb.europa.eu/home/html/index.en.html

http://cbssyr.sy/

https://www.cb.gov.sy

https://www.todayonline.com/singapore/singapore-stop-issuing-s10000-notes