The Coining of an Economy: When, Why, How

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Abstract: *Coins have played a crucial role in every economy. So close is their relationship that almost every economy has introduced at least one new denomination of coin to add it to its original set. This raises the question, when does an economy introduce a new denomination of coin? To answer the question, this paper studies a diverse set of 10 different economies over the period 1975-2019. It infers that sticky inflation compels an economy to introduce a new denomination; a low denominated but high velocity banknote is coined as financial prudence and durability make the coin a better alternative to fund routine transactions at the bottom of the pyramid. Even when coins are absent in the economy, had coins existed, sticky inflation would have forced conversion of lower banknote denomination to a coin.*

Keywords: *Coins; Inflation; Banknotes; CentralBank; Economy; Keynes; Fischer; Money; Demand*

1. INTRODUCTION

Transactions and so money, as a medium of exchange, have always been innate to any civilization. As the exchange modalities evolved into the contemporary monetary system, the monetary material format widened to include metal, paper, plastic, digital and now even crypto currency. The role of money has expanded over time. Initially, post the barter era, it just facilitated transactions. With commercial and financial complexities increasing, money's scope has aggregately increased from mere convenience and beauty (paper currency, circulatory coins and commemorative coins) to becoming the store of value (Treasury bullion) to easing of voluminous transactions (plastic / card money) to accelerating and freeing transactions from the constraints of time and space (digital and cryptocurrency).

Coins have been the first physical form of money. They were first produced circa 700-650 BC as a standard unit of exchange. For centuries (and even in current times), durability has been coins' salient feature, in spite of the constant changing of their shapes, sizes, designs and material. Again, coins are the only form of money that have survived changing times,

kingdoms, wars, businesses, governments, and social classes. When money began to be accepted as banknotes on a commercial scale in Europe by 1661 AD, the face value of coins started to get restricted to the lower rungs of the denomination ladder. The perenniality of coins have to be attributed to the non-perishability of the metals used as well as the close relationship of coins with commercial history, and hence mankind. Furthermore, coins tend to be cost-effective in the long run. It also has a sentiment value attached and hence we see coins like 1 cent (USD), 1 penny (GBP), 1 yen (JPY) still in circulation despite seigniorage being extremely negative. In the present world, coins are the most circulated form of money used at the bottom of the transaction pyramid. It is mainly the lower income groups that need coins, as much of their transactions are frequent and low-valued. It should be noted that even higher income groups demand coins to fund their routine expenditures.

An anecdote is historically contextual but the principle is perennial. This paper avers that presence of coins can be correlated to inflation. When inflation becomes sticky at a particular level and there is no perceptible drop in the volume of transactions, economies tend to not only introduce higher denominated banknotes but also convert thelowestdenominated paper money into coins. Inflationary pressure causes the frequency of lowest denomination notes to increase. Due to lower lifetime (in comparison to coins), this eventually adds to the burden of the exchequer. With losing value of money, a more durable form proves to be prudential in the long run; so coins replace the lowest denominated paper currency. This paper explores the phenomenon of converting the lowest denomination notes to coins when inflation becomes sticky by examining instances of various economies over time.

To better understand the role of coins in any monetary system, this paper uses theories connected to the demand for money. Fisher's Quantity Theory of Money, which maintains that $M^d = PT / V$ (where: M^d = Money demanded, V = Velocity of Circulation, P = Average Price Level and T = Volume of Transactions of Goods and Services). However, for Keynes, money is demanded to satisfy the transactionary, precautionary and speculative motives. From the transactionary motive (T_m) point of view, coins play a vital role. The velocity in the system is a function of transactions. Maximum velocity occurs in the unorganised space where the lower amount transactions occur at a rapid pace and in higher numbers. Most people engaged in the unorganised space also constitute the bottom of the pyramid. Hence, higher number of transactions occurs at the bottom of the pyramid (refer Figure 1). These transactions are of lower values which have to be facilitated by the coins. Thus, coins augment / amplify the velocity in the system and play a crucial role in the transactional motive of the money.
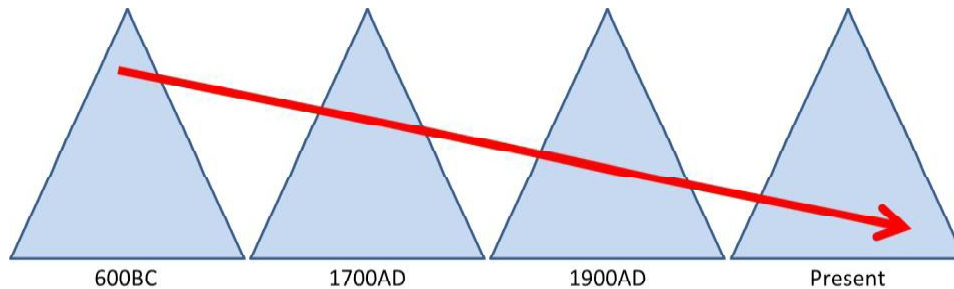
Figure 1: Coins now facilitate high velocity transactions at the bottom of the pyramid

Note: The pyramid represents economic classes with the rich at the top

2. LIST OF OBJECTIVES

The objective of this research paper is to find if any relationship exists between sticky inflation (inflation at least at the current level is here to stay) and conversion of the lowest-denominated high-velocity banknote into a coin. The crux of the paper will be to test the following sequential hypotheses:

2.1. Hypothesis 1

Sticky inflation (inflation in a particular range is here to stay) compels an economy to convert its lowest-denominated high-velocity banknote into a coin.

2.1.1. Hypothesis 1.1: Stickiness of inflation is observed only in a well-defined range of inflation values.

2.1.2. Hypothesis 1.2: Inflation of at least at 10% p.a. triggers an economy to convert its lowest-denominated high-velocity banknote into a coin.

2.2. Hypothesis 2

Phenomenon of conversion of lowest denominated high velocity banknote into a coin is independent of macroe-conomic parameters specific to an economy – GDP, inflation rate, political system (democracy, communist state etc.) etc.

2.3. Hypothesis 3

Loss of purchasing power due to sticky inflation forces the economy to phase out lower denominated coins

Given the lack of numerical data, an appropriate analytical method would be to test our hypotheses using anecdotal data from economies that

have migrated from their lowest-denominated high-velocity banknote to a coin.

3. CASE STUDIES

The relationship between inflation and coining of the lowest denominated paper currency has been verified by probing into the data of Argentina, Brazil, Burundi, Nigeria, Norway, Romania, South Korea, Sweden, Turkey and United Kingdom. The hypotheses stated in Section 2 will also be tested using the following case studies. The above mentioned economies fit into one of the following classification:

1. Switched to coins and are still coining
   (a) Hyperinflation induced coinage
   (b) High-inflation induced coinage
2. Switched to coins but are currently not coining
   (a) High inflation and are currently not coining
   (b) Digital currency and hence not coining
   (c) Low inflation and hence not coining

3.1. Switched to Coins and are Still Coining

3.1.1. Hyperinflation Induced Coinage

3.1.1.1. Argentina: Since the start of the 20th century, Argentina has experienced hyperinflation and defaulted on its debt eight times (Mander 2017). All this while, government resorted to printing more money as the means to curb this deficit. With inflation plaguing the economy, the country changed its currency thrice: Peso Ley (1970–1983), Peso Argentino (1983–1985), austral (1985–1991). This was followed by the Peso Convertible (1992-current) as their stable currency. The declining value of the peso indicates that the supply of pesos was consistently in excess of demand, giving rise to severe inflationary pressures. This paper limits itself to the australes period. Table 1 in Appendix B is a snapshot of Argentina's inflationary status.

As inflation seemed to be chronic, the country began introducing higher denominated banknotes in 1988. In 1989, the country introduced coins up to 10 australes. These coins only facilitated the Keynesian transactionary motive, and weren't an antidote to the hyperinflation. As a result when inflation almost hit 5000% in 1989, the country first introduced a 50,000 australes note as damage control, followed by an intermediate denomination of 10,000 australes a few months later. Before the end of 1990, notes as high

as 500,000 australes (to finance debt) and coins as high as 1,000 australes (to replace transactionary motive served by the same denominated note) were introduced (refer Figure 2 in Appendix B). Interestingly, again, a higher denomination (500 australes coin) was introduced before a lower denomination (100 australes coin). This, again, validates our hypothesis that coins replace notes when inflation becomes sticky.

Argentine peso (1992-current) is stable. The country introduced coins from 1 centavo to 50 centavos in 1992. Denominations of 1 Peso and 2 Pesos were introduced in 1994. With rising inflation which turned sticky, Argentina introduced a new family of coins in 2017-'18 with denominations of 1 Peso, 2 Pesos, 5 Pesos and 10 Pesos. Evidently, the centavo denominations aren't a part of this new family of coins as inflation has rendered these denominations ineffective despite they still being legal tender. Inflation has also compelled Argentina to switch to smaller and lighter coins. For further information, refer to Table 2 and Table 3 in Appendix B.

3.1.1.2. Brazil: Since 1942, Brazil had eight different currencies, including the cruzeiro (1942-86 and 1990-93), cruzado (1986-89), cruzado novo 1989-90), cruzeiro real (1993-94), Brazilian real (1994- present). Interestingly, one modern Brazilian

Real is equivalent to 2.75×10^{15} cruzeiro. This frequent demonetisation of currency was because of high inflation level from the 1980s. The 1980-1986 period is being studied here when cruzeiro was the predominant currency.

After the oil crises in 1970s, the Brazilian government had adopted deficit spending. Mismanaged fiscal policy sustained for some time as the government failed to generate enough tax revenues. The Brazilian government resorted to fund its spending by further borrowing. The creditors started demanding higher interest rates on the loans when they realized that the government has failed continuously to realize any revenues to cover its expenditure and payments. Eventually, borrowing for the government became dearer. Brazilian government, in response to the costlier borrowing, committed a major blunder as a panacea – printed more money.

Printing of money led to a significant increase in money supply in the economy in the mid-1980s, which aggravated inflation. Lower savings and closed economy with controlled currency trades added fuel to the fire. The economy deteriorated as the inflation went beyond control and reached epic proportions, resulting in hyperinflation in the late 1980s. Brazil's inflation in the 1980s was almost entirely monetarily induced, which led to

inflation rate as high as 3,000% in 1990 (He 2018). On average, prices and money rose at the same rate and per-capita output changed very little. The average change in velocity is small relative to changes in money, prices and nominal output. Brazil had to demonetise its currency, as temporary measures, to overcome its problems. Higher denomination coins acted as a cushion for transactions in ever rising prices situations. Figure 3 in Appendix C traces how coins have become irreplaceable the sphere of transactions.

As inflation picked up its pace, notes as high as 50,000 cruzeiros (1984) entered the system. These high denominated notes were introduced to finance the debt. In 1985, when inflation became sticky around a particular range, coins of 100, 200 and 500 cruzeiros (previously circulating as notes) entered circulation to cater to the routine transactions. Hyperinflation plagued the country as cruzeiros lost its value despite a short-term respite. This is evident from the fact that the country had to introduce a 100,000 cruzeiros note (1985) shortly after the introduction of 50,000 cruzeiros note (refer Figure 3 in Appendix C). This was followed by Brazil finally letting go of its four-decade old currency.

In 1993, the annual inflation rate was almost 2,500%. As part of a successful plan to stabilize the country's economy, the Real was introduced as currency in 1994. The coins were introduced in 1 centavo, 5 centavos, 10 centavos, 25 centavos, 50 centavos and 1 Real denominations. Banknotes were originally introduced in the denominations of 1, 5, 10, 50 and 100 reais. Later, intermediate denominations of 2 and 20 reais were introduced in 2000 and 2001 respectively. In November 2005, minting of 1 centavo coins ceased followed by ceasing of printing of 1 Real banknotes on 31st December 2005. Effects of sticky inflation stated above validate our hypotheses. For details on Brazilian Real coins, refer to Table 4 and Table 5 in Appendix C.

3.1.1.3. Romania: Romania's economic decline of 1980s fuelled the hyperinflation of 1990s. This decline can be attributed to both failures of central planning as well as Ceausescu's (then President of Romania) personal mismanagement of the economy. In 1990, the government increased the money supply in Romania from 748 billion lei (1991) to about 23 trillion lei (1999) (Karfakis 2003). Post 1997, government coined and replaced its lowest denominated banknotes as inflation went out of control. Economic prudence led to the conversion of these banknotes into coins as velocity of transactions for this denomination increased manifold and hence a durable form of currency was needed. As soon as a newly denominated coin was introduced, within a few months its banknote was discontinued. The inflation kept on rising and coins as high as 5,000 lei and banknotes as

high as 1,000,000 lei had to be introduced. In 2005, the Romanian lei was the world's least valued currency post which the new lei was introduced (1st July, 2005) at 1 new leu = 10,000 old lei. Refer Figure 5 in Appendix E for a snapshot view of Romania's currency history.

Romanian leu (1st July 2005) has coins in the denominations of 1 ban, 5 bani, 10 bani and 50 bani, through practically 1 ban coin isn't currently seen in circulation. The banknotes of denominations 1, 5, 10, 50, 100 and 500 lei were also introduced on 1st July 2005. A 200 lei banknote was introduced on 1st December 2006.

3.1.1.4. Turkey: Towards the end of the 20th century, the Turkish economy had encountered relatively high inflation levels. Several disinflation programs by the government proved to be futile. Turkey's yearly inflation never reached hyperinflationary levels but increased in a stepwise fashion over time: the average annual inflation rate was 20% in the 1970s, 35-40% in the early 1980's, 60-65% in the late 1980s and early 1990s, and around 80% before the government launched yet another disinflationary program in 1998 (Selcuk, Faruk and Ahmet, Ertugrul 2001).

Even after the disinflationary measures, the inflation became sticky and was continuously rising. There was continuous introduction of coins to facilitate the transactions during that time. During 1980-87, when inflation was 'walking', 20, 50, and 100 denomination notes were converted to coins. Despite the presence of 20 and 50 lira coins, a new denomination of 25 lira was introduced as a coin in 1985 indicating increase in velocity of transactions between 20 and 50 lira due to sticky inflation.

Deterioration of economic conditions led to a galloping inflation. The 1988-2000 saw a period of very high inflation levels and continuous conversion of lowest denomination notes to coins almost every year. The importance of coins for transactions is evident when coins of denomination as high as 100,000-250,000 lira were introduced. (Refer Figure 9 and Figure 10 in Appendix H).

In 2005, Turkey introduced their current currency, Turkish lira, with coins in the denominations of 1, 5, 10, 25, 50 kurus and 1 Turkish lira.

3.1.2. High-inflation Induced Coinage

3.1.2.1. Burundi: Inflation in Burundi has been rising consistently over the years. As inflation went beyond control, the country had to resort to introducing higher denominated banknotes. They started with introducing 2,000F as an intermediate denomination between 1,000F and 5,000F, as this denomination was needed for increasing volumes of transactions; with

inflation still on the higher side, this was followed by 10,000F banknote. When they realized that inflation is here to stay, they began coining the lower denominations. After 10F (1968), a 50F coin (2011) was introduced; the 20F denomination was skipped as it seemed ineffective to use this denomination at such high inflation. During introduction of 100F coin (2015), all the lower denominated banknotes were withdrawn. Since 2015, these above mentioned denominations exist till date. Refer Figure 4 in Appendix D for a snapshot of Burundi's currency history.

3.1.2.2. South Korea: After devaluation of hwan, currency during 1953-'62, South Korea reintroduced won. A Currency Reform was carried out in South Korea on June 10, 1962 to support the national plan initiatives and to channel hoarded wealth into industrial development. The new measures included the exchange rate reform of 1964 and the interest rate reform of 1965 (Kim, Kwan S 1991). A new won-denominated currency, which had a face value ten times higher than that of the hwan-denominated currency, was issued as legal tender, and the circulation of and transactions in hwan-denominated currency were prohibited; however, 50- and 10-hwan coins remained in circulation until March 21, 1975. The Bank of Korea replaced 50- and 10-hwan coins, that had remained in circulation as an exception under the ordinance on temporary measures for the circulation of coins, with newly issued 10-, 5- and 1-won coins on August 16, 1966.

Subsequently, banknotes and coins were issued in higher denominations as these became necessary in the course of economic development. The Bank of Korea replaced banknotes with coins by issuing 100-won coins on November 30, 1970 and 50-won coins on December 1, 1972. In keeping with the Fischerian view, as national income increased and the volume of transaction units expanded, the argument for the issue of high denomination notes became stronger. Thus the Bank issued 5,000-won notes on July 1, 1972 and 10,000-won notes on June 12, 1973. The Bank issued 1,000-won notes, medium denomination notes on August 14, 1975, for convenience in transactions.

By early 1980s, inflation had soared to new levels and was exhibiting stickiness. There was a need for the introduction of 500-won coin (Figure 6 in Appendix F) to facilitate increased number of transactions of basic goods which had become costlier because of rising inflation. And thus, 500-won notes began to be replaced by 500-won coins from June 12, 1982.

All these denominations exist till date, except 1 won and 5 won coins which, despite being legal tender, are rarely seen in circulation.

3.2. Switched to Coins but are Currently not Coining

3.2.1. High Inflation and are Currently not Coining

3.2.1.1. Nigeria: The present Nigerian currency – the Naira and Kobo – was introduced in 1973. The notes were N10, N5, N1 and 50k and the coins were 20k, 10k, 5k, 1k and 0.5k. The N50 was introduced in 1991 and the N1 and 50k were coined as a completely new set of coins were issued in the denominations of N1, 50k, 25k, 10k and 1k. From 1973 up until the mid-1990's, coins were widely in circulation and were used by all and sundry.

Between 1999 and 2005, N100, N200, N500 and N1000 notes were introduced as there was an impactful decrease in the value of the Naira that adversely affected the economy as inflation rose to double digits. 1 NGN was now almost worthless. People could no longer transact with smaller denominations as the value had dropped. So the coins slowly disappeared. Though the coins were still a legal tender, people had a strong aversion towards the usage of coins as they perceived it to be 'poor man's money'. Additionally, the Nigerians deterred the usage of coins as they were really heavy and hence people avoided carrying a lot of them. Also, the coins were not suited to the cultural needs of Nigerians who liked to throw money at celebrants at parties/occasions.

In 2007, a new set of coins were released in the denominations of N2, N1 and 50k in a bid to reintroduce coins into circulation while the N50, N20, N10 and N5 notes were redesigned. Coins from 1/2k to 25k were discontinued with effect from 28th February 2007. This set of coins was lighter and better looking but still the Nigerians rejected them as the previous problems were still unresolved. People still refused to use them. Both sellers and buyers alike rejected the use of coins, leading to a poor circulation of the coins.

Before the re-introduction of coins, goods were priced in multiples of fives because of the dearth of coins and this affected price levels significantly. No goods could be bought for N1 because no such denomination existed, so prices of the lowest-priced goods were raised to N5 and N10. In spite of proposing the idea of converting lower denomination notes to coins twice in last 15 years, Nigeria is probably the only country in West Africa where there is a total absence of the coins in the economy. "The top management of the Central Bank of Nigeria have decided to introduce currency denominations of N2,000 and N5,000. All the smaller denominations from the N50 downwards are also to be converted into coins" (Central Bank of Nigeria 2012). In May 2017, the Nigerian Senate had urged the Central Bank of Nigeria to look at the possibility of converting the country's lower

currency notes into coins to facilitate retail transactions in the economy. The need of coins on account of sticky inflation and money losing its value is clearly evident from the Nigerian experience, thereby validating our hypothesis.

3.2.2. Digital Currency and Hence not Coining

3.2.2.1. Sweden and Norway: Sveriges Riksbank, the oldest Central Bank in the world, between 1873 and 1876 introduced coins in denominations of 1, 2, 5, 10, 25, and 50 öre and 1, 2, 10, and 20 kronor. Since then, even with rising inflation, no higher denominated coin has been introduced. With rising inflation, metals used in coins changed from gold and silver to cheaper alloys, size of coins reduced, and the lower denominated coins ceased to be legal tender (In 2010, the last Swedish öre coin, the 50-öre, ceased to be fiat money).

Just one new denomination of coins has been introduced - 5 kronor. In 2016, 2 kronor coin was reintroduced (after discontinued production: 1971). "By introducing a 2-krona coin, fewer coins will be needed as the 2-krona coin will replace two 1-krona coins in many payments (Sveriges Riksbank 2016)." This could be a subtle hint to the underlying cause that with rising inflation, a significant volume of high-velocity transactions are now happening in coins. This led to the need to introduce this intermediate denomination (between 1 krona and 5 kronor), which also reduces the burden on 1 krona coin. Presently, the Swedish krona has coins in the denominations of 1, 2, 5 and 10. However, with the rapid penetration of digital transactions, the usage of coins is reducing. Figure 7 and 8 in Appendix G track the relationship between sticky inflation and coins.

Norges Bank, Norway's Central Bank, had decided that the 50-øre coin would be withdrawn from circulation and no longer be legal tender from 1 May 2012. "The reason that the 50-øre coin is being withdrawn is that it no longer circulates as an ordinary coin used for payment. While it is used in shops to give change, customers largely put the coins aside rather than use them for subsequent payments. This means that Norges Bank needs to produce a large number of 50-øre coins, even though there are a sufficient number of coins already in circulation. In recent years the annual net issue from Norges Bank has ranged between 15 and 22 million coins (Norges Bank 2011)"

3.2.3. Low inflation and hence not coining

3.2.3.1. United Kingdom: Inflation in the UK rose at 11.12% (CAGR) during the period 1975 – '83, followed by 3.75% (CAGR) during 1983 – '98. On an

average, inflation rose at 5.83% (CAGR) during 1975 – 2000, which still seems to be a high rate for a developed economy having large GDP. The introduction of £1 coin on 21ˢᵗ April, 1983 followed by discontinuation of £1 banknote on 11ᵗʰ March, 1988, was followed by introduction of £2 coin on 15ᵗʰ June, 1998 (coins minted 1997): all of which could be attributed to this unusually high inflation in a span of 25 years (refer Figure 11 in Appendix I).

Inflation rose at a nominal rate of 2.09% (CAGR) during 2000 – '17.

The Royal Mint's official website informs: "By 1980 it had become apparent that with the general decline in purchasing power, the £1 unit of currency was more appropriate to a coin than a banknote. The note was in constant use and on average each note only lasted nine months. A coin can last 40 years or more and with the growth in the vending industry, it was felt that a coin would be more useful." This further validates our hypothesis that the lowest denominated banknote had to be converted to coin due to inflation.

Figure 12 in Appendix I explains how circulation of various denominated banknotes varied during the 1975 – 2000 period. With the introduction of £1 coin, it can be inferred that the circulation of £1 banknote reduced drastically until it ceased to be legal tender. What seems to be unusual is the fact that circulation of £5 banknotes also declined, while £10 banknotes increased evidently. It can be inferred that as the purchasing power of the GBP reduced, people preferred using coins for their day to day smaller transactions.

An interesting point to be noted is that £2 denomination never existed (£1 banknote was legal tender and £5 banknote is still legal tender). Introduction of £2 coin could be due to reducing purchasing power of the GBP, with velocity of lower denominated currencies increasing, which resulted in the introduction of this new intermediate denominated, that too as metal. The number of £2 coins, as seen in Figure 13 in Appendix I, in circulation grew at a staggering 6.42% (CAGR). This again validates the acceptance of people to use a coin for high velocity T_m.

After the introduction of £2 coin, no new denominations have been introduced in the UK (coins from 1 penny to 2 Pounds are all in circulation). This is due to the fact that inflation has been low: CAGR of inflation between January 2000 and December 2018 was 2.12%.

4. CONCLUSION

We conclude our research by checking the validity of the hypotheses stated in Section 2.

1. We tested Hypothesis 1 which states that sticky inflation (inflation in a particular range is here to stay) compels an economy to convert its lowest-denominated high-velocity banknote into a coin as it can be validated from all the case studies.

    India converted its 1, 2 and 5 rupees (Rs) banknotes into coins and now banknotes of these denominations are rarely seen in circulation. Presently, banknotes and coins of Rs10 coexist but sticky inflation will compel India to completely migrate to Rs10 coins. "The central bank was in favour of growing the circulation of Rs 10 coins, the highest-denomination coin minted in India since its introduction in 2005, amid persistent high inflation over long time (Ray, Atmadip, 2018)". "Almost 10 years after the issue of the Rs 10 coin, the Centre today announced a new coin of Rs 20 denomination which will come in 12-edged polygon (dodecagon) shape (Economic Times 2019)." This case in point further strengthens our hypotheses.

2. We tested Hypothesis 1.1 which states that stickiness of inflation is observed only in a well-defined range of inflation values but we can't validate it as we lack credible data sources to find this well-defined range. Nevertheless, we have theorized a method to find this range which is explained in Section 4.2.

3. We tested Hypothesis 1.2 which states that inflation of at least at 10% p.a. triggers an economy to convert its lowest-denominated high-velocity banknote into a coin and it turns out to be negative as the case study of United Kingdom disproves it.

4. We tested Hypothesis 2 which states that phenomenon of conversion of lowest denominated high velocity banknote into a coin is independent of macroeconomic parameters specific to an economy – GDP, inflation rate, political system (democracy, communist state etc.) etc. and we have validated it using our case studies as all the countries chosen have diverse macroeconomic parameters and are not restricted to any particular time capsule.

5. We tested Hypothesis 3 which states that loss of purchasing power due to sticky inflation forces the economy to phase out lower denominated coins as it can be validated from all the case studies.

    In India, coins of denominations 25 paise and lower have ceased to be a legal tender as inflation has rendered them ineffective. Even a 50 paise coin is seldom seen in circulation, despite it being a legal tender, as all the prices are rounded off to the nearest rupee.

4.1. Key Inferences

Given sticky inflation, this is how coin management is undertaken:

1. In response to inflation, first higher denominated banknotes are introduced (to service debt) and when inflation becomes sticky around a particular range lower denominated, but high velocity, banknotes are coined to cater to day-to-day transactional needs (e.g., Argentina, Brazil etc)

2. When inflation is beyond control, the higher denomination banknote is coined first to ensure that the economy doesn't come to a halt. This is followed by coining an intermediate denomination coin as transactions can be completed smoothly only by bridging the gap (e.g., Argentina)

3. In situations of hyperinflation, paper currency is converted into coins to facilitate high velocity routine transactions

4. In some scenarios, a completely new intermediate denomination is introduced as a coin. Transactional velocity demands the economy to (re)introduce this denomination to lessen burden on other denominations (e.g., Great Britain, Sweden)

Transactional obsolescence, phases out lower denominations:

1. In many cases, rising inflation renders the lowest denominated coin as useless. This denomination seldom buys anything and hence people happily let go of this coin. Even the central bank doesn't withdraw the coins as, probably, the cost incurred in withdrawing this denomination from the system is much higher than the possible benefits. Another possible reason could be that the central bank wants to camouflage the sticky inflation by not letting the users of the currency know the apparent loss of purchasing power of this lowest denomination

Catering to routine transactions:

1. The principle of coining the lowest banknote is perennial. For low-ticket transactions, even if coins are replaced by other modes of payment (e.g., Digital methods) in modern economies, in absence of these alternative modes of payment the transaction would have been completed by coins. With sticky inflation, prices of even staple grocery items like a loaf of bread increases. Consequently, coins of higher denominations need to be introduced to facilitate these routine purchases

2. An economy will introduce a higher (e.g., UK) or even an intermediate denomination (e.g., Sweden) of coin so that the routine

high-velocity purchases can be completed using the minimum number of coins

4.2. Future Scope

This research lacks numerical analysis due to which it is unable to test Hypothesis 1.1. Since the case studies are from across the world and span varied time-zones, finding a credible data source fitting all the criteria was difficult. The research suggests researchers with access to data to prove the hypotheses numerically as well. This research can be expanded to study other countries as well. Had this research had access to relevant data, this is what and how it could have probed this topic further along these lines (refer to Appendix A).

Despite the numerical limitations of the research, it was able to validate the hypotheses and can therefore aver that conversion of lowest-denominated high-velocity banknote into a coin is due to sticky inflation. It has been further validated from the official statements made by a few central banks like Reserve Bank of India (India), Sveriges Riksbank (Sweden), The Royal Mint (UK).

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A FUTURE SCOPE

A.1 Range of inflation values

Hypothesis 1.1 states that stickiness of inflation is observed only in a well-defined range of inflation values. It is suggested to use food inflation data only. The following are the reasons why the research should avoid the use of any other inflation, say Consumer Price Index (CPI):

1. Different countries have different ways to measure inflation
2. Different countries have different basket of goods in consideration while measuring inflation
3. Countries that need to import certain basic commodities (e.g., oil) will observe higher inflation due to macroeconomic conditions not related to the importing economy
4. All the goods used to calculate inflation do not necessarily get consumed by all the sections of the society in equal proportions (e.g., oil might not be used by the weakest section)

However, food is a necessity and is consumed by all. Hence, everyone in the pyramid of the society will be affected by food inflation.

The food inflation data can be plotted against a timeline to chart introduction and discontinuation of a banknote and a coin in the economy. Average inflation rates can be measured between:

1. Introduction of a coin and introduction of the next coin
2. Introduction of a coin and discontinuation of the same denominated banknote
3. Introduction of a banknote and introduction of the same denominated coin
4. Introduction of a denomination (banknote or coin) and introduction of the next denomination (banknote or coin)

The method with least variance should be chosen to arrive at the range of inflation.

A.2 Regression and Correlation

The research suffers from the limitation of comparing just inflation to introduction of coins. Other macroeconomic parameters like GDP, Balance of Payments, Foreign exchange rates etc. could also affect this phenomenon. Running a regression model and using correlation to find the most suitable parameters would enable the researchers to arrive at more precise inferences and results.
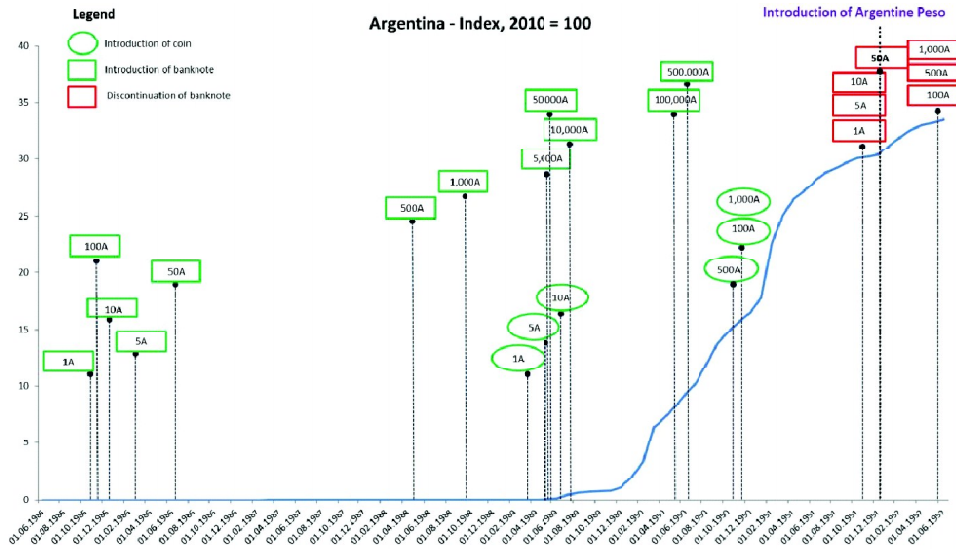
B. ARGENTINA

**Figure 2: Soon after introduction, hyperinflation forced Argentina to
replace its 500A and 1000A banknotes with coins**

Source: BIS

Note: Graph doesn't include coins below 1A and doesn't depict discontinuation of
banknotes above 1,000A.

Table 1: Argentina inflation was almost as high as 5000% in 1989 (Source: INDEC)

Period	Average	Maximum	Minimum
1920-1929	-1.7	17.1	-15.9
1930-1939	-0.3	13.0	-13.9
1940-1949	10.6	31.1	-0.3
1950-1959	30.3	111.6	3.7
1960-1969	23.3	31.9	7.6
1970-1979	132.9	444.0	13.6
1980-1989	750.4	4,923.3	87.6

**Table 2: 1 Peso and 2 Pesos were introduced within 2 years of issuance of
centavos (Source: BCRA)**

Denomination	Issuance	Weight (grams)	Diameter (mm)	Thickness (mm)
1 centavo	10.4.92	1.77	16.2	1.4 (octagonal) / 1.5 (circular)
5 centavos	1.1.92	2.02	17.2	1.4
10 centavos	1.1.92	2.25	18.2	1.4
25 centavos	1.1.92	5.40	24.2	1.8
50 centavos	10.4.92	5.80	25.2	1.8
1 Peso	1.9.94	6.35	23.0	2.2
2 Pesos	1.9.94	7.20	24.5	2.2

Table 3: Sticky inflation led to introduction of 5 and 10 Pesos and an overall reduction in size and weight of the Argentine Pesos (Source: BCRA)

Denomination	Issuance	Weight (grams)	Diameter (mm)	Thickness (mm)
1 Peso	12/22/17	4.3	20.0	1.7
2 Pesos	12/18/18	5.0	21.5	2.1
5 Pesos	12/22/17	7.3	23.0	2.2
10 Pesos	12/18/18	9.0	24.5	2.6

C BRAZIL
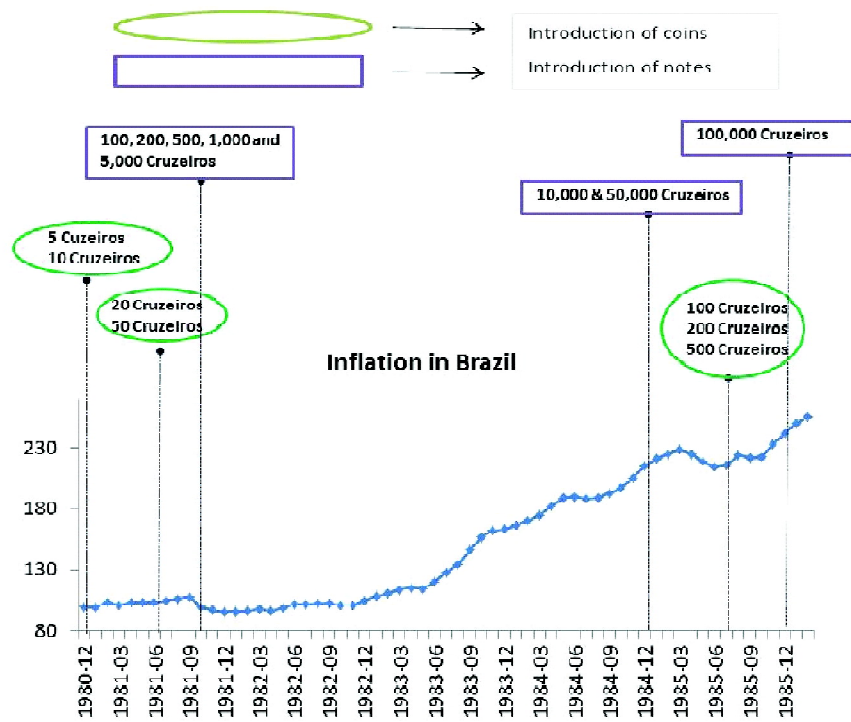
Figure 3: 100, 200 and 500 cruzeiro coins had to be introduced soon after introducing them as banknotes (Source: BIS)

Table 4: First series of Brazilian coins (Source: BCB)

Denomination	Weight (grams)	Diameter (mm)	Thickness (mm)
1 centavo	2.96	20.00	1.20
5 centavos	3.27	21.00	1.20
10 centavos	3.59	22.00	1.20
25 centavos	4.78	23.50	1.40
50 centavos	3.92	23.00	1.20

Table 5: Second series of Brazilian coins (Source: BCB)

Denomination	Weight (grams)	Diameter (mm)	Thickness (mm)
1 centavo	2.43	17.00	1.65
5 centavos	4.10	22.00	1.65
10 centavos	4.80	20.00	2.23
25 centavos	7.55	25.00	2.25
50 centavos (from 1998 to 2001)	9.25	23.00	2.85
50 centavos (2002 onwards)	7.81	23.00	2.85
1 Real	7.84	27.00	1.95
1 Real	7.00	27.00	1.95

D. BURUNDI
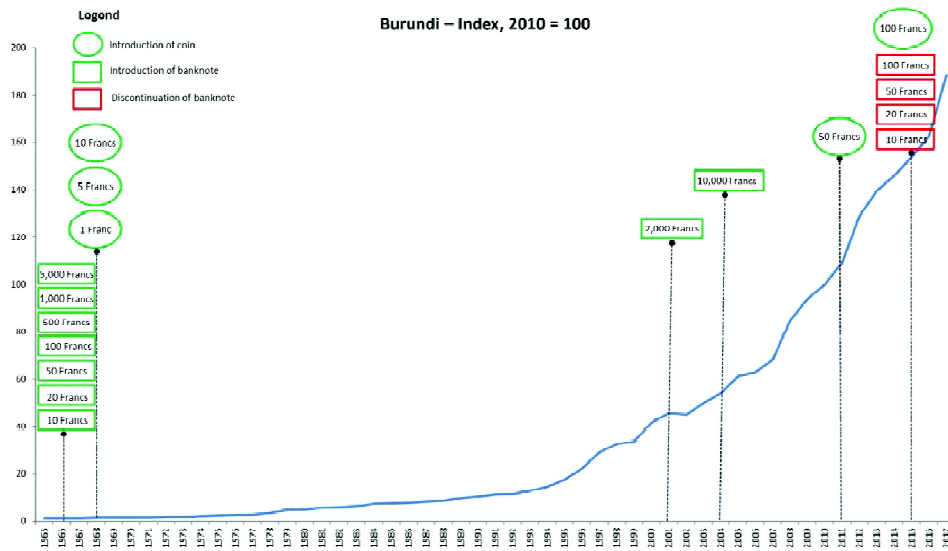
Figure 4: Inflation out of control: Burundi had to discontinue banknotes up to 100 Franc and introduce a 100 Franc coinin 2015 (Source: World Bank)

E   ROMANIA
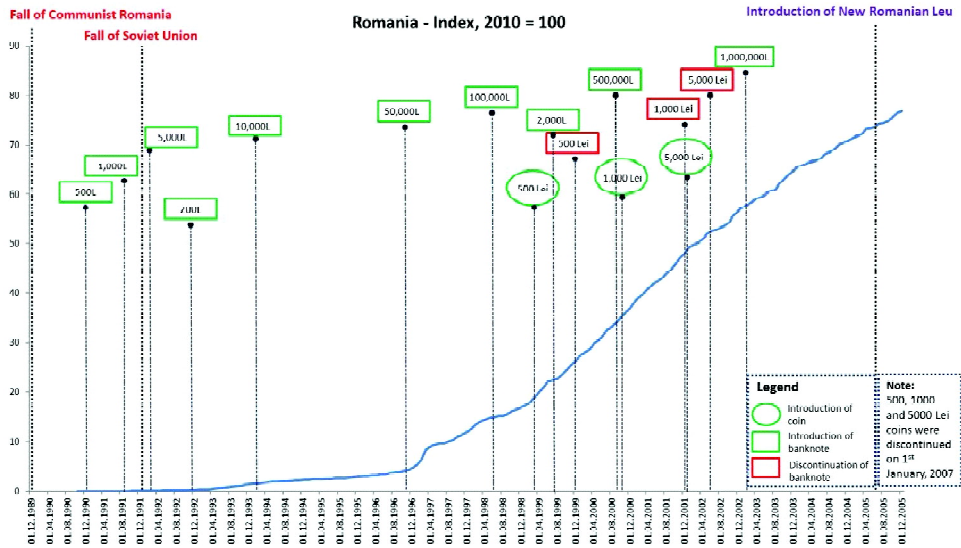
Figure 5: Soon after 500, 1000 and 5000 lei coins were introduced, the respective banknotes were withdrawn fromcirculation (Source: BIS)

F   SOUTH KOREA
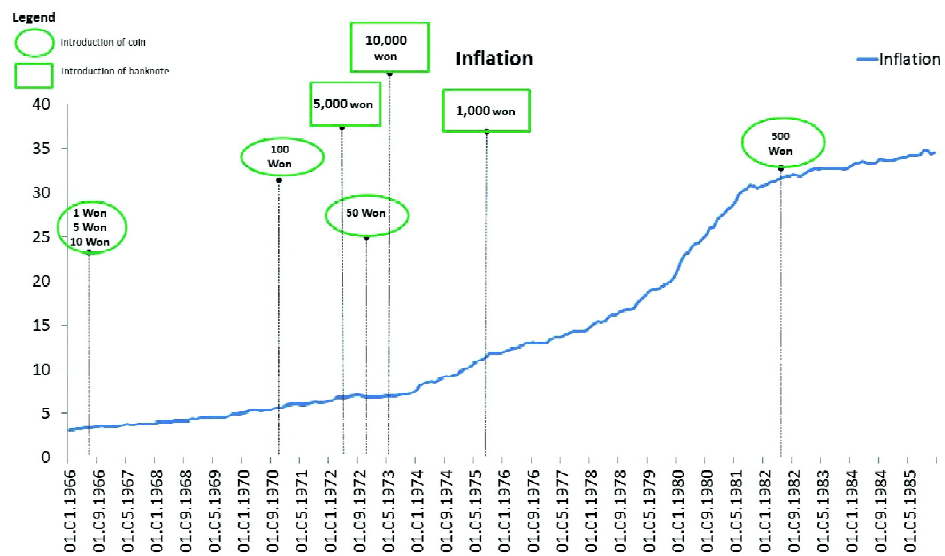
Figure 6: Introduction of 500-won coin in 1982 after inflation seemed to be sticky

G. SWEDEN
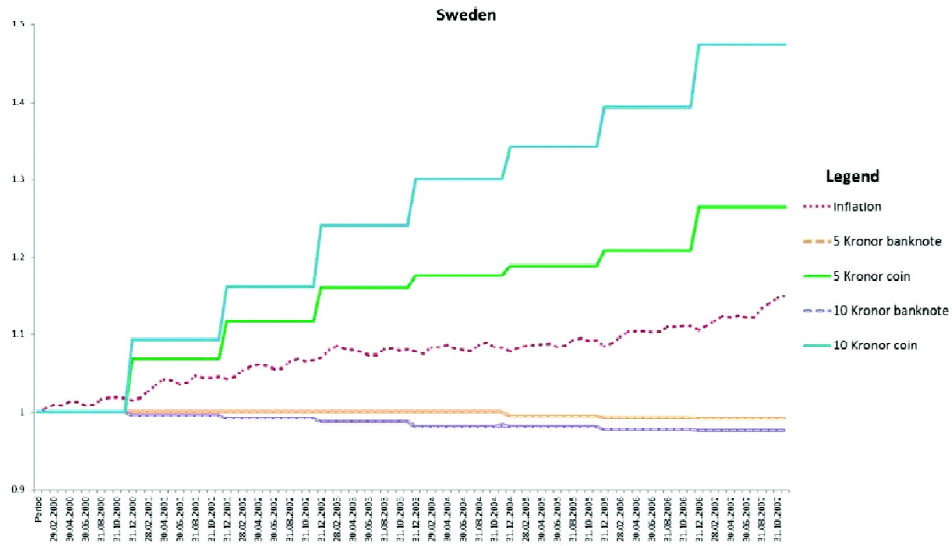
Figure 7: Usage of 5- and 10-kronor coins increased manifold (2000-'07) as their banknotes slowly phased out of theeconomy (Source: BIS, ECB)
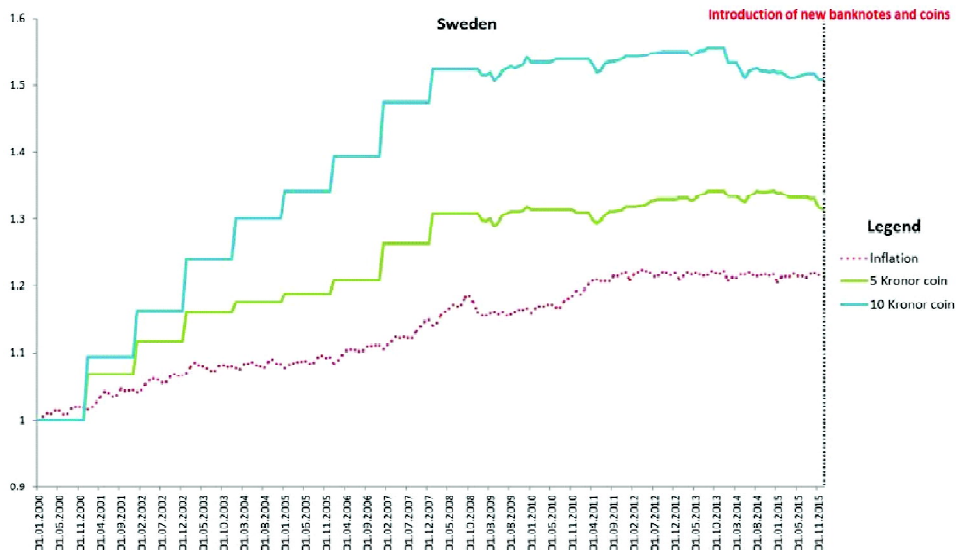
Note: Graph is visualized using January 2000 data as the base data

Figure 8: 10-kronor coins in circulation increased at a much faster pace than 5-kronor coins due to pressure from risinginflation in the Swedish economy (Source: BIS, ECB)

Note: Graph is visualized using January 2000 data as the base data

H. TURKEY
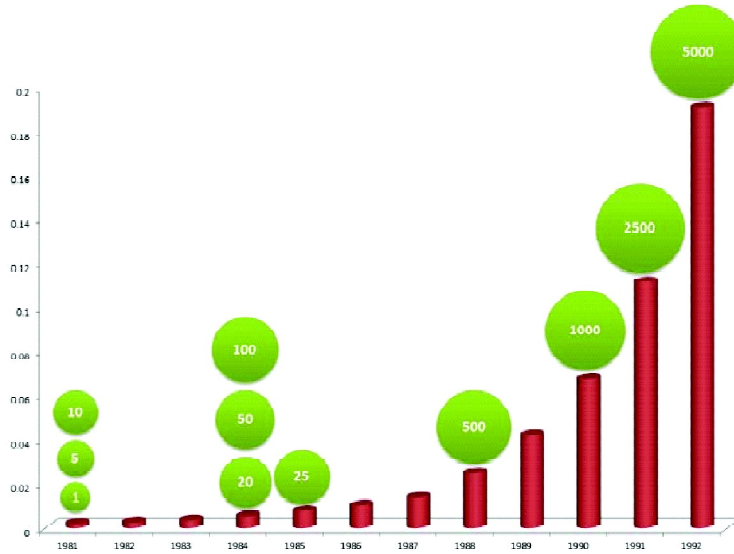
Figure 9: Hyperinflation forced Turkey to introduce 1 new coin denomination (on an average) per year during 1981-'92
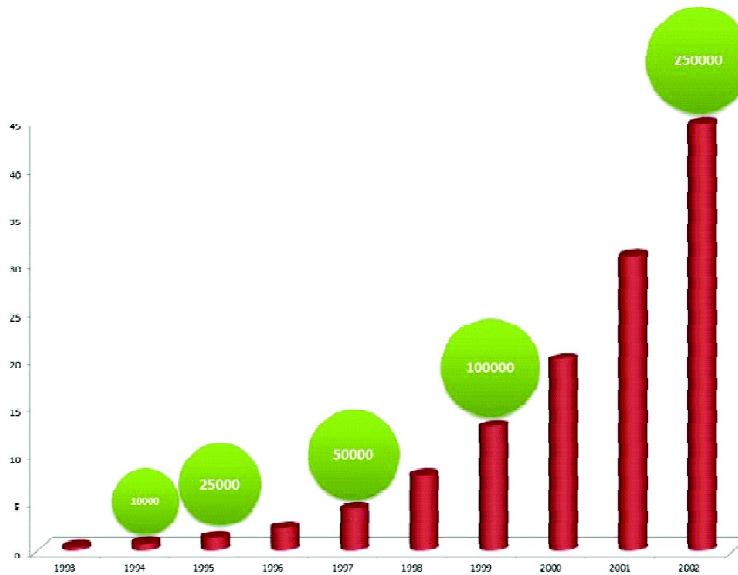
(*Source:* BIS)

Figure 10: Coin denominations as high as 250,000 lira had to be introduced to fulfil transactionary motive (Source:BIS)
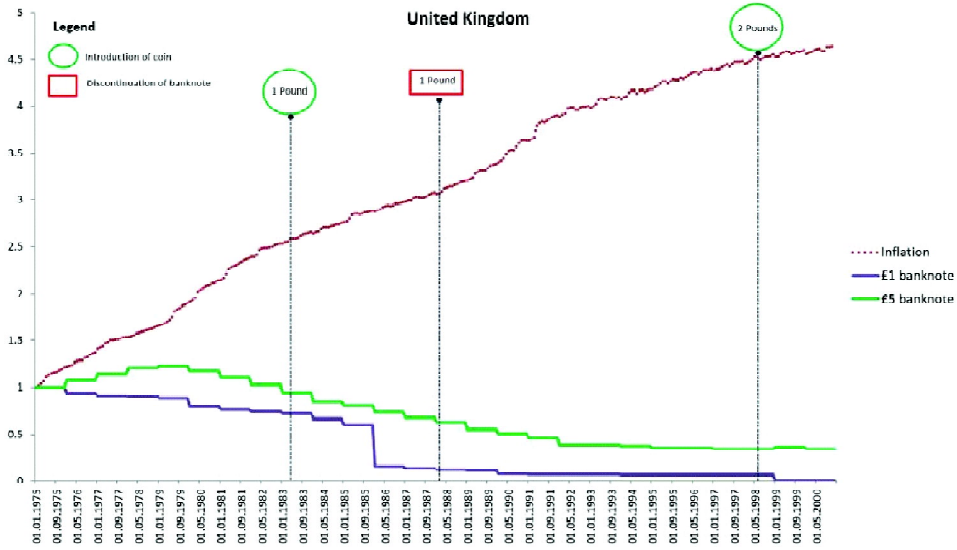
I   UNITED KINGDOM

Figure 11: Introduction of £1 and £2 coins and reduction in circulation of £1 and £5 banknotes with rising inflation

Note: Graph is visualized using January 1975 data as the base data
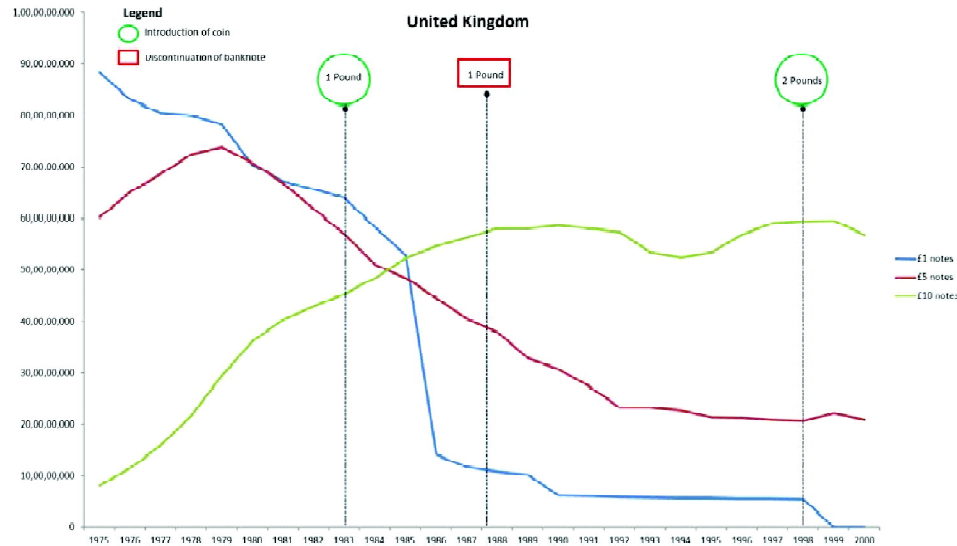*Source:* BIS, BoE

Figure 12: As inflation rose from 1975-2000, circulation of £1 and £5 banknotes plummeted while that of £10 banknotesrose (Source: BIS, BoE)

Note: Graph reflects the number of banknotes in circulation in absolute terms
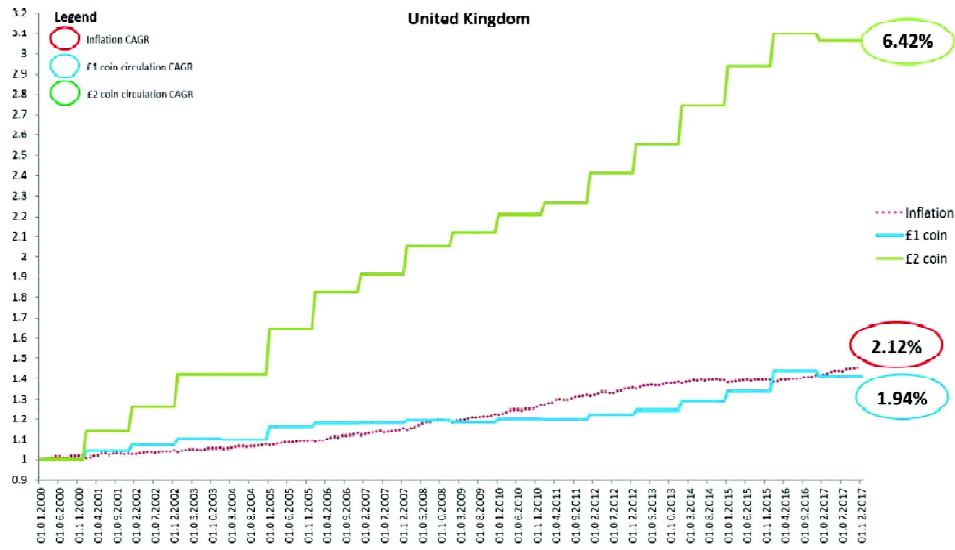
Figure 13: From 2000-'17, circulation of £2 coins grew at a staggering 6.42% CAGR (Source: BIS, ECB)

Note: Graph is visualized using January 2000 data as the base data