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Recovering Anchor Currencies and Decomposing Exchange Rate Behaviour into Component Regimes

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Abstract

Exchange rate regimes have evolved substantially over the years, right from the Gold Standard to the Bretton Woods era and post-Bretton Woods periods. The post-Bretton Woods era has seen the emergence of currency unions and a whole range of hybrid and sophisticated exchange rate regimes. This study attempts to recover the preferred anchor currencies of different countries and further uses a Markov-switching process to decompose exchange rate behaviour into component regimes. The regression-based results reveal the preferred anchor currencies while the Markov-switching results indicate that the model is able to decompose the currency behaviour of eight currencies into appreciating and depreciating regimes. Furthermore, the Markov results identify the key turning points in the exchange rate series, especially the 2008/2009 crisis period.

Keywords: exchange rate regime, anchor currency, Markov process

1. Introduction

This study applied an anchor currency regression-based model and a Markov regime switching model to monthly exchange rate time series over the period 2000-2019, with the aim of finding out how particular currencies behave towards major anchor currencies. The study was able to breakdown exchange rate behaviour into two competing regimes identified as appreciation and depreciation periods. The anchor currency regression model was applied to 70 currencies. The identified anchor currencies are the US Dollar, Euro, British Pound and Japanese Yen. The findings revealed that there is a major preference for particular anchors in different regions with the Euro dominant in Europe, Oceania and parts of Africa. In parts of West Africa, the preference is a peg to the Euro. The US Dollar is the preferred anchor in the Americas, Asia, and other parts of Africa. Of great importance is the fact that Middle East and Caribbean currencies have perfect pegs to the US Dollar and are consequently exactly tracking the variations in the US Dollar. However, even though there is a preferred anchor, several countries also prefer basket currency pegs. The Markov regime switching model was applied to four advanced and four emerging economy currencies. Findings indicate that the model performs well, and the switching probabilities capture key turning points in the exchange rate time series. The model is not able to capture the long swings exchange rate phenomenon.

Section 1.2 gives a survey of various perspectives and literature on exchange rate behaviour and regime classifications, section 1.3 discusses the models and data used, section 1.4 gives a discussion of the results and section 1.5 gives a conclusion to the study.

As stated by Svensson (1992), the exchange rate as conventionally defined is the domestic price of foreign exchange or currency, that is, the number of domestic currency units per foreign currency unit. Generally, exchange rate regimes can be classified as fixed, floating, and managed floating. Researchers have developed techniques that characterize the regimes based on certain variables and clustering the candidates for a certain regime accordingly. Studies have resulted in classifications of up to ten or even more exchange rate regimes. See Reinhart and Rogoff (2004). It is the responsibility of the monetary authorities to deploy an exchange rate regime policy or mechanism that may seek to maintain an exchange rate or allow it more flexibility as and when they deem fit. The exchange rate regime employed by a country has macroeconomic effects on the economy through inflation, price, capital flows, economic growth, and several other variables. Ghosh et al. (1997) shows

that inflation is lower and more stable under the pegged regime. Some studies have linked the fixed exchange rate regime and/or monetary union to more growth, trade, and less exchange rate volatility. Furthermore, Ghosh et al. (2015) show that macroeconomic vulnerabilities are significantly greater under less flexible regimes including hard pegs compared to floats. This is only a highlight of how important the regime employed by a country is for the economy.

In the integrated and globalised world of today, economies are intertwined. The risk of financial and currency crises is high, and consequently monetary policy management must consider effects of currency attacks and shocks coming from external sources. Ohno (1999) states that financial markets operate through expectations whose dynamics are not very well understood, and further adds that the financial markets are vulnerable to herding, over-borrowing, bubbles, reversals, and contagion. This has come into surface as evidenced by the 2007-2009 global financial crisis. Exchange rates remain a pillar of macroeconomic stability and avoiding mis-valuation of a currency is an important step. Mis-valuation is often a predictor of an impending currency attack. Where, a mis-valuation implies a country's exchange rate is not reflective of the true state of the economy. For instance, a strong currency should be represented by a strong economy and a weak currency should reflect a weak economy, not the other way around. The strength of an economy may be represented by stable and improved macroeconomic indicators like inflation and interest rates, the standard of living, unemployment, and current account position.

The main variables used in exchange rate classification are the exchange rate volatility, reserve volatility, interest rates and the behaviour of the exchange rate towards an anchor or reference currency. The more advanced economies, especially those practising the inflation targeting mechanism, have witnessed a drop in the exchange rate volatility over the years as opposed to the emerging market economies that have experienced more volatility and have more intervention in the markets. This is mainly attributed to fundamental institutional differences pointed out by Mishkin (2004), and Calvo and Mishkin (2003).

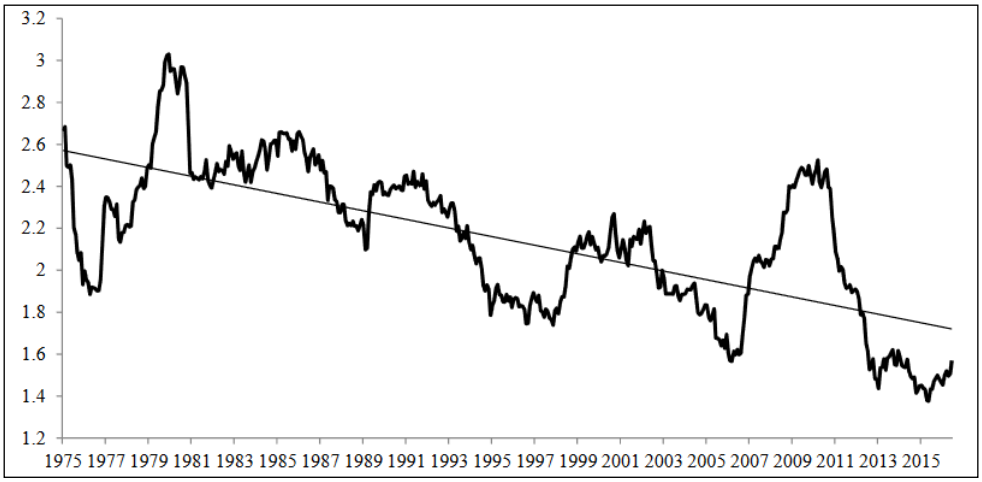

Figure 1. The declining volatility of the US Dollar-Deutsche Mark/Euro exchange rate

Source: Ilzetzki et al. (2017).

Empirical studies in exchange rate regime classifications show a clear discrepancy in the de facto and de jure regimes. See Calvo and Reinhart (2002). This discrepancy between the de facto exchange rate regimes, the regimes that countries actually follow and the de jure exchange rate regimes, the regimes that countries claim to officially follow and report to the International Monetary Fund (IMF) and other similar institutions, can be very misleading and pervasive according to Frankel and Wei (2008).

Ilzetzki et al. (2017) in their classification study of 194 countries (or territories) using monthly data on core exchange rate and inflation over the period 1946 to 2016, find that 80% of all countries covered are biased towards a less flexible exchange rate arrangement. They add that almost 40% of all countries under the inflation targeting framework adopt somewhat limited flexibility arrangements like crawling pegs. Hence, it is not right to assume that all inflation targeting countries adopt a floating regime. This is a re-enforcement of the same finding by Mishkin (2004). There is accordingly a markedly lower incidence of bi-polar or corner solutions; there is instead a marked increase in the adoption of intermediate regimes. Ilzetzki et al. (2017) further state that the evolving inconsistencies between the de facto and de jure exchange rate regimes have forced the IMF to move

from a de jure classification that it focused on in the 1990s to an additional classification to include a de facto one as well to avoid misalignment of monetary policy and economic decisions.

2. Literature Review

2.1 Brief History of the International Monetary System

Winton, a research-based investment management company in a 2017 article provides a detailed history of the modern international monetary system, some of which is presented herein.

2.1.1 Classical Gold Standard (1870-1914)

Before the 1870s, most monetary systems were based on a bimetallic standard. Only Britain was on the Gold Standard. By using gold as its trading currency, Britain forced her trading partners like Germany and the US to adopt this metallic standard currency form. By 1900, a good number of countries had adopted gold as a form of exchange with only a few sticking to silver. Bordo (2003) adds that by 1900 most nations had switched away from silver and bimetallic standards and adhered to the Gold Standard. Fiat money and floating was considered to be a radical departure from fiscal and monetary stability, and was only acceptable in case of global emergencies like wars and financial crises. Countries like Spain and Austria-Hungary that adopted fiat money and permanently floated were viewed with disfavour. Over this period, central banks were willing to convert paper currencies into a pre-determined amount of gold, thus, ensuring stable exchange rates in terms of gold. A country could not simply alter its money supply without experiencing gold flows since currencies were backed by gold. Sir John Swanwick Bradbury, a British Economist and an official of the Treasury in the 20th century put it, the Gold Standard was knave-proof and characterized by low interest rates, price stability and increased world trade.

The collapse of the Gold Standard in 1914 was mainly due to World War I (1914-1918), countries needed a source to finance their war debts and gold was an inconvenience. In addition, this was a scarce metal. Governments resolved to printing more money and issuing bonds. In 1925, Britain and other advanced economies returned to the Gold Standard, but this did not last long. Britain returned to the Gold Standard at the pre-war parity in order to please its creditors and this left the Pound 10% overvalued against the US Dollar due to the inflation gap since 1914. In 1931, Britain abandoned the Gold Standard again and several countries followed suit.

2.1.2 Bretton Woods (1945-1971)

The agreement at Bretton Woods introduced a new era in monetary policy management. This resulted in the creation of the International Monetary Fund, the World Bank, and the international gold-exchange standard. This was seen as an opportunity to correct the mistakes that led to the Great Depression of the 1930s and to help rebuild after World War II (1939-1945). During this era, several countries pegged their currencies to the US Dollar at specified parities. The US Dollar in turn was convertible into gold at a fixed rate of $35/oz; this characteristic defined the fixed exchange rate regime period preceding the 1970s. This only applied to US Dollars held by central banks and governments, not private persons. Central banks had to intervene in markets to fix their exchange rates against the Dollar, which in turn was pegged to gold. According to Bordo (2003), the agreement allowed narrow bands of 2.5% around parity and the right to change parity in the event of a fundamental misalignment, therefore, *fixed but adjustable*. It was supposed to combine the advantages of the Gold Standard (sound money) with those of floating (flexibility and independence). The system was purposely meant to overcome the weaknesses characterized by the classical Gold Standard. Several nations had difficulties in finding parities consistent with their balance of payment positions, setting the stage for the collapse of the Bretton Woods. In addition, the re-alignment of parities led to crises in the early years of the Bretton Woods system. The IMF was responsible for bailing out countries with balance of payments crises.

2.1.3 Demise of the Bretton Woods (1971-1973)

Like all economic systems, the Bretton Woods System had its weaknesses, some of which led to its demise. The US was at the centre of the Bretton Woods System given its large influence and dominance in international trade, gold stock and global finance. This influence inclined the US to run chronic trade deficits that are still present today. Several countries were angered by this and threatened to liquidate their Dollar reserve balances into gold. In addition, the US was characterized by high inflation rates in the 1960s due to the expansionary fiscal policy, something that many European countries feared would be imported into their economies. This was caused by the *Dollar fight* where a number of countries, especially in Western Europe, were converting their Dollars into gold. For fear of depletion of American gold, President Nixon closed the US Federal Reserve's gold window, effectively suspending the commitment to provide gold to foreign central banks at any rate. Darby et al. (1983)

state that the increasing US monetary growth led to rising inflation, which spread to the rest of the world through growing US balance of payments deficits. This led to growing balance of payments surpluses in Germany and other countries. The German monetary authorities (and other surplus countries) attempted to sterilise the inflows but were eventually unsuccessful, leading to growing inflationary pressure. Despres et al. (1966) argue that the growing US balance of payments deficit was of no great concern because the rest of the world voluntarily held Dollar balances, thus, the Bretton Woods System could have continued in operation.

According to Kawai and Akiyama (1998) in their account of the evolution of exchange rates, before the suspension of the convertibility of the US Dollar to gold by President Richard Nixon in 1971, exchange rate fluctuations of most IMF member countries had been limited to ±1% around par values set in terms of gold or the US Dollar. After the Nixon shock, these countries moved towards the floating exchange rate regime. The year 1973 saw the European Community countries sever the link between their currencies and the US Dollar. Some countries feared the risk of the true floating regime era and decided to maintain a peg or a managed float to the currencies of major industrialised economies. Western Europe countries limited their exchange rate fluctuations within margins of ±2.25% with each other and a band of ±4.5% against the Dollar. This was referred to as the 'snake regime', eventually forming the European Monetary System (Note 1) in 1979 (Note 2). This saw the emergence of the Deutsche Mark as the dominant currency in Europe and many countries began to mimic the monetary policies of the Bundesbank. Germany, being the most stable and developed economy in the region made this inevitable; other countries in the region anchored their inflation rates to that of Germany, which was the lowest in Europe. The French Franc also had considerable influence coupled with its CFA zone prevalently in West and Central Africa. Eventually these two blocks (French Franc and Deutsche Mark) merged to form the Euro Area in 1999.

In the 1970s, the numeraire or reference currency, the US Dollar, was connected or linked to the supply and value of gold. Today, the numeraire is connected to the supply of US goods and services, in general terms, the performance and the value that the globe attaches to the US economy (fiat currency). There have been outcries from nations both in emerging and advanced economies for a return to the Gold Standard based currency, a time of exchange rate stability and capital mobility, at the expense of monetary independence. The return to the Gold Standard has been supported by Alan Greenspan who served as the Chair of the US Federal Reserve from 1987-2006. In his words, "We did very well in the 1870-1914 period with an international Gold Standard". He argues that the Gold Standard restricts the amount of money that is produced, and this helps control inflation. It takes a lot for a shift in the international monetary system, sometimes a serious financial crisis or even a world war. However, it is hard to predict when the next shift shall come, and so, we wait.

2.2 Classification of Exchange Rate Regimes

Frankel (1992) pioneered a technique aimed at recovering the weights assigned to currencies in order to determine whether a regime is fixed or floating. This technique has been used and extended by a number of researchers over the years and still remains a strong model to date.

Levy-Yeyati and Sturzenegger (2005) in their paper, Deeds vs. Words, covering all IMF- reporting countries over the period 1974-2000 revealed that pure floats are associated with minor nominal exchange rate volatility and that there has been an increase in the number of dirty floats (Note 3) over the years. Their findings support the *fear of floating* phenomenon. They point out that countries that appear to behave according to a de jure regime during tranquil times may be tempted to change their course of action once the regime is under stress. Levy-Yeyati and Sturzenegger (2016) extend their earlier studies through 2014 to cover the financial crisis period and increase the sample size; they report that there was a growth in the number of floaters over the financial crisis period. Pegs remained the preferred regime for low-income countries. Also, the number of countries which run a fixed regime without stating that they do (fear of pegging) has increased remarkably. Their findings further revealed that fixed regimes are characterized by relatively low nominal exchange rate volatility (with an average absolute change of 0.60% per month as opposed to 1.59% in the case of floats), and high volatility in reserves (19.15% against 5.66% for floats).

Calvo and Reinhart (2002) use monthly data over the period 1970-1999 for 39 countries across all continents trying to compare what countries say and what they do, focussing on whether countries that claim to float are indeed doing so, and whether countries are moving further towards corner solutions as they say. Analysing the behaviour of exchange rates, foreign exchange reserves and interest rates, they find that these countries had a volatility of these variables somewhat similar to those with a pegged regime. They show that the volatility in these variables of de jure floaters differs to a much greater extent from true floaters. Concluding that countries that say they allow their exchange rate to float mostly do not, there seems to be an epidemic case of *fear of*

floating. Schnabl (2003) tries to replicate the technique identified by Calvo and Reinhart (2002) on Central and Eastern Europe countries with some augmentations. Findings revealed that all the four (Note 4) countries in the study classified as fixed regimes show very low exchange rate volatility against the Euro and Dollar, particularly the Euro. And, among the de jure floaters, three (Note 5) countries pegged their currencies to the Euro.

Reinhart and Rogoff (2004), in a classification covering 153 countries over the period 1946-2001, consider exchange rates in parallel markets. They develop an algorithm; in what they call a natural classification algorithm, allowing for up to fourteen categories of exchange rate regimes ranging from a strict peg to a dysfunctional freely falling or hyper-float. Some of their findings revealed that de facto floating was common during the early years of the Bretton Woods era of fixed exchange rate regimes. Many de jure floats of the post-1980s turned out to be de facto pegs, crawling pegs or narrow bands to an anchor currency. Important to note in their findings, 53% of the countries listed in the IMF classification as managed floats turned out to be de facto pegs, crawls, or narrow bands to an anchor. Their famous classification has been used by many researchers in the areas of macroeconomics and finance.

According to Frankel (1999), most countries classified by the IMF as fixed regimes have in fact had re-alignments and most of those listed as floaters in fact intervene in the foreign exchange markets frequently.

Shambaugh (2004) (Note 6) while examining the effect of the fixed regime on monetary autonomy using a sample of over 100 developing and industrial countries from 1973 through 2000, creating a de facto coding system that focusses on the volatility of the exchange rate, and dividing countries into pegs and non-pegs, reports that his classification technique disagrees with the reported IMF de jure status about 12% of the time. He finds that most countries that claim to float do so to some degree and some are mislabelled.

Ghosh et al. (1997) in their investigation of whether the regime matters for macroeconomic performance, argue that the de jure classification captures the formal commitment of the central bank to intervene in the foreign exchange market while the de facto classification obviously has the advantage that it captures actual behaviour. They therefore adopt a technique that combines the de jure and de facto classifications in their study. They define a pegged regime as one with frequent and infrequent adjusters, the former being defined as regimes with more than one change per year in either parity or, for basket pegs, in the weights. They divide the regimes into three; pegged, intermediate and floating. They further find that a pegged regime is associated with lower inflation.

Kawai and Akiyama (1998) examine officially reported and empirically observed exchange rate arrangements of more than 100 countries over the period 1970-1996 and find that most countries, especially in Asia, Latin America and the Middle East, attempt to peg their exchange rates particularly to the US Dollar, forming somewhat a *Dollar block.* The researchers further report that the role played by the Japanese Yen remains rather less significant.

Ilzetzki et al. (2017) in a comprehensive study of 194 countries over the period 1946-2016 state that the often-cited post-Bretton Woods transition from fixed to floating exchange rate regimes is overstated and emphasise that regimes with limited flexibility remain preferred and in the majority. The US Dollar still scores as the world's dominant anchor currency (Note 7), and by a very large margin, with a much wider use today than 70 years ago, and the global role of the Euro (Note 8) seems to have stalled (Note 9), maybe for now. Some scholars argue that the world is headed towards a multi-polar system, especially with the rise of China in the global economy. This will undermine the influence of the US Dollar and increase the weight of the Chinese Renminbi. Eichengreen (2011) re-iterates that it is very likely that the Euro will be the anchor currency in Europe, the US Dollar in the Americas, leaving the emerging Renminbi anchoring in Asia, a role that the Japanese Yen has failed to take on to date. It is difficult to quantitatively disaggregate the influence of the Chinese Renminbi on its own since it has had a long history of being pegged to the US Dollar.

2.3 The Choice of the Exchange Rate Regime

The choice of an exchange rate regime may depend on several factors, such as the level of development of a country. Advanced economies have the capacity to defend their exchange rates against speculative attacks. Obstfeld and Rogoff (1995) add that if their commitment to use those resources lacks credibility with markets, the costs to the broader economy of defending a regime against speculative attacks could be very high. A major disadvantage of this regime (fixed regime) is that the central bank loses control of domestic money supply, and as a consequence, monetary independence, and cannot use monetary policy for stabilisation purposes in case of economic shocks. See Obstfeld and Rogoff (1995) for a detailed discussion.

Frankel (1999) classifies regimes as; Fixed arrangements (currency unions, currency boards and truly fixed arrangements), Intermediate arrangements (adjustable pegs, crawling pegs, basket pegs and target zones) and

Floats (managed and free floats). Managed floats are also known as dirty floats, defined as a readiness to intervene in the foreign exchange market without defending any particular parity and most intervention is intended to lean against the wind; buying the currency when it is rising and selling when it is falling.

A number of countries, especially emerging market economies, are within the intermediate regimes like target zones and crawling pegs. According to Bordo (2003), exchange rate regimes have evolved a lot over the past 100 years; the advanced economies seem to get it right while the emerging markets try to emulate and may get the choice right occasionally. The regimes range from pure floats to the hard pegs of currency boards, dollarization, and currency unions.

Of course, the regime employed by a country would also depend heavily on macroeconomic variables like inflation rates, reserves, financial market development and the general macroeconomic direction desired by the monetary authorities.

According to the IMF Annual Report on Exchange Arrangements and Exchange Restrictions 2017, the de jure regimes are classified as indicated below.

2.3.1 No Separate Legal Tender

The currency of another country may circulate as the sole legal tender. Some countries have become dollarized, substituting their currencies with the US Dollar, these include Ecuador and El Salvador in Latin America and Zimbabwe in Africa. This form of arrangement involves the complete surrender of a nation's monetary policy independence. Currency unions for this matter are classified based on the arrangement governing the joint currency. The Euro, for example, is classified as a floating currency.

2.3.2 Currency Board

A currency board arrangement is a monetary arrangement based on an explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate, combined with restrictions on the issuing authority to ensure the fulfilment of its legal obligation. This implies that domestic currency is usually fully backed by foreign assets, eliminating traditional central bank functions such as monetary control and lender-of-last-resort, and leaving little scope for discretionary monetary policy. According to Chang and Velasco (2000), under a currency board, the amount of base money in circulation is always exactly equal to the foreign reserves of the central bank. Therefore, there cannot be a balance of payments crisis. For instance, a Peso central bank will stand ready to exchange Dollars for Pesos at a fixed exchange rate and, in addition, it is committed not to create or destroy Pesos in any other way.

2.3.4 Conventional Peg

The country formally pegs its currency at a fixed rate to another currency or basket of currencies, where the basket is formed, for example, from the currencies of major trading or financial partners and weights reflect the geographic distribution of trade, services, or capital flows. The anchor currency or basket weights are public or notified to the IMF. The country authorities stand ready to maintain the fixed parity through direct intervention (that is, via sale or purchase of foreign exchange in the market) or indirect intervention (for example, via exchange rate related use of interest rate policy, imposition of foreign exchange regulations, exercise of moral suasion that constrains foreign exchange activity, or intervention by other public institutions). There is no commitment to irrevocably keep the parity. The exchange rate may fluctuate within narrow margins of less than ±1 percent around a central rate or the maximum and minimum value of the spot market exchange rate must remain within a narrow margin of 2 percent for at least six months.

2.3.5 Stabilized Arrangement

This entails a spot market exchange rate that remains within a margin of 2 percent for six months or more (with the exception of a specified number of outliers or step adjustments) and is not floating. The required margin of stability can be met either with respect to a single currency or a basket of currencies, where the anchor currency or the basket is ascertained or confirmed using statistical techniques. Classification as a stabilized arrangement requires that the statistical criteria are met and that the exchange rate remains stable as a result of official action (including structural market rigidities). The classification does not imply a policy commitment on the part of the country authorities.

2.3.6 Crawling Peg

The currency rate is adjusted in small amounts at a fixed rate or in response to changes in selected quantitative indicators, such as past inflation differentials vis-à-vis major trading partners or differentials between the inflation target and expected inflation in major trading partners. The rate of crawl can be set to generate

inflation-adjusted changes in the exchange rate (backward looking) or set at a predetermined fixed rate and/or below the projected inflation differentials (forward looking). The rules and parameters of the arrangement are public or notified to the IMF. Obstfeld and Rogoff (1995) state that the crawling peg is common among high-inflation developing countries in which the government announces a schedule of small, discrete devaluations in order to prevent inflation differentials from cumulating, thereby necessitating a single large devaluation.

2.3.7 Crawl-like Arrangement

The exchange rate must remain within a narrow margin of 2 percent relative to a statistically identified trend for six months or more (except for a specified number of outliers) and the exchange rate arrangement cannot be considered as floating. Normally, a minimum rate of change greater than allowed under a stabilized (peg-like) arrangement is required. However, an arrangement will be considered crawl-like with an annualized rate of change of at least 1 percent, provided that the exchange rate appreciates or depreciates in a sufficiently monotonic and continuous manner.

2.3.8 Pegged Exchange Rate within Horizontal Bands

This involves the confirmation of the country authorities' de jure exchange rate arrangement. The value of the currency is maintained within certain margins of fluctuation of at least ±1 percent around a fixed central rate, or the margin between the maximum and minimum value of the exchange rate. It includes arrangements of countries in the ERM of the European Monetary System (EMS), which was replaced with the ERM II on January 1, 1999, for those countries with margins of fluctuation wider than ±1 percent. The central rate and width of the band are public or notified to the IMF.

2.3.9 Other Managed Arrangement

This category is a residual and is used when the exchange rate arrangement does not meet the criteria for any of the other categories. Arrangements characterized by frequent shifts in policies may fall into this category.

2.3.10 Floating

A floating exchange rate is largely market determined, without an ascertainable or predictable path for the rate. In particular, an exchange rate that satisfies the statistical criteria for a stabilized or a crawl-like arrangement will be classified as such unless it is clear that the stability of the exchange rate is not the result of official actions. Foreign exchange market intervention may be either direct or indirect, and such intervention serves to moderate the rate of change and prevent undue fluctuations in the exchange rate, but policies targeting a specific level of the exchange rate are incompatible with floating. Indicators for managing the rate are broadly judgmental (for example, balance of payments position, international reserves, and parallel market developments). Floating arrangements may exhibit more or less exchange rate volatility, depending on the size of the shocks affecting the economy.

2.3.11 Free Floating

A floating exchange rate can be classified as free floating if intervention occurs only exceptionally and aims to address disorderly market conditions and if the authorities have provided information or data confirming that intervention has been limited to at most three instances in the previous six months, each lasting no more than three business days. If the information or data required are not available to the IMF, the arrangement will be classified as floating. Detailed data on intervention or official foreign exchange transactions will not be requested routinely from member countries, but only when other information available to the IMF is insufficient to resolve uncertainties about the appropriate classification.

Also, according to the IMF, the monetary policy frameworks employed by central banks are as follows.

2.3.12 Exchange Rate Anchor

The monetary authority buys or sells foreign exchange to maintain the exchange rate at its predetermined level or within a range. The exchange rate, thus, serves as the nominal anchor or intermediate target of monetary policy. These frameworks are associated with exchange rate arrangements with no separate legal tender, currency board arrangements, pegs (or stabilized arrangements) with or without bands, crawling pegs (or crawl-like arrangements), and other managed arrangements. Common anchor currencies include the US Dollar, Euro or a composite consisting of two or more currencies as an anchor.

2.3.13 Monetary Aggregate Target

The intermediate target of monetary policy is a monetary aggregate such as M0, M1, or M2, although the

country may also set targets for inflation. The central bank may use a quantity (central bank reserves or base money) or price variable (policy rate) as an operational target.

2.3.14 Inflation Targeting Framework

This involves the public announcement of numerical targets for inflation, with an institutional commitment by the monetary authority to achieve these targets, typically over a medium-term horizon. Additional key features normally include increased communication with the public and the markets about the plans and objectives of monetary policymakers and increased accountability of the central bank for achieving its inflation objectives. Monetary policy decisions are often guided by the deviation of forecasts of future inflation from the announced inflation target, with the inflation forecast acting (implicitly or explicitly) as the intermediate target of monetary policy.

2.4 Within the Band Regimes

Krugman (1991) (Note 10), using a basic monetary model, developed an elegant fundamental model of exchange rate behaviour under a target zone exchange rate regime. The main result shows that the expectation that monetary policy will be adjusted to limit exchange rate fluctuation affects the exchange rate behaviour even when the exchange rate lies inside the target zone, and is therefore not being defended actively. Most scholars have provided a modification or an extension of this model one way or the other. A target zone should not be confused with a fixed exchange rate regime; a target zone may allow the exchange rate to fluctuate around a fairly wide predetermined reference rate. It could be 10% or any other reasonable rate on either side of the central rate. It is argued that countries may adopt a target zone regime since it does not require a lot of monetary policy action compared to the strictly pegged regime whose defence is a full-time job.

The Krugman (1991) model is based on two critical assumptions; the target zone is perfectly credible; market agents believe the lower and upper edges of the band will remain fixed forever and the exchange rate will forever stay within the band. Secondly, the exchange rate is defended with minimal interventions by the monetary authorities, money supply remains constant and no interventions as long as the exchange rate remains within the band. These assumptions are reiterated by Svensson (1992).

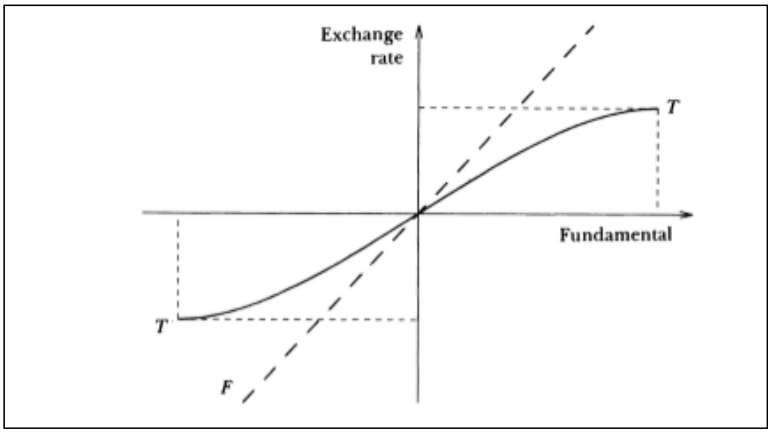

Figure 2. The Krugman model of exchange rate target zones

Source: Svensson (1992).

The model predicts the S-shape non-linear relationship between the exchange rate and its fundamental determinants as shown by the curve TT. The line F represents the equilibrium exchange rate in the free-floating regime. The assumption is that the exchange rate depends linearly on macroeconomic fundamental and the expected future value of a currency. Within the fundamental, there are two components, that is, velocity and domestic money supply where velocity is exogenous and stochastic while the money supply is changed or altered by the central bank from time to time to control and manage the exchange rate. As long as the exchange rate lies within the band, the money supply remains unchanged. The stochastic process is assumed to follow a Brownian motion without drift. The main results from the Krugman model are the *honeymoon* effect and *smooth pasting*. As revealed in literature by Svensson (1992), if the exchange rate is higher and closer to the upper edge of the exchange rate band, the probability that it will reach the upper edge is higher. Thus, the probability that there will be future intervention to reduce money supply and strengthen the currency is higher. The target zone exchange rate is less than the free-float exchange rate for a certain level of the fundamental. He further adds that

the slope of the target zone exchange rate function is zero at the edges of the band, hence, the exchange rate at this point is insensitive to changes in the fundamental; this is *smooth pasting*. The *honeymoon* effect implies that a perfectly credible target zone has the stabilization effect and *smooth pasting* implies the exchange rate is a non-linear function of is fundamental determinants and insensitive to these fundamentals at the edge of the exchange rate band.

A further concept to the target zone literature is the time varying re-alignment risk which occurs when the exchange rate band is allowed to shift over a period. Bertola and Svensson (1993) pioneered interest in this area and were the first to present an exchange rate target zone model with time varying re-alignment risk. The introduction of time varying re-alignment risk changes the process by which the interest rate differentials are determined and the interpretation of interest rate differentials against exchange rate plots. The interest rate differential is now equal to the sum of the expected rate of currency depreciation within the band and the expected rate of re-alignment. The diagram below shows the log of the French Franc/Deutsche Mark exchange rate from the start of the European Monetary System in March 1973 through to 1992 with a band of ±2.25% around a central rate. There were re-alignment shifts in September 1979, October 1981, June 1982, March 1983, April 1986 and January 1987 with the Franc being devalued against the Mark, that is, the number of Francs per Mark increased.

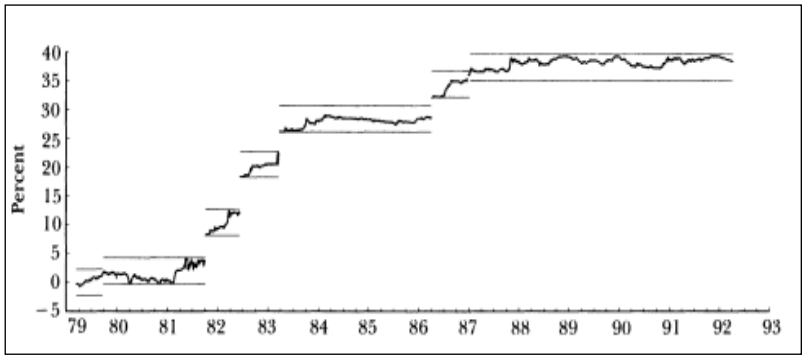

Figure 3. Log French Franc/Deutsche Mark exchange rate

Source: Svensson (1992).

Hurley et al. (1993) in their study of the appropriate level of reserves required to defend an exchange rate target zone found that; for the case of Ireland, reserves were approximately optimal for most of the 1980s but significantly below optimal during 1989 and 1992. Furthermore, the researchers concluded that foreign exchange reserves should at least be kept above 25% of domestic credit.

2.5 Optimal Currency Area (OCA)

Frankel (1999) defines an optimum currency area as a region for which it is optimal to have its own currency and its own monetary policy. Mundell (1961) defines an OCA as a currency area for which the costs of relinquishing the exchange rate, an internal instrument of adjustment (within the area) are outweighed by the benefits of adopting a single currency or a fixed exchange rate regime. The registered success of the Eurozone has of recent re-ignited studies in the optimum currency area and its applicability. Fleming (1971) and Ricci (2008) stress that the similarity of pre-union inflation rates across countries may be considered as an important factor determining the OCA. Countries may have different Phillips curves (Note 11) and therefore the act of imposing a unique level of inflation by adopting a common currency may automatically generate some costs. The OCA theory was fast put forward by Mundell (1961) (Note 12) where he develops a simple two-entity model which could be regions or countries, initially at full employment and balance of payments equilibrium, and introduces asymmetric shocks to output and an adjustment mechanism. He asks the question; whether countries intending to form common markets and economic unions should allow each of their national currencies to fluctuate or form a single currency area. He argues that the subject of flexible exchange rates can be separated into two distinct questions. The first is whether a system of flexible exchange rates can work effectively and efficiently in the modern world economy. For this to be answered, it must be demonstrated that: (1) an international price system based on flexible exchange rates is dynamically stable after taking speculative demands into account; (2) the exchange rate changes necessary to eliminate normal disturbances to dynamic equilibrium are not so large as to cause violent and reversible shifts between export and import-competing industries; (3) the risks created by

variable exchange rates can be covered at reasonable costs in the forward markets; (4) central banks will refrain from monopolistic speculation; (5) monetary discipline will be maintained by the unfavourable political consequences of continuing depreciation, as it is to some extent maintained today by threats to the levels of foreign exchange reserves; (6) reasonable protection of debtors and creditors can be assured to maintain an increasing flow of long-term capital movements and (7) wages and profits are not tied to a price index in which import goods are heavily weighted. The second question he answers is how the world should be divided into currency areas; the stabilization argument for flexible exchange rates is valid only if it is based on regional currency areas. If the world can be divided into regions within each of which there is factor mobility and between which there is factor immobility, then each of these regions should have a separate currency which fluctuates relative to all other currencies. This carries the argument for flexible exchange rates to its logical conclusion. However, if labour and capital are insufficiently mobile within a country then flexibility of the external price of the national currency cannot be expected to perform the stabilization function attributed to it, and one could expect varying rates of unemployment or inflation in the different regions. A key weakness of the Mundell (1961) model is that he assumed that economic agents did not incorporate expectations about future movements in the price level, interest rates, exchange rates and government policy.

Symmetry in business cycles has been put forward by some scholars as a condition for the OCA. Symmetry in the business cycle is defined as a positive co-movement between the two countries' output; the shocks or disturbances affect the countries in a much similar way, in other words, symmetric. The existence of highly correlated business cycles is a signal that the two countries can almost form an OCA with a common monetary policy. Asymmetric shocks on the other hand tend to come along with inflationary pressures for the country that has gained from this sort of shock, monetary expansion is still possible though. Asymmetric shocks are caused by differences in financial and tax systems, structural differences in labour markets and institutions. Shocks could come from shifts in demand as described in the model by Mundell (1961). It is important to note that the actions of monetary policy have an effect on the exchange rates if not handled carefully (appreciation and depreciation). In relation to this, Ricci (2008) states that the exchange rate between two areas is an effective instrument of short-run adjustment if the following conditions hold; (1) the two areas face asymmetric shocks, so that an adjustment of the relative price of the goods produced in the two countries is required; (2) domestic prices are not fully flexible, that is, prices do not adjust immediately to shocks (price stickiness); (3) pass-through (Note 13) is not large, therefore a relative price change due to exchange rate change is not immediately neutralised by domestic price movements.

Bayoumi and Eichengreen (1998) in a study that takes into consideration the exchange rate regimes employed by the advanced economies find that the OCA variables (Note 14) have an explanatory power towards the variations in exchange market pressures, and so, exchange rate behaviour. The OCA variables affect the bilateral exchange rates through market conditions and intervention, with asymmetric shocks being the main source of exchange market pressures, and proxies for deterioration in the transactions value of money due to floating provide the main motivation for intervention.

2.6 Why Countries Float or Peg and Anchor Currencies

Levy-Yeyati and Sturzenegger (2005) findings support the fact that countries may declare a regime and behave differently in order to avoid speculative attacks (Note 15) on their currencies. In this regard, fixers may declare a more flexible regime, the concept of *hidden pegs*. Their findings further reveal that intermediate regimes like crawling pegs and bands have reduced in number over the years. Furthermore, they find that de facto floats are characterized by small amounts of exchange rate variability, so, a large number of these countries intervene in the markets in order to maintain a certain exchange rate. This is in opposition to the textbook definition of a floating regime, confirming the concept of *fear of floating* introduced by Calvo and Reinhart (2002).

Ilzetzki et al. (2017) emphasize that the reserve currency composition is a good indicator of whether a country may be inclined to intervening in the markets to defend its exchange rate value against the currency whose share of the reserve composition is higher. For instance, if the Euro takes a bigger share of the reserve composition in relation to other currencies, this country is likely to choose the Euro as an anchor. The historical colonial relationship between two countries may also play a part when it comes to choosing an anchor currency. By default, emerging economies, to a greater extent, peg their currencies to that of their colonial masters. Countries facing macroeconomic instabilities like high inflation rates tend to choose as an anchor the currency of a country whose performance they want to mimic. Pegging to a low-inflation currency has the advantage of reducing domestic inflationary pressures.

Many scholars have argued that a fixed exchange rate regime is associated with less exchange rate volatility, and

as a result, likely to increase trade. A country whose foreign trade is mostly with Eurozone countries and invoices in Euros is likely to deploy the Euro as an anchor currency. Mussa (1986) argues that the real exchange rates show greater volatility under floating regimes than they do under the fixed regime. Kenen and Rodrik (1986) argue that the volatility of the real exchange rate depresses trade, and so, a fixed regime is pro-trade. Aristotelous (2001) contradicts this result and reveals that the regime employed by a country has no effect on the export volume. Bacchetta and Van Wincoop (2000) introduce a new perspective altogether, adding that, adopting a fixed regime does not necessarily lead to more trade, the volume of trade will depend on how the regime is implemented. Rose (2000) argues that countries in a currency union trade more with each other than they do with countries outside a union, approximately 3.35 times more with each other. This finding is further supported by Adam and Cobham (2007).

Under The Maastricht Treaty signed in 1992 by members of the European Community to further European integration, countries within the union and candidates to adopt (Note 16) the Euro currency are required to peg their currencies to the Euro over a band for a period of at least 2 years. This pegging enables the EU to gain a credible mechanism for evaluating potential Eurozone members. The Danish Krone is the only currency in the ERM II stage, hence, pegging its exchange rate to the Euro. According to the European Central Bank, the Danish Krone fluctuates within a band of ±2.25% against the Euro. However, the standard ERM II fluctuation band is ±15%. This inconsistency is simply because of the existence of an already high degree of convergence of the Danish Krone against the Euro.

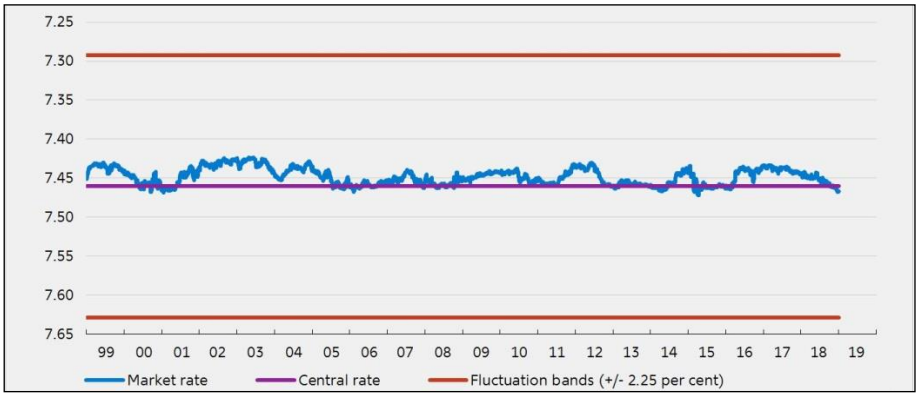

Figure 4. Exchange rate of the Krone/Euro

Source: Danmarks Nationalbank.

Several countries have foreign currency denominated debt in anchor currencies like the US Dollar and Euro, thus, find it wise to peg to these currencies and avoid destabilising fluctuations while they service their foreign debt.

Theoretical grounding reveals that the floating exchange rate regime acts as a shock absorber to internal and foreign macroeconomic shocks, enabling the economy to adjust accordingly by adjusting interest rates, this, with the assumption of capital mobility. These could include inflationary shocks, financial crises, commodity price shocks and business cycles with booms and depressions (output or unemployment shocks). Fixed exchange rate regimes are linked to financial crises since the monetary authorities must constantly defend the exchange rate regime which may not be possible at times due to inadequate reserves and underdeveloped capital markets. This was evident during the Asian financial crisis of 1997, the Mexican crisis of 1995, and the Russian crisis of 1997. McKinnon (2000) uses high frequency (daily) data to test for the weight of the Dollar versus the Yen and notes in his study that by keying to the Dollar, the macroeconomic policies of the Asian crisis economies (Note 17) were loosely tied to each other. Some of the countries affected by the 1997 crisis (Note 18) subsequently switched to an inflation targeting monetary framework regime that is primarily characterized by a floating exchange rate regime. Baig (2001) in a study examining the daily exchange rate behaviour of 5 East Asian currencies before, during and after the Asian crisis of 1997 found that these countries maintained a de facto peg to the US Dollar over the pre-crisis period, however, he adds that this result may not be reliable given that the results from the regressions of de jure floaters or the control group exhibited large and significant coefficients similar to those of the Asian crisis countries. Mishkin (2004) points out that countries employing inflation targeting as a monetary policy framework are not necessarily targeting only inflation but the exchange rate as well thereby intervening in the foreign exchange markets to defend a regime, an act that contradicts the inflation targeting model.

The pegged system, especially to a recognised and stable anchor currency like the US Dollar, is a good practise

to attract foreign investors. Investors can evaluate their returns on investment over time easily with less fluctuations.

2.7 Regimes and Crises

According to Calvo and Mishkin (2003), countries often choose an intermediate path when it comes to exchange rate regimes; that is, an exchange rate is often stabilized by the central bank, but might sometimes shift, often known as a "soft peg." However, in the aftermath of the macroeconomic crisis across East Asia over the period 1997-1998, a view emerged that this exchange rate regime was in part responsible for the depth of the macroeconomic crisis. The governments of Thailand, Malaysia, South Korea, and other nations in that region had kept exchange rates fixed, closely following the US Dollar. Frankel (1999) argues that, contrary to what is always claimed that Mexico, Thailand, Indonesia, Korea, Russia or Brazil formally pegged their currencies to the US Dollar when their crises hit, they actually were following varieties of bands, baskets, and crawling pegs. This remains open to debate as other scholars have found a rather different result.

Chang and Velasco (2000) provide a detailed and impressive model of the relationship between financial fragility and the exchange rate regime, comparing currency boards, fixed rates, and flexible rates, with and without a lender of last resort. They note that under a currency board, the exchange rate is fixed, and the central bank does not issue domestic credit, and therefore these economies are vulnerable to bank runs and not currency crises. A fixed exchange rate regime is more prone to bank runs, exchange rate crises and balance of payments crises. A flexible exchange rate system implements the social optimum and eliminates runs, provided the exchange rate and credit policies of the central bank are appropriately designed. They argue that the abilities of the currency boards have been observed in the successes registered by Hong Kong and Argentina over turbulent periods in the recent past when financial institutions came under intense pressures globally.

Aghion et al. (2001), while developing a model of currency crises driven by the interplay between the credit constraints of private domestic firms and the existence of nominal price rigidities and examining the impact of various shocks including expectations shocks, argue that currency crises can occur under both the fixed and flexible exchange rate regimes since the primary source of the currency crisis is identified as the deteriorating balance sheet of private firms. They add that an initial regime may be able to maintain a stable exchange rate when the economy is hit by small shocks, however, if the shock is large, then the initial regime has little influence in preventing a currency crisis. The regime employed ultimately becomes irrelevant.

Haile and Pozo (2006), using a broad sample of 35 countries, test whether the exchange rate regime employed by a country has an impact on the vulnerability of the countries to a currency crisis using an Extreme Value Theory (Note 19) technique. They construct an exchange market pressure index and a Hill Estimator/Tail Index to identify exchange market crises. The index is constructed as the weighted average of nominal exchange rate depreciation, change in domestic and foreign interest rates differential, and decrease in foreign exchange reserves. In their words, "We find that the actual or de facto exchange regime plays no role in determining currency crisis periods. Fundamentals and contagion instead appear to be the main determinants of currency crises. We find, however, that while the de facto exchange regime fails to explain currency crises, the declared exchange regime does play a role with declared pegs increasing the likelihood that a nation experiences a currency crisis. Our results are consistent with the idea that soft pegs are easy targets for speculators and as such have a higher probability of resulting in a currency crisis with the peg turning into a float."

Calvo and Mishkin (2003) state that one danger of a hard exchange rate peg is the risk of being locked into a misaligned exchange rate, defined as a sizeable difference between its actual level and the one which fundamentals would dictate. They further note that neither the fixed nor the freely floating regimes has an unblemished record with regard to crises and that no exchange rate regime can prevent macroeconomic turbulence. The choice of the regime should be chosen to match the characteristics of the economy in question. The researchers state in their paper that the regime chosen is of second-order importance. Of primary importance is the need for reforms; more regulation for the financial sector, fiscal constraint and developing a predictable monetary policy and more trade openness. These reforms will help emerging market economies be more immune to currency crises.

2.8 The Testing, Estimation, and Classification Models

Frankel (1992), Frankel and Wei (1994), Ohno (1999) and McKinnon (2000) use a technique that recovers the weights that countries assign to certain anchor currencies or currency baskets containing currencies that countries may claim to peg to. If the weight assigned to an anchor currency is close to one, then a peg or fixed regime is identified. In all studies, the researchers find that the coefficients estimated for the Asian economies are close to one for the US Dollar, indicating a close peg. Ohno (1999) extends and/or modifies this technique by

incorporating the real effective exchange rate, constructing multiple currency baskets containing currencies of three industrial blocks, that is, Yen, US Dollar and Euro. He adds that there is a high risk associated with using high frequency data when evaluating exchange rate performance. His simulations reveal that there were no risky pre-crisis exchange rate misalignments among the worst hit countries of the 1997 Asian crisis.

As earlier stated, Calvo and Reinhart (2002) test for the de facto exchange rate regimes using three criteria; monthly percentage exchange rate changes, monthly percentage changes of official foreign reserves and monthly absolute changes in nominal short-term interest rates, estimating the probability that a variable falls within a predetermined bound that defines a certain exchange rate regime. For instance, if a bound is set at 2.5%, then the probability that the monthly exchange rate change falls within the 2.5% band will be greatest for the fixed regime and lowest for the freely floating regime. They follow the same procedure to examine the behaviour of reserves and interest rates that are used by governments as monetary policy tools.

Levy-Yeyati and Sturzenegger (2005, 2016) define exchange rate regimes according to the behaviour of three variables; changes in the nominal exchange rate, volatility of these changes and the volatility of international reserves (Note 20). Fixed exchange rate regimes are characterized by more changes in international reserves aimed at reducing the volatility in the nominal exchange rate, and flexible regimes are characterized by substantial volatility in nominal rates with relatively stable reserves. The researchers develop clusters, the clusters with high volatility of reserves and low volatility of nominal exchange rate are fixers while those with low volatility in international reserves and substantial volatility in the nominal exchange rate identify as flexible. They note that reserves are notoriously hard to measure and there is a large difference between changes in reserves (Note 21) and interventions. Their approach uses a cluster analysis to identify the exchange rate regimes based on the classification variables. This is a multivariate approach used to identify homogeneous observations, according to similarities between data points along certain identified dimensions.

Ilzetzki et al. (2017) (Note 22) stress that any classification algorithm must simultaneously determine both an anchor currency, if any, and its degree of fixity or flexibility. They go ahead and develop an anchor or reference currency classification algorithm, emphasizing that this can prove to be a heavy task given that there is a great degree of flexibility in exchange rates globally and some anchor or reference currencies may not be declared by monetary authorities.

Frankel and Wei (2008) propose an extension to the original regression-based technique that incorporates an exchange market pressure variable, defined as a percentage increase in the value of the currency plus the percentage increase in reserves. This answers the question as to what extent the authorities allow the increase in international demand for a currency to show up as an appreciation in the currency and to what extent as an increase in reserves.

3. Models and Data

3.1 Anchor Currency Regressions

The regression equation below is used to investigate or recover the weights that monetary authorities in a country may attach to the three main global anchor currencies.

$$\Delta Ln(\frac{LCY}{CHF})_t = \beta_1 + \beta_2 \Delta Ln(\frac{USD}{CHF})_t + \beta_3 \Delta Ln(\frac{EUR}{CHF})_t + \beta_4 \Delta Ln(\frac{JPY}{CHF})_t + \beta_5 \Delta Ln(\frac{GBP}{CHF})_t + \varepsilon_t$$

Where LCY is the domestic currency of the country under study, USD is the US Dollar, EUR is the Euro, JPY is the Japanese Yen, GBP is the British Pound, and finally, CHF is the Swiss Franc, the numeraire. The technique aims to recover the weights, βs, that are assigned by each country to the potential anchor currencies. That is, it aims to decompose the variation in each domestic currency due to the variation in the chosen anchor currencies. A β close to one and statistically significant shows a sign of pegging, and a β close to zero and not significant is a sign of a floating regime.

It is tempting to use the Chinese Renminbi as a possible anchor currency in the Equation above given its recent inclusion to the Special Drawing Rights (SDR) (Note 23) basket and increased share in global GDP, however, this will not be a good idea given that it has for a long period of time been known to be pegged to the US Dollar. This would obscure or confound, to a great extent, the integrity of the findings of this study.

The Swiss Franc is chosen as a numeraire currency to express the value of all currencies in terms of a common currency. The Swiss Franc is the preferred choice because it is a freely floating currency of an advanced economy. In addition, the volume of trade between Switzerland and the countries chosen in the sample is quite minimal. A significant volume of trade would encourage pegging to reduce the exchange rate risk associated with exchange rate fluctuations.

Furthermore, the Swiss Franc is considered a haven (Note 24) currency. The stability of the Swiss government, sound macroeconomic stability and developed financial system makes it a good candidate as a numeraire. To a greater extent, Switzerland is legally independent of the European Union, this shields the country from negative shocks and pressures from the EU and Euro Area. However, the currency periodically faces an upward pressure due to increased demand given that it is a haven; this could result in an overvalued currency.

3.2 Markov Regime Switching Models

The Autoregressive (AR) version of the Markov process is chosen since it allows a smooth transition from one regime to another. This model is essentially trying to describe the intervention behaviour of the central bank. It is also appropriate when the exchange rates exhibit long swings in one direction. This discussion closely follows the work of Hamilton (1989), Hamilton (1990), Engel and Hamilton (1990), Hamilton (1994) and Kim (1994). The Markov-switching regression models, chains and estimation procedure are described below.

Take a simple process of y_t, in this case, y_t is the log of the nominal exchange rate at time t, with $t = 1,2, \dots T$, and described by 2 states as below.

$$State\ 1: y_t = \mu_1 + \Phi y_{t-1} + \varepsilon_t$$
$$State\ 2: y_t = \mu_2 + \Phi y_{t-1} + \varepsilon_t \quad (1)$$

μ_1 and μ_2 are the intercepts in the respective states that are unobservable, Φ is the AR term that allows for smooth transition between states, and ε_t, a white noise error with variance σ^2. The 2 states are essentially modelling shifts in μ. It is possible to express the above model as;

$$y_t = s_t\mu_1 + (1 - s_t)\mu_2 + \Phi y_{t-1} + \varepsilon_t \quad (2)$$

s_t is 1 if the process is in state 1 and 0 otherwise.

Allowing the intercept to depend on the state that the process is in, up to k states, the model can be expressed as;

$$y_t = \mu_{s_t} + \Phi y_{t-1} + \varepsilon_t \quad (3)$$

$\mu_{s_t} = \mu_1$ if $s_t = 1$, $\mu_{s_t} = \mu_2$ if $s_t = 2$ and $\mu_{s_t} = \mu_k$ if $s_t = k$.

Equation 4 below describes a MSDR (Markov-Switching Dynamic Regression) process that allows the intercept to switch across 2 states, as in Krolzig (2013).

The conditional density of y_t is dependent only on the realisation of the current state that the process is in, s_t. The conditional density is;

$$f(y_t|s_t = i, y_{t-1};\ \theta) \quad (4)$$

θ is a representation of a vector of parameters. Given that there are k states, then it follows that there are k conditional densities as shown below.

$$\tau_t = \begin{bmatrix} f(y_t|s_t = 1;\ y_{t-1};\ \theta) \\ f(y_t|s_t = 2;\ y_{t-1};\ \theta) \\ \vdots \\ f(y_t|s_t = k;\ y_{t-1};\ \theta) \end{bmatrix} \quad (5)$$

τ_t is therefore a $k \times 1$ vector of conditional densities.

The transition probabilities can be represented by a $k \times k$ matrix as;

$$P = \begin{bmatrix} p_{11} & p_{21} & \cdots & p_{k1} \\ p_{12} & p_{22} & \cdots & p_{k2} \\ \vdots & \vdots & \cdots & \vdots \\ p_{1k} & p_{2k} & \cdots & p_{kk} \end{bmatrix} \quad (6)$$

With columns summing up to 1, that is, $\sum_{j=1}^{k} p_{ij} = 1$.

The transition probabilities in functional form are expressed as;

$$p_{ij} = \frac{\exp(-q_{ij})}{1+\exp(-q_{i1})+\exp(-q_{i2})+\cdots+\exp(-q_{i,k-1})} \quad (7)$$

For $j \in (1, 2, \dots, k-1)$.

To normalise p_{ik}, the restriction below is imposed. Please note the difference in the numerator.

$$p_{ik} = \frac{1}{1+\exp(-q_{i1})+\exp(-q_{i2})+\cdots+\exp(-q_{i,k-1})} \quad (8)$$

Of particular interest is a model that allows gradual adjustment between states. This can be done using a MS-AR (Markov-Switching Autoregressive) model.

$$y_t = \mu_{s_t} + \Phi(y_{t-1} - \mu_{s_{t-1}}) + \varepsilon_t \tag{9}$$

Notice that, in this case, the current value of y_t depends on the value of its switching mean in the current state and its lagged value.

A MS-AR model with k number of states/regimes with covariates included will be of the form;

$$y_t = \mu_{s_t} + X_t\alpha + Z_t\beta_{s_t} + \sum_{i=1}^{k} \Phi_{i,s_t}(y_{t-i} - \mu_{s_{t-i}} - X_{t-i}\alpha - Z_{t-i}\beta_{s_{t-i}}) + \varepsilon_{s_t} \tag{10}$$

y_t is the dependent variable at time t, μ_{s_t} is the state dependent intercept, X_t are covariates whose coefficients α are state-invariant, Z_t are covariates whose coefficients, β_{s_t}, are state-dependent, Φ_{i,s_t} is the i^{th} AR term in state s_t, $\mu_{s_{t-i}}$ is the intercept corresponding to the state that the process was in at period $t-i$, $\beta_{s_{t-i}}$ is the coefficient vector on Z_{t-i} corresponding to the state that the process was in at period $t-i$ and ε_{s_t} iid $N(0, \sigma_{s_t}^2)$.

Now, again consider a 2-state/regime process, and in both regimes, y_t follows a normal distribution. The transition probabilities can be denoted as shown below. The implication of this is that the probability of regime 1 occurring at time t depends solely on the regime at time $t-1$.

$$p_{ij} = Pr(s_t = j | s_{t-1} = i) \tag{11}$$

With $i, j = 1,2$.

The transition probabilities in a 2×2 matrix can be expressed as;

$$P = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix} \tag{12}$$

Where the transitional probabilities may be calculated as;

$$\begin{aligned} p[s_t = 1 | s_{t-1} = 1] &= p_{11} \\ p[s_t = 2 | s_{t-1} = 1] &= p_{12} = 1 - p_{11} \\ p[s_t = 2 | s_{t-1} = 2] &= p_{22} \\ p[s_t = 1 | s_{t-1} = 2] &= p_{21} = 1 - p_{22} \end{aligned} \tag{13}$$

p_{11} is the probability that the series is in state 1 at time $t-1$ and remains in state 1 at time t, p_{12} is the probability that the series is in state 1 at time $t-1$ and transitions to state 2 at time t, p_{22} is the probability that the series is in state 2 at time $t-1$ and remains in state 2 at time t and p_{21} is the probability that the series is in state 2 at time $t-1$ and transitions to state 1 at time t.

The expected duration in a state is computed as;

$$ED = \frac{1}{1 - p_{ij}} \tag{14}$$

Since the states are latent, then it follows that one can never know for sure which regime prevailed at a certain time as the states remain unobservable. To draw meaningful inference about the progression of y_t over time, then state probabilities and other θ parameters will need to be estimated using maximum likelihood.

$$\theta = [\mu_1, \mu_2, \Phi_1, \Phi_2, \sigma_1^2, \sigma_2^2, p_{11}, p_{22}]' \tag{15}$$

$$\xi_{jt} = Pr(s_t = j | \Omega_t; \theta) \tag{16}$$

Where $j = 1,2$ and $\Omega_t = (y_t, y_{t-1}, \dots, y_1, y_0)$ are observations at time t.

For $t = 1,2, \dots, T$, inference is performed iteratively with step t accepting as input values in Equation 17 below and producing as output Equation 16.

$$\xi_{i,t-1} = Pr(s_{t-1} = i | \Omega_{t-1}; \theta) \tag{17}$$

For $i = 1,2$. Note the differences in the subscripts.

The density of y_t conditional on s_t is given by;

$$\eta_{jt} = f(y_t | s_t = j, \Omega_{t-1}; \boldsymbol{\theta}) = \frac{1}{\sigma_{s_t}\sqrt{2\pi}} \exp\left(-\frac{1}{2\sigma_{s_t}^2}\left[y_t - \mu_{s_t}\right]^2\right) \tag{18}$$

The conditional density of the t^{th}observation can be computed from;

$$f(y_t|\Omega_{t-1};\boldsymbol{\theta}) = \sum_{i=1}^{2}\sum_{j=1}^{2} p_{ij}\xi_{i,t-1}\eta_{jt} \tag{19}$$

Giving an output of;

$$\xi_{jt} = \frac{\sum_{i=1}^{2} p_{ij}\xi_{i,t-1}\eta_{jt}}{f(y_t|\Omega_{t-1};\boldsymbol{\theta})} \tag{20}$$

The execution of this iteration leads to the evaluation of the sample conditional log likelihood in Equation 21 below.

$$Logf(y_1, y_2, \dots, y_T|y_0;\theta) = \sum_{t=1}^{T} logf(y_t|\Omega_{t-1};\theta) \tag{21}$$

An estimate of θ can be obtained by maximising Equation 21 above.

The smoothed probabilities are computed using an algorithm developed by Kim (1994). This recursion is called the Kim-smoother.

$$\xi_{t|T} = \xi_{t|t} \odot \left[P'(\xi_{t+1|T}(\div)\xi_{t+1|t})\right] \tag{22}$$

$\odot$ indicates element-by-element multiplication.

The expectation maximisation algorithm for obtaining maximum likelihood estimates of parameters for processes subject to discrete shifts developed by Hamilton (1990) is applied to the likelihood function in Equation 21.

3.3 Data

Monthly nominal exchange rate data per CHF on 70 countries to best represent the globe was collected. The sample period was 2000-2019 and the data was collected from the IMF-IFS database. The countries in the sample are;

Europe; Albania, Armenia, Bulgaria, Czech Republic, Denmark, Hungary, Iceland, Norway, Poland, Romania, Russia, Sweden, Turkey, and Ukraine.

Americas; Argentina, Aruba, Barbados, Bahamas, Brazil, Canada, Chile, Colombia, Jamaica, and Mexico

Middle East, South and East Asia; Bahrain, China, Hong Kong, India, Israel, Malaysia, Oman, Philippines, Qatar, Saudi Arabia, Singapore, South Korea, Thailand, and United Arab Emirates.

Oceania; Australia, Fiji, and New Zealand.

Africa; Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea-Bissau, Kenya, Mali, Morocco, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Tanzania, Togo, Tunisia, Uganda and Zambia.

After applying the anchor currency regressions discussed in section 1.3.1 and getting a good feel of how the different currencies behave according to the anchors, a smaller sample comprising of the log exchange rate per US Dollar of 4 advanced economies (UK, Euro Area, Switzerland and Canada) and 4 emerging market economies (Hungary, Romania, South Korea and South Africa) is chosen, and a more complex approach, the 2-regime Markov-switching model, discussed in section 1.3.2 is used to study the behaviour of these currencies.

4. Discussion of Results

4.1 Descriptive Statistics

The descriptive statistics presented are the mean, standard deviation, minimum, maximum, skewness and kurtosis. The discussion here will focus mainly on the mean and tail behaviour moments, that is, the skewness and kurtosis, to draw any kind of preliminary inference.

Table 1 presents the results for European currencies. From the mean results, the Armenian Dram and Hungarian Forint exhibit the highest figures per CHF, 397.578 and 207.866 respectively. Mean exchange rates are obviously very sensitive to the chosen reference currency. As expected, the British Pound and Euro show the lowest values per CHF in that order, reporting means of 0.571 and 0.742 per CHF respectively. The skewness and kurtosis of the Euro and many currencies, particularly in Europe, exhibit somewhat similar behaviour. The Danish Krone, Bulgarian Lev and Hungarian Forint mimic the behaviour of the Euro almost perfectly. This is evidence of pegging or a sign of convergence towards adopting the Euro; this is especially true for Denmark, an ERM II member, that is moving towards adopting the Euro.

Table 1. Time series moment summary statistics - Europe

	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Albanian Lek	98.865	18.130	72.949	135.665	0.290	1.633
Armenian Dram	397.578	71.817	256.414	516.295	-0.141	1.780
British Pound	0.571	0.139	0.380	0.821	0.148	1.470
Bulgarian Lev	1.451	0.217	1.170	1.887	0.463	1.692
Czech Koruna	20.770	2.668	14.538	26.454	-0.084	2.393
Danish Krone	5.527	0.826	4.460	7.206	0.465	1.693
Euro	0.742	0.111	0.598	0.964	0.462	1.691
Hungarian Forint	207.866	49.635	143.297	298.616	0.466	1.615
Icelandic Krona	92.158	34.769	44.122	146.566	-0.046	1.247
Norwegian Krone	6.191	1.266	4.606	8.768	0.895	2.325
Polish Zloty	3.049	0.570	2.014	4.125	0.222	1.801
Romanian Leu	2.938	0.881	1.145	4.283	-0.075	1.807
Russian Ruble	33.894	16.805	15.647	77.668	1.052	2.694
Swedish Krona	6.911	1.136	5.225	9.255	0.573	2.077
Turkish Lira	1.815	1.133	0.344	6.550	1.458	5.286
Ukrainian Hryvnia	10.140	8.587	3.027	29.570	1.193	2.800

Table 2 combines North America, Latin America and Caribbean currencies. The mean results indicate that the Pesos of Colombia and Chile reported the highest values per CHF, 2091.626 and 518.012 respectively. It is important to note that Latin America has over the recent past experienced crisis after crisis, both economic and political. These crises have inevitably had an effect on currency values and behaviour, with some countries facing pressures to devalue their currencies altogether, see for example Damill et al. (2013). However, this is not the focus of this study. It can be said that the US Dollar, Bahamian Dollar and Canadian Dollar are relatively strong currencies in this region, reporting means of 0.899, 0.899 and 1.080 per CHF respectively, almost a 1:1 parity. The skewness and kurtosis of the Dollar currencies of USA, Bahamas, Barbados and the Florin of Aruba exhibit exactly the same behaviour, all with skewness and kurtosis values of -0.423 and 2.107 respectively. This is clear evidence of pegging, presumably to the US Dollar. Furthermore, it is important to observe that the US Dollar and Bahamian Dollar have exactly the same value per CHF, 0.899. From this result, it is obvious to conclude that the Bahamian Dollar maintains a strict 1:1 parity to the US Dollar.

Table 2. Time series moment summary statistics - Americas

	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Argentine Peso	6.282	7.083	0.560	39.707	2.359	9.287
Brazilian Real	2.230	0.764	1.046	4.252	0.766	2.727
Canadian Dollar	1.080	0.156	0.830	1.411	0.505	2.079
Chilean Peso	518.012	104.090	303.621	716.918	0.111	2.295
Colombian Peso	2091.626	535.409	1175.520	3374.476	0.656	2.724
Jamaican Dollar	78.955	36.413	24.511	140.384	0.068	1.598
Mexican Peso	11.925	4.452	5.098	21.191	0.294	2.019
US Dollar	0.899	0.170	0.561	1.281	-0.423	2.107
Aruban Florin	1.610	0.305	1.003	2.292	-0.423	2.107
Bahamian Dollar	0.899	0.170	0.561	1.281	-0.423	2.107
Barbadian Dollar	1.798	0.341	1.121	2.561	-0.423	2.107

Table 3 currencies are of Middle East, and South and East Asian countries, right from Saudi Arabia to Japan. Also included are the US Dollar descriptive statistics for comparison purposes. The mean figures show that the Korean Won and Japanese Yen reported the highest values per CHF, at 1005.998 and 94.442 respectively. For an advanced economy, Japan's exchange rate value may cause one to ask questions, it is rather out of range when compared with that of its peer countries. This may be attributed to its high level of indebtedness; Japan's debt is reported to be at about twice its annual GDP and its long-term sovereign debt rating has been cut by credit rating agencies due to this. It has the largest amount of debt on the globe. The Dinar of Bahrain and Rial of Oman are rather strong, reporting means of 0.338 and 0.346 per CHF respectively. Generally, Middle East currencies are stronger than the East Asian currencies, with mean values ranging from Bahrain's 0.338 to Israel's 3.541. Just like the Caribbean currencies in Table 1.2, the Bahraini Dinar, Omani Rial, Saudi Riyal, UAE Dirham and Qatari

Rial exhibit exactly the same tail behaviour as the US Dollar, all with a skewness and kurtosis of -0.423 and 2.107 respectively. The Hong Kong Dollar too follows closely with only a slight and negligible difference in the kurtosis value at 2.110. Again, this is an indicator of perfect pegging, presumably to the US Dollar.

Table 3. Time series moment summary statistics - Asia

	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Chinese Renminbi	6.356	0.664	4.639	8.208	-1.000	3.733
Hong Kong Dollar	6.994	1.318	4.371	9.985	-0.423	2.110
Indian Rupee	47.486	15.142	25.592	74.610	0.263	1.520
Israeli new Shekel	3.541	0.468	2.299	4.538	-1.108	3.814
Japanese Yen	94.442	15.964	60.759	132.751	0.189	2.396
Korean Won	1005.998	190.607	635.803	1375.504	-0.308	1.565
Malaysian Ringgit	3.241	0.617	2.130	4.466	0.264	2.388
Philippine Peso	42.934	7.053	24.332	55.731	-0.802	3.214
Singapore Dollar	1.306	0.115	0.983	1.548	-1.195	3.816
Thai Bhat	31.587	3.319	22.635	38.266	-0.621	3.015
Bahraini Dinar	0.338	0.064	0.211	0.482	-0.423	2.107
Omani Rial	0.346	0.065	0.216	0.492	-0.423	2.107
Saudi Riyal	3.372	0.638	2.102	4.803	-0.423	2.107
UAE Dirham	3.302	0.625	2.058	4.703	-0.423	2.107
Qatari Rial	3.273	0.620	2.040	4.662	-0.423	2.107
US Dollar	0.899	0.170	0.561	1.281	-0.423	2.107

Table 4 presents the descriptive statistics of Oceania currencies. The mean statistics of these three currencies are rather low, ranging from the Australian Dollar's 1.153 to the Fijian Dollar at a value of 1.711 per CHF. The New Zealand Dollar reports the mid-point value at 1.339 per CHF. The skewness and kurtosis values seem rather neutral to all the 4 possible anchor currencies. Inference may not be drawn at this point.

Table 4. Time series moment summary statistics - Oceania

	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Australian Dollar	1.153	0.131	0.947	1.457	0.602	2.109
Fijian Dollar	1.711	0.339	1.233	2.239	0.072	1.287
New Zealand Dollar	1.339	0.120	1.053	1.666	-0.027	2.613

Table 5 shows the descriptive statistics of African currencies. Also included are the Euro descriptive statistics for comparison purposes. The Shilling currencies of Uganda and Tanzania show the highest mean values at 2181.291 and 1318.461 per CHF respectively. The Tunisian Dinar and Ghanaian Cedi are perhaps the strongest currencies, reporting mean values of 1.458 and 1.602 per CHF respectively. Comparing the tail behaviour of the West African CFA to the possible anchor currencies, it is observable that the CFA's tail behaviour perfectly mimics that of the Euro, with a skewness and kurtosis of 0.462 and 1.691 respectively. For the rest of the currencies in the region, it is hard to draw any inference on possible pegging at this point.

Table 5. Time series moment summary statistics - Africa

	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Algerian Dinar	73.946	22.749	43.485	121.904	0.605	2.131
Egyptian Pound	6.779	4.422	1.983	18.867	1.720	5.074
Eritrean Nakfa	13.346	3.396	5.402	19.690	-0.860	2.825
Ethiopian Birr	13.443	7.475	4.661	29.147	0.365	1.606
Ghanaian Cedi	1.602	1.551	0.019	4.915	0.702	2.145
Kenyan Shilling	75.875	21.649	44.068	118.828	0.135	1.503
Moroccan Dirham	8.107	1.283	6.219	10.491	0.279	1.489
Nigerian Naira	151.443	74.377	57.420	327.476	1.035	3.196
Rwandan Franc	560.559	192.346	217.718	908.699	-0.001	1.935
Seychellois Rupee	9.312	4.663	3.169	15.654	-0.143	1.190
South African Rand	8.424	3.406	3.857	16.251	0.634	2.078

Tanzanian Shilling	1318.461	580.589	451.592	2400.617	0.257	1.810
Tunisian Dinar	1.458	0.561	0.784	2.997	0.795	2.560
Ugandan Shilling	2181.291	938.240	909.642	3926.727	0.405	1.716
West African CFA	486.682	72.638	392.529	632.646	0.462	1.691
Zambian Kwacha	5.263	2.781	1.656	12.399	0.918	2.763
Euro	0.742	0.111	0.598	0.964	0.462	1.691

Overall, the descriptive statistics do not reveal any evidence that currencies included in the sample tend to peg to the Japanese Yen and British Pound. The preferred currencies are the US Dollar and Euro.

4.2 Anchor Currency Regressions

In order to save on space, given the big number of countries in the sample, only a few of the regression results are presented. However, this is followed up with a geographical map that shows the preferred anchor currency for each country in the sample. Some of the results in the following discussion are taken in comparison to the descriptive statistics results, especially those from which some inference could be drawn.

Table 6 shows the regression results of 6 European countries. Based on the results presented, Armenia and Ukraine are the only European countries that attach a much higher weight to the US Dollar than the Euro. Bulgarian and Denmark attach extremely high weights to the Euro, 0.968 and 0.942 respectively. Poland and Sweden closely follow the Euro too, with statistically significant weights. Bulgaria and Ukraine prefer anchoring to the Euro and US Dollar respectively; the results of the other possible anchor currencies are not significant. As far as these results are concerned, there is evidence of pegging to the US Dollar and Euro in Europe, but not strictly perfect pegs. This, to a greater extent, is consistent with the skewness and kurtosis results discussed earlier.

Table 6. FX regression results - Europe

	Armenia	Bulgaria	Denmark	Poland	Sweden	Ukraine
USD	0.764***	-0.000951	0.00879	0.0271	-0.0183	0.876***
	(0.0738)	(0.00944)	(0.0120)	(0.0818)	(0.0531)	(0.164)
EUR	-0.118	0.968***	0.942***	0.892***	0.796***	0.0713
	(0.0989)	(0.0127)	(0.0161)	(0.110)	(0.0712)	(0.220)
GBP	0.215**	0.0184	0.0240*	0.156	0.182***	0.274
	(0.0741)	(0.00947)	(0.0120)	(0.0821)	(0.0533)	(0.164)
JPY	0.171**	0.000245	-0.00310	-0.158*	-0.0197	-0.0616
	(0.0598)	(0.00765)	(0.00972)	(0.0664)	(0.0431)	(0.133)
N	228	228	228	228	228	228

Standard errors in parentheses.

* p < 0.05, ** p < 0.01, *** p < 0.001 significance level.

Note. The table shows the weights that country monetary authorities attach to the major global anchor currencies. For instance, Bulgarian Lev authorities attach a high and significant weight of 0.968 to the Euro. This can be interpreted as, a 1% change in the value of the Euro leads to a 0.968% change in the value of the Bulgarian Lev.

Table 7 presents the regression results of the Americas. The results clearly indicate that the preferred anchor currency in this region is the US Dollar, with Mexico and Jamaica attaching weights of up to 0.850 and 0.973 respectively. Canada, on the other hand, attaches a moderate weight of 0.571 to the US Dollar, 0.363 to the Euro and 0.161 to the British Pound, with all weights significant to a certain extent. Argentina, Brazil, Chile and Colombia prefer the US Dollar only. Regarding possible perfect pegs, the regressions are able to clearly identify these currencies. The weights attached by Aruba, Bahamas and Barbados to the US Dollar are exactly equal to 1. This is strong evidence of perfect pegging, consistent with the skewness and kurtosis results reported in Table 2 that showed these statistics were exactly equal to those of the US Dollar. This is essentially a US Dollar dominated region.

Table 7. FX regression results - Americas

	Argentina	Brazil	Canada	Chile	Colombia	Jamaica	Mexico
USD	0.775***	0.636***	0.571***	0.532***	0.586***	0.973***	0.850***
	(0.191)	(0.146)	(0.0683)	(0.0965)	(0.114)	(0.0501)	(0.0939)
EUR	-0.0224	0.306	0.363***	0.203	0.278	-0.0357	0.208
	(0.256)	(0.196)	(0.0915)	(0.129)	(0.152)	(0.0671)	(0.126)
GBP	0.306	0.170	0.161*	0.186	0.198	0.163**	0.218*
	(0.192)	(0.147)	(0.0685)	(0.0969)	(0.114)	(0.0503)	(0.0942)
JPY	0.101	-0.213	-0.0342	-0.00316	-0.0257	-0.0208	-0.245**
	(0.155)	(0.118)	(0.0554)	(0.0782)	(0.0922)	(0.0406)	(0.0761)
N	228	228	228	228	228	228	228

Standard errors in parentheses.

* p < 0.05, ** p < 0.01, *** p < 0.001 significance level.

Note. The table shows the weights that country monetary authorities attach to the major global anchor currencies. For instance, Brazilian Real authorities attach a significant weight of 0.636 to the US Dollar. This can be interpreted as, a 1% change in the value of the US Dollar leads to a 0.636% change in the value of the Brazilian Real.

Table 8 presents the regression results of Asia. Again, one can very fast see the influence of the US Dollar in this region, with Hong Kong and Philippines attaching weights of 0.990 and 0.844 to the US Dollar respectively. The US Dollar-weights of the other countries in the region are not far from the Hong Kong and Philippines benchmark. There are also basket currency anchor preferences too, for instance, Singapore attaches weights of 0.546, 0.179, 0.0699 and 0.109 to the US Dollar, Euro, British Pound and Japanese Yen respectively. South Korea and Thailand too prefer basket currency anchoring. Extending on from the descriptive statistics results presented in Table 3, there is strong evidence of perfect pegs to the US Dollar by Bahrain, Oman, Saudi Arabia, UAE and Qatar. These countries report regression coefficients exactly equal to 1 for the US Dollar anchor, which is very much consistent with the skewness and kurtosis tail behaviour results.

Table 8. FX regression results - Asia

	China	Hong Kong	Korea	Oman	Philippines	Singapore	Thailand
USD	0.913***	0.990***	0.461***	1.000	0.844***	0.546***	0.599***
	(0.0241)	(0.00424)	(0.0815)	(.)	(0.0576)	(0.0333)	(0.0469)
EUR	0.00170	-0.00147	0.218*	-2.24e-16	0.157*	0.179***	0.106
	(0.0323)	(0.00569)	(0.109)	(.)	(0.0772)	(0.0447)	(0.0629)
GBP	0.0331	-0.000548	0.249**	-2.68e-16	0.00486	0.0699*	0.0582
	(0.0242)	(0.00426)	(0.0818)	(.)	(0.0578)	(0.0335)	(0.0471)
JPY	0.0192	0.00620	0.0351	-3.00e-16	0.00156	0.109***	0.123**
	(0.0196)	(0.00344)	(0.0661)	(.)	(0.0467)	(0.0270)	(0.0381)
N	228	228	228	228	228	228	228

Standard errors in parentheses.

* p < 0.05, ** p < 0.01, *** p < 0.001 significance level.

Note. The table shows the weights that country monetary authorities attach to the major global anchor currencies. For instance, Korean Won authorities attach a significant weight of 0.249 to the British Pound. This can be interpreted as, a 1% change in the value of the British Pound leads to a 0.249% change in the value of the Korean Won.

Table 9 is a presentation of the regression results of Oceania. The Euro, as an anchor, plays a significant role in this region, with Australia and New Zealand reporting weights of 0.638 and 0.424 respectively. The US Dollar and British Pound are not far behind though. There is no significance reported for the Japanese Yen but there is noticeable importance of the British Pound as an anchor in this region. The coefficients attached to the three preferred anchors are also moderate in value. Unlike some regions where countries prefer a single anchor currency, the countries in this region prefer anchoring to a currency basket.

Table 9. FX regression results - Oceania

	Australia	Fiji	New Zealand
USD	0.201*	0.498***	0.234*
	(0.0902)	(0.0567)	(0.0936)
EUR	0.638***	0.423***	0.424***
	(0.121)	(0.0761)	(0.126)
GBP	0.219*	0.0181	0.252**
	(0.0905)	(0.0571)	(0.0940)
JPY	-0.0470	0.0290	-0.100
	(0.0731)	(0.0460)	(0.0759)
N	228	227	228

Standard errors in parentheses.

* p < 0.05, ** p < 0.01, *** p < 0.001 significance level.

Note. The table shows the weights that country monetary authorities attach to the major global anchor currencies. For instance, Australian Dollar authorities attach a significant weight of 0.638 to the Euro. This can be interpreted as, a 1% change in the value of the Euro leads to a 0.638% change in the value of the Australian Dollar.

Table 10 reports the regression results of Africa. The US Dollar is the preferred anchor for Ethiopia, Ghana, Nigeria and Uganda, reporting significant weights of 0.947, 1.537, 0.855 and 0.807 respectively, with Ethiopia and Ghana solely preferring the US Dollar to a currency basket. African periphery countries of Morocco and Tunisia that are close to Europe attach a higher weight to the Euro than other possible anchors, at 0.740 and 0.587 respectively. South Africa too is inclined towards the Euro as an anchor. The only country in the entire sample that has a preference for the British Pound as a number one anchor currency is found in this region, Seychelles, attaching a significant weight of 0.655. The Japanese Yen does not report any significant degree of importance in this region. As earlier reported in Table 5, the West African CFA exhibited the exact tail behaviour as the Euro, and this result is further supported in the regression results with a weight exactly equal to 1 in favour of the Euro. The strict pegging result is therefore confirmed.

Table 10. FX regression results - Africa

	Ethiopia	Ghana	Morocco	Nigeria	South Africa	Seychelles	Tunisia	Uganda
USD	0.947***	1.537**	0.230***	0.855***	0.223	0.474**	0.267***	0.807***
	(0.0615)	(0.497)	(0.0229)	(0.0997)	(0.142)	(0.179)	(0.0339)	(0.0874)
EUR	0.0885	-0.0716	0.740***	-0.0917	0.391*	-0.174	0.587***	0.251*
	(0.0824)	(0.667)	(0.0307)	(0.134)	(0.191)	(0.240)	(0.0455)	(0.117)
GBP	0.106	-0.141	0.00634	0.360***	0.240	0.655***	0.0512	0.187*
	(0.0619)	(0.500)	(0.0230)	(0.100)	(0.143)	(0.180)	(0.0340)	(0.0877)
JPY	-0.00579	-0.377	0.00798	-0.0481	0.000960	-0.267	0.0201	-0.0593
	(0.0498)	(0.403)	(0.0185)	(0.0809)	(0.115)	(0.145)	(0.0275)	(0.0709)
N	225	225	228	228	228	228	228	228

Standard errors in parentheses.

* p < 0.05, ** p < 0.01, *** p < 0.001 significance level.

Note. The table shows the weights that country monetary authorities attach to the major global anchor currencies. For instance, Ugandan Shilling authorities attach a high and significant weight of 0.807 to the US Dollar. This can be interpreted as, a 1% change in the value of the US Dollar leads to a 0.807% change in the value of the Ugandan Shilling.

In general, the Euro and US Dollar are the dominant anchor currencies, however, many countries prefer basket currency anchoring, spreading the risk in different proportions among the major anchor currencies. Figure 5 shows a summary of country preference for the two preferred anchor currencies across the globe. The British Pound and Japanese Yen are rather unpopular.

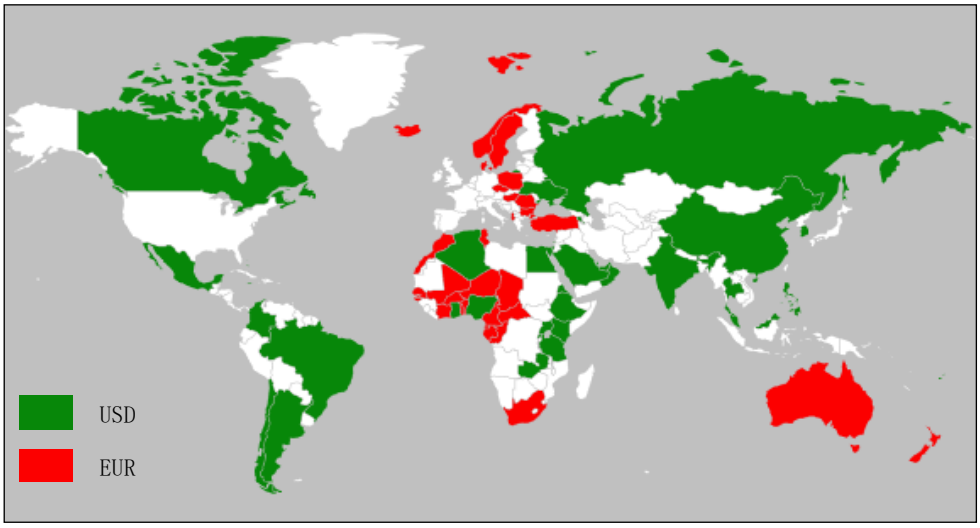

Figure 5. Anchor currencies

These regression results are robust and remain more or less the same when the numeraire is changed to the New Zealand Dollar.

4.3 Markov Regime Switching Model

To the results of the 2-state/regime Markov-switching AR (2) model now. For all the eight currencies, each model is estimated separately, and the Akaike information criteria showed that 2 lags and 2 states were appropriate for each currency. Even after deciding to go against the Akaike information criteria on the appropriate number of lags and states, a global maximum is not reached, and so the specification remains appropriate. The maximum likelihood estimates are presented in Table 11 along with some diagnostic tests on the residuals of the different currency models.

Table 11. Markov-switching results

	British Pound	Euro	Swiss Franc	Canadian Dollar	Hungarian Forint	Romanian Leu	Korean Won	South African Rand
μ_1	-0.473	-0.237	-0.115	0.084	5.437	1.324	6.999	2.542
	(0.140)	(0.079)	(0.128)	(0.122)	(0.189)	(0.051)	(0.041)	(0.484)
μ_2	-0.445	-0.223	0.006	0.180	5.455	1.345	7.034	2.685
	(0.141)	(0.076)	(0.126)	(0.121)	(0.187)	(0.049)	(0.045)	(0.485)
Φ_1	1.165	1.300	1.131	1.290	1.208	1.379	1.261	1.232
	(0.067)	(0.069)	(0.065)	(0.062)	(0.064)	(0.061)	(0.062)	(0.066)
Φ_2	-0.174	-0.319	-0.142	-0.300	-0.218	-0.406	-0.289	-0.239
	(0.068)	(0.068)	(0.064)	(0.062)	(0.066)	(0.059)	(0.062)	(0.066)
σ_1^2	0.018	0.030	0.025	0.017	0.046	0.028	0.017	0.033
	(0.001)	(0.005)	(0.002)	(0.001)	(0.006)	(0.002)	(0.0009)	(0.002)
σ_2^2	0.035	0.017	0.016	0.018	0.024	0.011	0.055	0.029
	(0.006)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.013)	(0.005)
p_{11}	0.983	0.925	0.996	0.995	0.971	0.984	0.995	0.991
p_{22}	0.871	0.968	0.995	0.996	0.993	0.983	0.894	0.878
$ED(1)$	57.973	13.297	255.289	221.689	34.799	60.718	186.141	111.414
$ED(2)$	7.763	31.197	216.655	251.205	140.586	59.424	9.478	8.169
$Normality$ (Note 30)	[0.000]	[0.034]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
$Autocorrelation$ (Note 31)	[0.427]	[0.328]	[0.757]	[0.403]	[0.623]	[0.318]	[0.001]	[0.479]
$ARCH(1)$ (Note 32)	[0.043]	[0.597]	[0.578]	[0.791]	[0.016]	[0.092]	[0.002]	[0.848]

Standard errors in parentheses and p-values in square brackets.

The selected model allows the intercept, μ, and variance, σ^2, to vary across the two regimes, which is realistic

for exchange rate behaviour. The point estimates indicate that the first regime for the British Pound, Euro and Swiss Franc are associated with a declining exchange rate (appreciation) and an increasing exchange rate (depreciation) for the other five currencies. The second regime is also characterized by a declining exchange rate for the British Pound and Euro. For cases where both states have the same sign, the point estimate magnitude will indicate which regime has a greater effect. For instance, in the case to the British Pound, the first state is characterized by a greater decline in the exchange rate than the second state, so the states/regimes are being decomposed into sub-regimes. Maximum likelihood estimates associated state 1 with a 0.473% monthly fall in the British Pound, 0.237% fall in the Euro, 0.115% fall in the Swiss Franc, 0.084% rise in the Canadian Dollar, 5.437% rise in the Hungarian Forint, 1.324% rise in the Romanian Leu, 6.999% rise in the Korean Won and 2.542% rise in the South African Rand. State 2 indicated a 0.445% fall in the British Pound, 0.223% fall in the Euro, 0.006% rise in the Swiss Franc, 0.180% rise in the Canadian Dollar, 5.455% rise in the Hungarian Forint, 1.345% rise in the Romanian Leu, 7.034% rise in the Korean Won and 2.685% rise in the South African Rand. The economic interpretation is much more straight forward and makes more sense if the regime dependent intercepts are of opposite signs, this important result is only captured by the Swiss Franc. Engel and Hamilton (1990), while investigating long swings (Note 25) in the US Dollar stated that long swings will exist if; μ_1 and μ_2 are opposite in sign, with p_{11} and p_{22} large or close to 1. The transition probabilities are all close to 1, indicating that there is a high probability that the exchange rate stays in one regime, hence, fewer switches. This probability can be interpreted as a measure of regime is persistence. This persistence is not permanent since the probabilities, $p_{11}, p_{22} < 1$, a switch eventually occurs. Probability estimates of p_{11} range from 0.925 to 0.996 while p_{22} range from 0.871 to 0.996. The expected duration of each regime is also reported, the Swiss Franc and Canadian Dollar show the highest duration in specific regimes; the Swiss Franc will take an average of 255.289 months in an appreciating regime and 216.655 months in a depreciating regime while the Canadian Dollar will spend an average of 221.689 months in state 1 and 251.205 months in state 2. From this information, it is viable to conclude that the Swiss Franc and Canadian Dollar may be more stable than the other currencies that spend minimal time in either regime, shifting more frequently. The Romanian Leu spends more or less an even amount of time in either of the two states, 60.718 and 59.424 months in state 1 and state 2 respectively, another sign of currency stability. The Korean Won, Hungarian Forint and South African Rand report the widest spread between the months spent in the two competing states.

The diagnostic tests show that the residuals are not normally distributed for all eight currencies, which is a common occurrence. Autocorrelation results are generally good, except for the Korean Won, which shows presence of autocorrelation. ARCH tests detect the presence of ARCH effects in the British Pound, Hungarian Forint and the Korean Won data; an indicator that GARCH models may also be used to model the behaviour of these specific currencies.

From observation of the filtered (Note 26), smooth (Note 27) and specifically one-step (Note 28) probabilities presented alongside the exchange rate series, one can conclude that the MS-AR (2) model performs quite well, and is able to identify the important turning points in the evolution of most of the currencies, especially the 2007/2008 financial crisis. One can draw inference by observing the appreciation and depreciation regimes of the respective currencies along with the regime probabilities of choice.

Given that the one-step, filtered and smooth probabilities ideally identify the two competing regimes as appreciating and depreciating ones, it becomes difficult to easily interpret the findings, as the mean (μ) of all the currencies, with the exception of the Swiss Franc, are of the same sign in the different states as shown in Table 11. That, notwithstanding, the graphical results can still be interpreted. It is the usual assumption that there will be a regime switch if the probability is greater than 0.5. The model is therefore quite intuitive.

From Figure 6, one-step probability models are able to identify 4 depreciation periods of the British Pound and 11 depreciation periods for the Euro. Figure 7 shows that the Swiss Franc model clearly captures 2 depreciation periods, with one clearly lasting much longer than the other, almost 99 months. The Canadian Dollar results identify 5 depreciation regimes. From Figure 8, one can observe that the one-step probabilities capture at least 5 Hungarian Forint depreciation periods and 2 South African Rand depreciation periods. Romanian Leu results show 5 depreciation periods while the South Korean Won shows 2 depreciation periods, these are shown in Figure 9. From these results, it is evident that the Euro currency switches the most while the Swiss Franc, South African Rand and the South Korean Won switch the least. Since these are probabilities, then the other side of the coin, appreciation, can simply be seen by flipping the one-step probability graphs over. Of course, the model is subject to weaknesses that can easily be observed from the graphical results as some depreciation regimes identified by the probabilities may include periods of appreciation. This is noticeable by comparing the one-step probability graphs to the exchange rate time series as demonstrated in Figure 6, Figure 7, Figure 8 and Figure 9.

Consider, for example, the British Pound and Euro series, the shaded regions (regimes) may capture depreciations and appreciations. The filtered probabilities for both depreciation and appreciation regimes are shown in Figure 10 and Figure 11. Smooth probabilities are also presented in Figure 12 and Figure 13. The smooth probabilities of the Canadian Dollar differ a lot from the one-step and filtered probabilities. It is difficult to explain in detail why this is the case, but it could be due to the fact that different types of information are used to compute these 3 forms of probabilities.

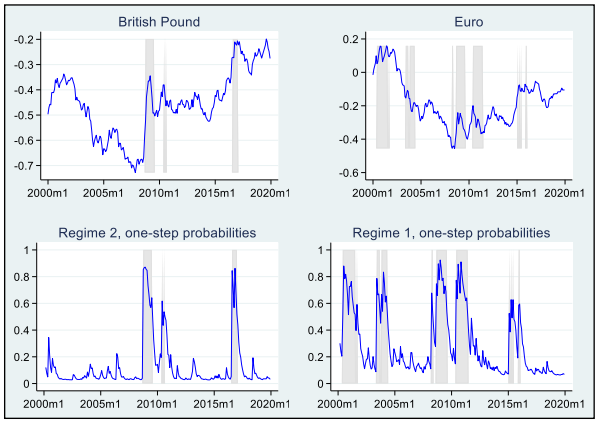

Figure 6. Exchange rates and one-step probabilities

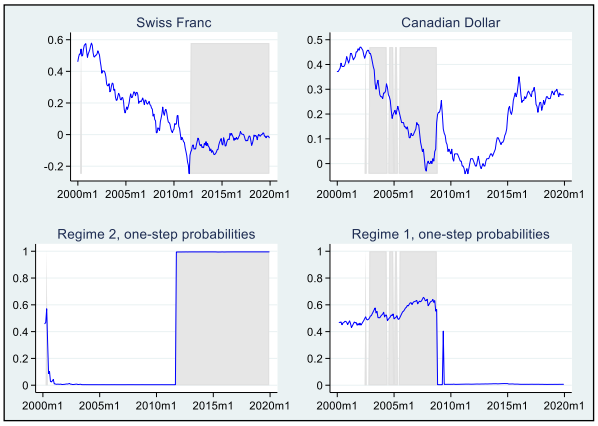

Figure 7. Exchange rates and one-step probabilities

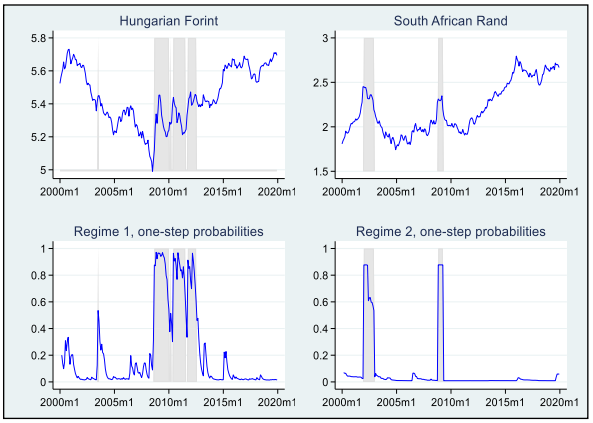

Figure 8. Exchange rates and one-step probabilities

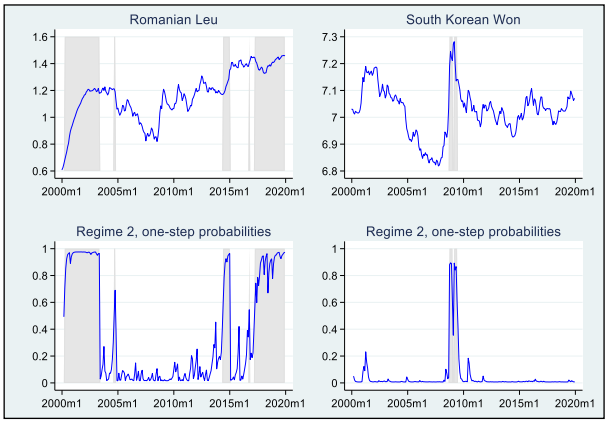

Figure 9. Exchange rates and one-step probabilities

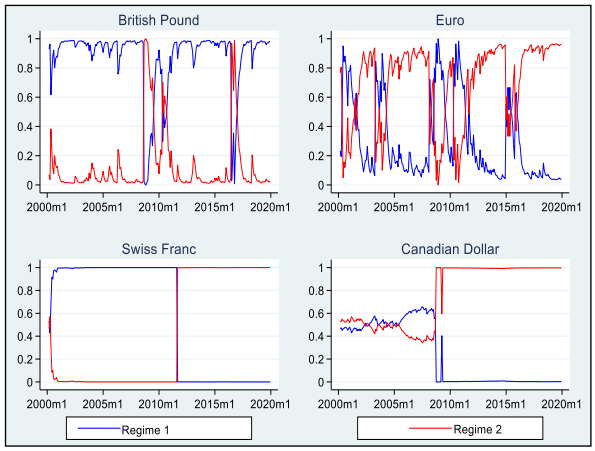

Figure 10. Filtered probabilities

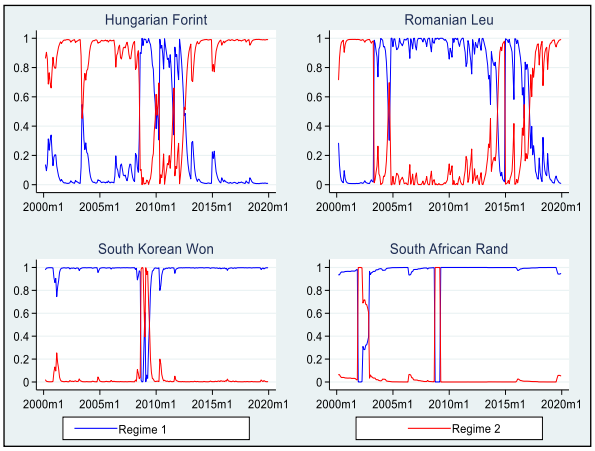

Figure 11. Filtered probabilities

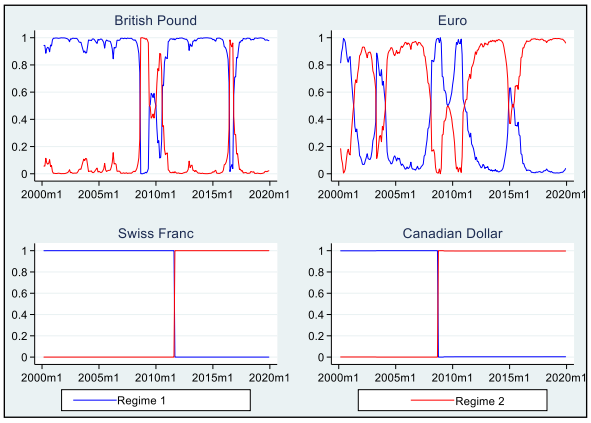

Figure 12. Smooth probabilities

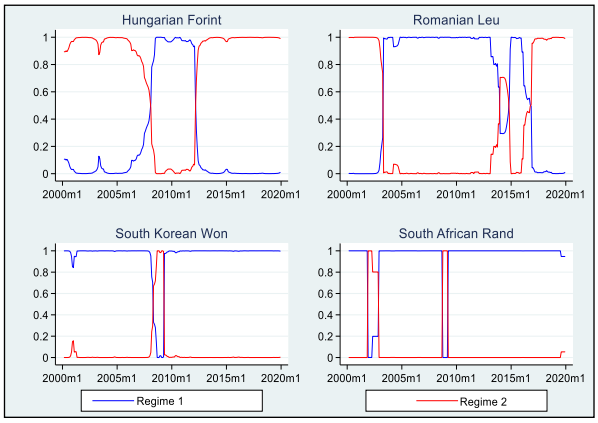

Figure 13. Smooth probabilities

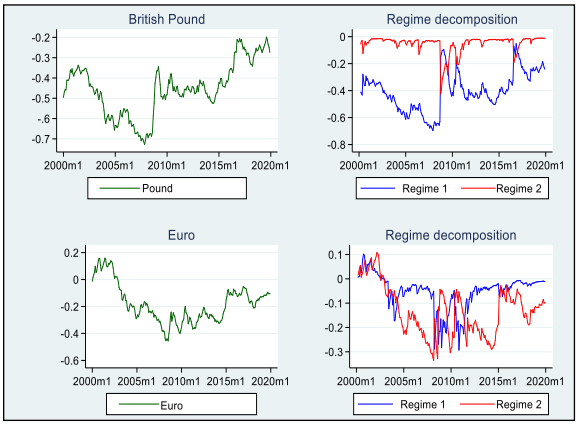

Figure 14. Regime decomposition

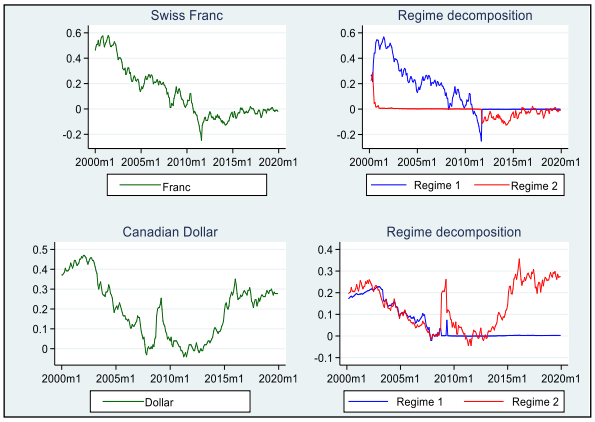

Figure 15. Regime decomposition

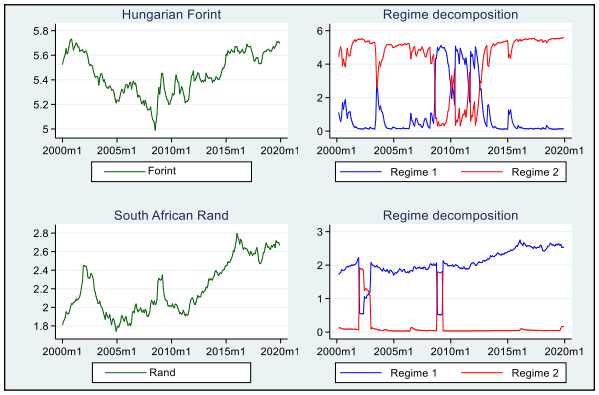

Figure 16. Regime decomposition

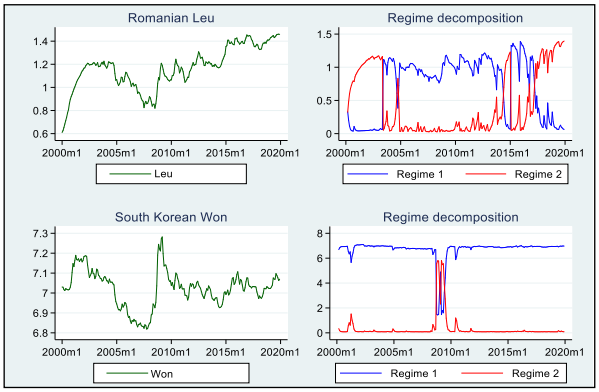

Figure 17. Regime decomposition

The values of the two competing exchange rate regimes, for each currency, are decomposed and presented in the right panel of Figure 14, Figure 15, Figure 16 and Figure 17. The left panel simply shows the log exchange rate values with no competing regimes.

5. Conclusion

This study investigated exchange rate behaviour towards major global anchor currencies and made use of the Markov-switching autoregressive process to decompose exchange rate behaviour into possible states/regimes. There seems to be a major preference for particular anchor currencies within different global regions,

re-enforcing the findings of Eichengreen (2011), with the Euro being predominantly preferred in Europe, some parts of Africa and Oceania. The US Dollar is preferred in the rest of the world, with strictly pegged regimes in the Gulf and the Middle East region, and the Caribbean, whose currencies exactly track the US Dollar, essentially eliminating volatility against this particular anchor currency. There is also evidence of some authorities preferring a 1:1 (Note 29) parity with their anchor currency of choice. From the results, it is evident that currencies like the British Pound and Japanese Yen have lost popularity over the years, especially with the emergence of the Euro and the unity that comes with it. Onto the Markov-switching results, the model was able to decompose the currency behaviour of 8 currencies into appreciating and depreciating regimes, and identified the key turning points in the exchange rate series, especially the 2008/2009 crisis period. However, the Markov model was not able to capture the Engel and Hamilton (1990) long swings phenomenon, with the exception of the Swiss Franc.

References

Adam, C., & Cobham, D. (2007). Exchange Rate Regimes and Trade. *Manchester School, 75***,** 44-63. https://doi.org/10.1111/j.1467-9957.2007.01037.x

Aghion, P., Bacchetta, P., & Banerjee, A. (2001). Currency crises and monetary policy in an economy with credit constraints. *European Economic Review, 45***,** 1121-1150. https://doi.org/10.1016/S0014-2921(00)00100-8

Aristotelous, K. (2001). Exchange-Rate Volatility, Exchange-Rate Regime, and Trade Volume: Evidence from the UK-US Export Function (1889-1999). *Economics Letters, 72***,** 87-94. https://doi.org/10.1016/S0165-1765(01)00414-1

Bacchetta, P., & Van Wincoop, E. (2000). Does Exchange-Rate Stability Increase Trade and Welfare? *American Economic Review, 90***,** 1093-1109. https://doi.org/10.1257/aer.90.5.1093

Baig, M. T. (2001). *Characterizing exchange rate regimes in post-crisis East Asia*. International Monetary Fund. https://doi.org/10.5089/9781451857092.001

Bayoumi, T., & Eichengreen, B. (1998). Exchange rate volatility and intervention: Implications of the theory of optimum currency areas. *Journal of International Economics, 45***,** 191-209. https://doi.org/10.1016/S0022-1996(98)00032-4

Bertola, G., & Svensson, L. E. O. (1993). Stochastic devaluation risk and the empirical fit of target-zone models. *The Review of Economic Studies, 60***,** 689-712. https://doi.org/10.2307/2298131

Bordo, M. D. (2003). Exchange rate regime choice in historical perspective. *National Bureau of Economic Research*. https://doi.org/10.3386/w9654

Calvo, G. A., & Mishkin, F. S. (2003). The mirage of exchange rate regimes for emerging market countries. *Journal of Economic Perspectives, 17***,** 99-118. https://doi.org/10.1257/089533003772034916

Calvo, G. A., & Reinhart, C. M. (2002). Fear of floating. *The Quarterly Journal of Economics, 117***,** 379-408. https://doi.org/10.1162/003355302753650274

Chang, R., & Velasco, A. (2000). Financial fragility and the exchange rate regime. *Journal of Economic Theory, 92***,** 1-34. https://doi.org/10.1006/jeth.1999.2621

Damill, M., Frenkel, R., & Rapetti, M. (2013). Financial and currency crises in Latin America. *The handbook of the Political Economy of Financial Crises*, 296.

Darby, M. R., Lothian, J. R., Gandolfi, A. E., Schwartz, A. J., & Stockman, A. C. (1983). *The international transmission of inflation*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226136431.001.0001

Despres, E., Kindleberger, C. P., & Salant, W. S. (1966). *The dollar and world liquidity: A minority view*. Brookings Institution.

Eichengreen, B. (2011). *Exorbitant Privilege: The rise and fall of the Dollar and the Future of the International Monetary System*. Oxford University Press.

Engel, C., & Hamilton, J. D. (1990). Long swings in the dollar: Are they in the data and do markets know it? *The American Economic Review***,** 689-713. https://doi.org/10.3386/w3165

Fleming, J. M. (1971). On exchange rate unification. *The economic Journal, 81***,** 467-488. https://doi.org/10.2307/2229844

Frankel, J., & Wei, S. J. (2008). Estimation of de facto exchange rate regimes: Synthesis of the techniques for

inferring flexibility and basket weights. *IMF Staff Papers, 55*, 384-416. https://doi.org/10.1057/imfsp.2008.18

Frankel, J. A., & Wei, S. J. (1994). Yen bloc or dollar bloc? Exchange rate policies of the East Asian economies. *Macroeconomic Linkage: Savings, Exchange Rates, and Capital Flows, NBER-EASE Volume 3.* University of Chicago Press.

Frankel, J. A. (1992). *Is Japan creating a yen bloc in East Asia and the Pacific?* National bureau of economic research. https://doi.org/10.3386/w4050

Frankel, J. A. (1999). *No single currency regime is right for all countries or at all times*. National Bureau of Economic Research. https://doi.org/10.3386/w7338

Ghosh, A. R., Gulde, A. M., Ostry, J. D., & Wolf, H. C. (1997). *Does the nominal exchange rate regime matter?* National Bureau of Economic Research. https://doi.org/10.3386/w5874

Ghosh, A. R., Ostry, J. D., & Qureshi, M. S. (2015). Exchange rate management and crisis susceptibility: A reassessment. *IMF Economic Review, 63*, 238-276. https://doi.org/10.1057/imfer.2014.29

Haile, F. D., & Pozo, S. (2006). Exchange rate regimes and currency crises: an evaluation using extreme value theory. *Review of International Economics, 14*, 554-570. https://doi.org/10.1111/j.1467-9396.2006.00643.x

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the Econometric Society*, 357-384. https://doi.org/10.2307/1912559

Hamilton, J. D. (1990). Analysis of time series subject to changes in regime. *Journal of Econometrics, 45*, 39-70. https://doi.org/10.1016/0304-4076(90)90093-9

Hamilton, J. D. (1994). *Time Series Analysis*. Princeton, NJ: Princeton University Press. https://doi.org/10.1515/9780691218632

Hurley, M., Mccormack, P., & O'brien, S. (1993). The Optimum Level of Reserves in an Exchange Rate Target Zone. *Economic and Social Review, 25*, 95-107.

Ilzetzki, E., Reinhart, C. M., & Rogoff, K. S. (2017). Exchange arrangements entering the 21st century: Which anchor will hold? National Bureau of Economic Research. https://doi.org/10.3386/w23134

Kawai, M., & Akiyama, S. (1998). The role of nominal anchor currencies in exchange rate arrangements. *Journal of the Japanese and International Economies, 12,* 334-387. https://doi.org/10.1006/jjie.1998.0419

Kenen, P. B., & Rodrik, D. (1986). Measuring and Analyzing the Effects of Short-term Volatility in Real Exchange Rates. *Review of Economics and Statistics, 68*, 311-315. https://doi.org/10.2307/1925511

Kim, C. J. (1994). Dynamic linear models with Markov-switching. *Journal of Econometrics, 60*, 1-22. https://doi.org/10.1016/0304-4076(94)90036-1

Klein, M. W., & Shambaugh, J. C. (2012). *Exchange rate regimes in the modern era*. MIT Press.

Krolzig, H. M. (2013). *Markov-switching vector autoregressions: Modelling, statistical inference, and application to business cycle analysis*, Springer Science & Business Media.

Krugman, P. R. (1991). Target Zones and Exchange Rate Dynamics. *The Quarterly Journal of Economics, 106*, 669-682. https://doi.org/10.2307/2937922

Levy-Yeyati, E., & Sturzenegger, F. (2005). Classifying exchange rate regimes: Deeds vs. words. *European Economic Review, 49*, 1603-1635. https://doi.org/10.1016/j.euroecorev.2004.01.001

Levy-Yeyati, E. L., & Sturzenegger, F. (2016). Classifying exchange rate regimes: 15 years later. https://doi.org/10.2139/ssrn.2820762

Mckinnon, R. I. (2000). The East Asian dollar standard, life after death? *Economic Notes, 29*, 31-82. https://doi.org/10.1111/1468-0300.00024

Mishkin, F. S. (2004). Can Inflation Targeting Work in Emerging Market Countries? National Bureau of Economic Research, Inc. *NBER Working Papers: 10646*. https://doi.org/10.3386/w10646

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review, 51*, 657-665.

Mussa, M. (1986). Nominal exchange rate regimes and the behavior of real exchange rates: Evidence and implications (pp. 117-214). https://doi.org/10.1016/0167-2231(86)90039-4

Obstfeld, M., & Rogoff, K. (1995). The mirage of fixed exchange rates. *Journal of Economic Perspectives, 9*,

73-96. https://doi.org/10.1257/jep.9.4.73

Ohno, K. (1999). Exchange rate management in developing Asia: Reassessment of the pre-crisis soft dollar zone. *ADBI Research Paper Series.*

Reinhart, C. M., & Rogoff, K. S. (2004). The modern history of exchange rate arrangements: A reinterpretation. *the Quarterly Journal of Economics, 119***,** 1-48. https://doi.org/10.1162/003355304772839515

Ricci, L. A. (2008). A model of an optimum currency area. *Economics: The Open-Access, Open-Assessment E-Journal, 2*, 8. https://doi.org/10.5018/economics-ejournal.ja.2008-8

Rose, A. K. (2000). One money, one market: The effect of common currencies on trade. *Economic Policy, 15*. https://doi.org/10.1111/1468-0327.00056

Schnabl, G. (2003). De jure versus de facto Exchange Rate Stabilization in Central and Eastern Europe. *Tuebingen University Economics & Business Administration Working Paper*. https://doi.org/10.2139/ssrn.464082

Shambaugh, J. C. (2004). The effect of fixed exchange rates on monetary policy. *The Quarterly Journal of Economics, 119***,** 301-352. https://doi.org/10.1162/003355304772839605

Svensson, L. E. O. (1992). An Interpretation of Recent Research on Exchange Rate Target Zones. *The Journal of Economic Perspectives, 6***,** 119-144. https://doi.org/10.1257/jep.6.4.119

Notes

Note 1. The European Monetary Fund was also established to provide credit to members experiencing balance of payment problems.

Note 2. See Kawai and Akiyama (1998), The Role of Nominal Anchor Currencies in Exchange Rate Arrangements, the paper covers the evolution of exchange rate arrangements of almost all countries in the world over the period 1970-1996.

Note 3. In the words of Levy-Yeyati and Sturzenegger (2016), flexible exchange rates are characterized by little intervention in the exchange rate markets together with unlimited volatility of the nominal exchange rate. Conversely, a fixed exchange rate regime occurs when the exchange rate does not move while reserves are allowed to fluctuate. Under a crawling peg, changes in the nominal exchange rates occur with stable increments (i.e., low volatility in the rate of change of the exchange rate) while active intervention keeps the exchange rate along that path. Finally, a dirty float should be associated to the case in which volatility is relatively high across all variables, with intervention only partially smoothing exchange rate fluctuations.

Note 4. Bulgaria, Estonia, Lithuania, and Latvia.

Note 5. The Czech Republic, Slovenia, and Slovakia.

Note 6. See also Klein and Shambaugh (2010), Exchange Rate Regimes in the Modern Era.

Note 7. Its role has even expanded further after the collapse of the Ruble zone, the Ruble zone emerged after the collapse of the Soviet Union in December 1999. The countries that emerged formed some kind of currency union where they all used the Ruble as their primary currency. The influence of the US Dollar has expanded further to the Middle East over the years.

Note 8. Ilzetzki et al. (2017) also state in their paper that from the early 1980s until the introduction of the Euro, the German Deutsche Mark sphere expanded, first in Western Europe and later in the East. The Euro inherited the German Deutsche Mark and French Franc zones (the French Franc zone included the current eight West African states that use the West African CFA Franc currency that was tightly pegged to the French Franc).

Note 9. There seems to be a declining share of Europe in the world output today, weakening the role of the Euro.

Note 10. The basic model is, $s = m + v + \gamma E[ds]/dt$; where s is the log of the nominal exchange rate, m the domestic money supply, v represents the velocity shocks and the last term is the expected rate of depreciation. The two fundamentals in the equation are money supply and the velocity shift. Velocity is assumed to be a Brownian motion without drift, that is, the realised sample paths are continuous over time with no discrete jumps. This implies that the free-float exchange rates behave like random walks. It should be noted that m is shifted only in order to defend the target zone, therefore preventing s from exceeding some predetermined maximum value. Svensson (1992) gives a detailed explanation.

Note 11. This econometric model describes the inverse relationship between inflation and unemployment; a

decrease in unemployment correlates with higher rates of wage rises/inflation.

Note 12. The model was developed within the IS-LM-FE framework.

Note 13. This is a measure of how responsive international prices are to changes in exchange rates. If the degree of pass-through is large, then there is a high probability of transmission of inflation between countries.

Note 14. The variables that determine the regime employed by a country as predicted by the OCA are asymmetric output disturbances, trade linkages, the usefulness of money for domestic transactions, and the extent of labour mobility.

Note 15. In what is referred to as Black Wednesday in Britain, George Soros, a currency trader, made an estimated $1 billion in profit after a timely and brave bet against the Sterling and Bank of England in 1992. When Britain joined the ERM, the rate was set at 2.95 DM per Sterling, allowing a flexibility of about 6% on either side. The economy was not doing well compared to the German economy with the inflation rate three times that of Germany, setting the stage for a burst period. Traders took advantage of this and started short selling the Sterling. This forced Britain to withdraw from the ERM because the Sterling value fell below the lower limit specified by the ERM.

Note 16. Other criterion to adopt the Euro as a sole currency include among others; countries are required to maintain their public debt as a percentage of GDP and GDP growth at 60% and 3% respectively, hold nominal long-term interest rate in the preceding year that did not exceed 2% of the three most stable price-stable members, and run an inflation rate over the preceding year that did not exceed that of the three lowest inflation member states by more than 1.5%. These are all outlined in the Stability and Growth Pact (SGP). These conditions were agreed upon by all the European Union member states.

Note 17. The crisis economies were Indonesia, Korea, Malaysia, Philippines, and Thailand. It is important to note that the economies of Hong Kong, Singapore and Taiwan pegged their currencies to the Dollar but were not hit hard by the 1997 Asian crisis.

Note 18. Ohno (1999) states that many Asian countries were priced out of international competition by pegging their currencies to the US Dollar which appreciated greatly during 1995-1997. This meant that some currencies were overvalued in the period leading up to the Asian crisis of 1997.

Note 19. Extreme Value Theory (EVT) is useful in dealing with the statistical modelling of rare or extreme events. It has widely been used in other disciplines like engineering, earth sciences, traffic prediction and biology. For instance, it can be used to estimate the probability that an earthquake or flood may occur over a specified period of time, say a 50-year period.

Note 20. Their incorporation of the behaviour of reserves goes a step further from the Reinhart and Rogoff (2004) study that classifies regimes based on the degree of exchange rate variability.

Note 21. Reserves may change due to expenditure on foreign assets, foreign aid or purchase of certain plant and equipment by governments, like arms.

Note 22. This is an extension of the Reinhart and Rogoff (2004) classification that introduces classification based on the anchor/reference currencies, inflation targeting cases and treatment criteria for Eurozone countries.

Note 23. SDR refers to an international type of monetary reserve currency created by the IMF in 1969 that operates as a supplement to existing money reserves of member countries. It was created as a result of concerns raised about the limitations of gold and the US Dollar as the sole means of settling international accounts. The SDR generally reflects the importance of a currency in the world's trading and financial system. There are weights attached to each of the 5 currencies included in the SDR basket, with the US Dollar having the highest, and the British Pound the least at the time of writing this document.

Note 24. A haven is an investment that usually retains or increases in value during times of market turbulence, and thus, limit an investor's exposure to losses in times of market downturns and high volatility periods, including crises. Other haven investments include gold, treasury bills and cash, just to mention but a few.

Note 25. Engel and Hamilton (1990) define long swings as a situation in which the value of a currency increases in one direction over long periods of time.

Note 26. Estimates probabilities of the states at each time period using previous and contemporaneous data by using the nonlinear filter.

Note 27. Estimates probabilities of the states at each time period using all sample data by using the smoothing algorithm.

Note 28. Estimates probabilities of the states at each time period using previous information on the dependent variable.

Note 29. This includes currencies like the Bahamian and Barbadian Dollars that clearly indicate a 1:1 parity against the US Dollar.

Note 30. Shapiro-Wilk, W test, H_o: normality.

Note 31. Breusch-Godfrey, LM test, H_o: no serial correlation.

Note 32. ARCH, LM test, H_o: no ARCH effects.