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**DE FACTO CLASSIFICATION OF
MONETARY REGIMES**

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ABSTRACT

In the field of research on monetary policies, there is often uncertainty about which regime each Central Bank is carrying out and whether they truly implement what they claim to do. This investigation aims to propose a classification of monetary regimes based upon members' actual, *de facto*, arrangements that may differ from the officially announced. Contrasting the *de jure* regimes -built upon what countries declare to be running- from the *de facto* -based on what actually happens- leads to a more accurate classification of monetary regimes implemented by countries in practice. The methodology employed is based on the use of cluster analysis that groups cases according to similarities in the behavior of the three variables of reference: nominal exchange rate, interest rate, and the monetary base. The study attempts to generate useful information for those who study the implications of the different regimes by exposing clearly what countries have been doing in terms of monetary policy. The following thesis will be limited on building a classification and describing the most apparent trends that took place during the past forty-six years. However, on average, evidence supports that inflation targeting and exchange rate monetary regimes are the most employed ones.

INTRODUCTION

Monetary policy regimes embody the constraints imposed by economic nature and the self-enforced limits by institutions on the monetary authorities' ability to influence the evolution of macroeconomic aggregates¹. The essence relies on how each country's Central Bank can impact the money supply and demand markets by using different variables. Throughout the years, it has been shown that there are three possible directions or structures that could be employed when it comes to determining monetary policies; these could be condensed as (i) fixing the monetary base, (ii) controlling the exchange rate, and (iii) establishing an inflation targeting regime -achieved by fixing the interest rate-. For the purpose of this investigation, the behavior of the three monetary instruments will be analyzed, aiming to observe and determine how authorities interact with them. Understanding how these three variables can impact the money supply and demand markets is essential to this study's intent.

The Central Bank can manipulate the monetary base through monetary emissions or by performing open market transactions -buying and selling government bonds that impact the money multiplier- and, therefore, the money supply in the economy. The monetary base comprises the circulating currency and the bank reserves, making the banking system have a strained relationship regarding reserve requirements set by monetary authorities. Consequently, whenever a Central Bank manipulates the money supply in an economy, the nominal interest rate -which can also be understood as the opportunity cost of holding money- will also change. Whenever there is a surplus of money, the interest rates will tend to decrease by definition due to the greater supply of money relative to an unchanged demand. To get players in the economy to be willing to hold the extra money, the interest rate must decrease. Conversely, when there is a shortage of money supply in the economy, the interest rate will tend to increase to discourage pressure on the money demand. It is relevant to highlight the fact that the monetary base does not include non-cash assets, such as demand deposits, time deposits, or checks.

The second mechanism through which monetary authorities can impact the economy is the exchange rate regimes that rule in each country. These can be classified into four categories

¹ Michael D. Bordo, Anna J. Schwz. "Monetary Policy Regimes and economic performance: The Historical Record". September, 1997

based on the level of intervention on the market and its nominal exchange rate volatility. Fixed exchange rate regimes limit a central bank's ability to adjust interest rates as needed for economic growth and require a large pool of reserves to support the currency when it is under pressure. These types of regimes occur when the exchange rate does not move, but the reserves are allowed to fluctuate. On the contrary, flexible exchange rates are distinguished for having very little intervention in the market, while allowing the nominal exchange rate to be extremely volatile if needed. The crawling peg regime refers to a system where a band of rates is established and currency is allowed to fluctuate within them, therefore granting low volatility in the rate of change of the exchange rate. The band of rates may be adjusted frequently, especially in times of high exchange rate volatility. Lastly, a dirty float regime occurs when volatility is particularly high across all variables and the Central Bank intervenes partially to change the direction or the pace of change of a country's currency value.

Inflation Targeting is the name given to the monetary policy that occurs when monetary authorities follow a specific inflation rate target for the medium-term -which is announced to the public- and adjust the interest rate to achieve it. The logic behind this convention suggests that raising interest rates usually cools the economy to hold inflation while lowering interest rates generally accelerates the economy, thus boosting inflation. The popular method through which one can determine whether a certain country has performed inflation targeting is by looking at the stability in the evolution of its interest rates: the highest the volatility, the most likely IT is taking place. Targeting locks in expectations of low inflation, which reduces the inflationary impact of macroeconomic shocks². The inflation targeting model has become increasingly popular in academia and policy making over the last decades, making it usually believed to be the most efficient mechanism to increase the Central Bank's credibility and transparency in countries with weak and uncertain institutions.

The objective of this investigation is to propose a classification of monetary regimes employed by all countries around the world so that trends can be constructed and analyzed, aiming to determine, if possible, what regime has been the most popular throughout the years and which one the most effective in that same studied period. The motivation to study the classification of monetary regimes originated while reading the *De facto classification of*

² Laurence M. Ball, Niamh Sheridan. "Does inflation targeting matter?" December, 2004.

exchange rate regimes published in 2003 by Sturzenegger & Levy-Yeyati.³ Acknowledging the existence of a substantial discrepancy between what countries declare to run as exchange rate regimes and what they actually end up doing has triggered a desire to study and elaborate a classification in order to determine whether the same phenomenon takes place in the monetary regimes as well. This is why a deep analysis of the evolution of the monetary base, nominal interest rate and exchange rate regimes has been conducted and processed.



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³ Sturzenegger, F., & Levy-Yeyati, E. (2003, September). A de facto Classification of Exchange Rate Regimes: A Methodological Note. Federico Sturzenegger.

LITERATURE REVIEW

Economists have long sought the ideal framework for monetary policy aiming to contribute to the nominal stability of macroeconomic variables. The primary duty of monetary authorities should be to grant a transparent and clear framework that promotes favorable conditions for economic development and growth. This is why extensive literature can be found describing the analysis and evolution of monetary regimes throughout history.

Since the early 1990s, many economists have believed they had finally found the optimum monetary policy approach: inflation targeting (IT). The performance of this regime seems to have significantly reduced both the rate of inflation and inflation expectations beyond what would have likely occurred in the absence of inflation targeting (Mishkin 1999). Data collected by Ball and Sheridan (2004) shows that not only inflation targeting has been reduced since the implementation of IT, but that it has been the most stable than in recent decades. Targeting locks in expectations of low inflation, which reduces the inflationary impact of macro-economic shocks. For these reasons, many economists advocate inflation targeting as the most effective policy for the Federal Reserve and the European Central Bank⁴.

The paper published in 2004 by Ball and Sheridan's, "Does inflation targeting matter?" attempts to measure the effects of inflation targeting on macroeconomic performance. A sample of twenty countries from OECD was elaborated, where countries were divided into "targeters" (countries that implemented IT) and "non-targeters" (countries that did not implement IT). Surprisingly, the outcome suggests that there is not enough empirical information to support that macroeconomic aggregates' improvements result from implementing IT. Examining inflation targeting countries alone demonstrates that, on average, they improved between the period before and after the targeting period. However, countries that did not adopt inflation also experienced improvements in the same time period studied. Hence, the authors conclude that there is no enough empirical information to support that the better performance resulted from targeting.

⁴ Laurence M. Ball, Niamh Sheridan. "Does inflation targeting matter?" December, 2004.

Calvo Reinhart's work (2002) focuses on observing the classification of exchange rate regimes worldwide. Throughout the paper, he alleges that several countries that have declared floating exchange rates had actually been intervening in the money supply or manipulating the economy's interest rate. In conclusion, his study entails that there might be a difference between the announced, *de jure*, monetary policy stated in the IMF and the *de facto* exchange rate regimes. This literature supports that the table of results presented in appendix I -built upon the *de facto* reports- was elaborated with reliable data.

In addition to Calvo Reinhart (2002), Roberto Chang and Andres Velasco expand on exchange rate regimes' evolution in the paper "Exchange-Rate Policy for Developing countries." The authors observe that a transition from fixed exchange rates to flexible ones has been taking place simultaneously to inflation rates falling sharply. According to the IMF, in the mid-1970s, approximately 85% of the countries employed pegged exchange rate regimes. Nevertheless, this number has declined abruptly in the following decades as most countries began to adopt flexible or floating exchange rates. Chang and Velasco (2000) explain that the question nowadays has shifted from "to float or not to float" to "how to float." A possible explanation to this variation in the trend could be adjudicated to the banking and financial crisis: "Recent crisis not only caused several exchange-rate pegs to be abandoned but they also strongly showed that currency collapses were closely associated with the fragility of the financial sector" (Chang and Velasco, 2000).

On the other hand, the classification and evolution of monetary-based regimes have scarcely attracted any consideration. Consequently, there is very little literature available on the evolution of this instrument throughout the years. Mishkin examines monetary policy changes by increasing transparency and accountability and expands on how countries have shifted from monetary targeting into inflation targeting regimes (Mishkin, 2001). Additionally, Roger graphically portrays the evolution of countries adopting this regime from 1989 to 2008. As a result, he concludes that there is a pattern in which industrialized countries' tend to zero. In contrast, in non-industrialized countries, a few percent continue to adopt monetary targeting policies. Mishkin's contribution is consistent with the results presented in *Graph 1: evolution of monetary regimes throughout the years*, where it can be inferred that policies that target monetary base have had the lowest percentage of implementation and a decreasing trend throughout the years.

Finally, David Cobham analyses the classification of monetary policy frameworks focusing on "advanced" and "emerging" economies since the end of the Bretton Woods international monetary system (Cobham, 2018). He investigates the conditions and instruments available to monetary authorities and the implementation of different policy frameworks. The focal point of his classification relies on monetary authorities' objectives and the extent to which they are attained. The author's classification is based on six main categories, which include: the behavior of monetary authorities, the nature of the monetary instruments that are being targeted, how precise that target is, and whether it is stationary or converging. The classification considers both pre-announced targets for exchange rates, monetary aggregates, inflation, and the realized values of these and other indicators (Cobham, 2018). The IMF Article IV reports were used to obtain information on the aims and objectives of the monetary authorities as well as the final stated outcome.

Public confidence and credibility in monetary authorities and institutions play a crucial role when it comes to executing a successful monetary policy. Decisions on investments, prices, and future demands are based on expectations, which are substantial for stabilizing financial markets. Inadequate confidence in the monetary policies that are being implemented may result in higher inflation expectations and elevated costs, altering the economy's efficiency. Consequently, exemplifying the *de facto* monetary policies for countries worldwide will contribute to greater transparency and reliability. This work aims to construct a new classification based on the IMF's *de facto* reports by adopting the cluster analysis methodology. Literature that investigates the evolution of monetary regimes has been reviewed to corroborate the consistency of the classification proposed. The papers previously cited expand upon the evolution of the trends and validate that the results presented in *Graph I: the evolution of monetary regimes throughout the years* are coherent. The most apparent tendency shows that exchange rate regimes were once the most employed but then declined over time, while inflation targeting escalated consistently since the early 1990s and has gained more strength and approval throughout the years. In addition, monetary regimes that focus on controlling the monetary base present the lowest implementation rates and are in continuous decay. Moreover, the classification method, cluster analysis, is based on statistical data, resulting in a very precise and accurate work. Countries will be classified according to their real monetary practices. By providing new information on what is already available, the intent is to contribute significant input to researchers on this field.

METHODOLOGY

Database Elaboration

To begin with, a database was created using the information published in the International Financial Statistics. The IFS is based on various IMF data collection: it includes series for all Fund member countries plus Anguilla, Aruba, China, P. R.: Hong Kong, China, P.R.: Macao, Montserrat and the Netherlands Antilles. The time period used was established from 1973 until 2018, considering the end of the Bretton Woods Agreement.⁵

Data was compiled for every country during each month along the predetermined period, and afterward, the standard deviation for every correspondent year was calculated. The intention was to acknowledge whether there had been a variation in any of the three variables. To compute this database, the appropriate indicator for each variable had to be found. For the interest rate, the *Interest Rates, Deposit, Percent per annum* indicator was used, and for the exchange rate, *Exchange Rates, National Currency per US Dollar*⁶, *Rate* was used. After the information was downloaded, a *Log* transformation was applied in order to reduce skewness.

On the other hand, identifying the monetary base was more strenuous considering there have been methodological changes in the way of expressing this variable in the reports. The International Monetary Fund (IMF) introduced the Standardized Report Forms (SRF), a unified criterion for countries reporting their monetary and financial statistics to the IMF.⁷ The SRF allows for cross-country harmonization of data sources and methodology for the compilation and presentation of statistics transparently and consistently. According to the functions performed by the Central Banks and whether some policy issues are delegated to the central government or not, there are two types of indicators for the monetary base. These categories are SRF countries -standardized reported form- and non-SRF countries

⁵ Since the collapse of the Bretton Woods system, IMF members have been free to choose any form of exchange arrangement they wish (except pegging their currency to gold): allowing the currency to float freely, pegging it to another currency or a basket of currencies, adopting the currency of another country, participating in a currency bloc, or forming part of a monetary union.

⁶ For those countries that use the US as their domestic currency, Exchange Rates, Domestic currency per Euro, Rate were used.

⁷ The majority of the countries use the standardized report forms (SRFs) to report monetary data to the IMG and are presented under SRF countries. The old presentation is used for those countries that do not use the SRFs for reporting monetary data and are presented under non-SRF countries. The presentation of these countries will be changed to the new presentation when the countries implement the reporting of SRF-based data.

-non-standardized reported form-⁸. Countries that use the SRF method express their monetary base as Monetary Base⁹, while those that are non-SRF express it under the indicator Reserve Money¹⁰. Acknowledging that the indicators could change, the information had to be cross-checked yearly for each country.

Once the data observation for all variables was allocated to each month, the yearly standard deviation was calculated. This is how each country ended up having a specific standard deviation value assigned for each one of the three variables analyzed (ER, IR, MB). Finally, a new database that compiled these processed observations was created and employed to construct the clusters.



⁸ Appendix 1

⁹ The code for this indicator in the IFS is FASMB_XDC

¹⁰ The code for this indicator in the IFS is 14_XDC

Cluster Analysis

Clustering methods are useful whenever the researcher is interested in grouping together objects based on multivariate similarity. This procedure is often employed as a data exploration, hypothesis testing, and confirmation tool. The methodology consists of processing grouping objects into subsets that have meaning in the context of a particular problem. Observations are assigned to groups -known as clusters- so that observations within each group are similar to one another concerning variables of interest.

Two types of cluster algorithms can be employed; these include: non-hierarchical and hierarchical. Hierarchical clustering repeatedly links pairs of clusters until every data object is included in the hierarchy. These clusters are known to develop a tree-like structure, which can be agglomerative or divisive. On the other hand, in non-hierarchical clusters, such as the k-means algorithm, the relationship between clusters is undetermined.

With both approaches, an important matter is determining the similarity between objects so that clusters can be formed from observations with high similarity to each other. Commonly, distance functions such as the Manhattan and Euclidean distance are used to determine similarity. A distance function yields a higher value for pairs of objects that are less similar to one another.

There is a large variety of methods through which cluster analysis can be performed, but for this investigation, the K-Means approach is the one that adequates the most due to the fact that it requires minimal manipulation of the classification criteria.

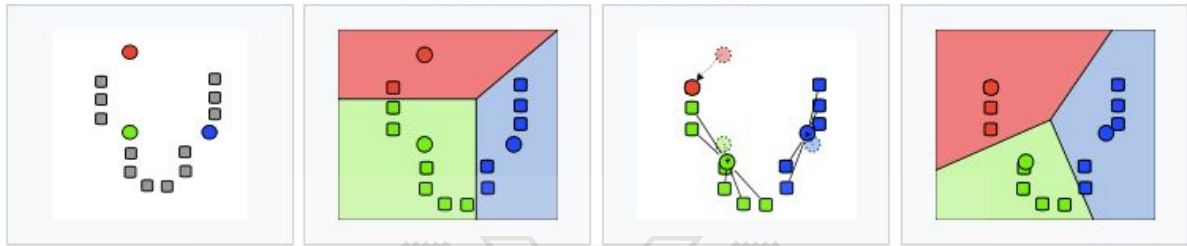
K-Means Clustering

K-means cluster analysis is an example of a non-hierarchical clustering method that requires the least intervention from the researcher and aims to partition n observations into k clusters.

The first and main step to begin this analysis is the definition of the number of clusters to be generated by the algorithm, while letting cluster centers (centroids) be iteratively estimated from the data. Each observation should belong to the cluster with the nearest mean, taking into account that if an observation is nearer the centroid of a cluster other than the one it

currently belongs, it should be reassigned. This process should be repeated until all the observations are nearest the centroid of the cluster to which they belong.

In the clustering algorithm, K means are generated within the data, which is shown in the coloured circles. As previously mentioned, clusters are created by associating every observation to the nearest mean. The centroid of each cluster will become the new mean and these steps will be repeated until the convergence is reached.



Given a current set of means $\{m_1, \dots, m_k\}$ is minimized by assigning each observation to the closest (current) cluster mean (Hastie, Tibshirani, & Friedman, 2008). That is,

$$C(i) = \|x_i - \bar{x}_k\|^2$$

K-means clustering is intended for situations in which all variables are of the quantitative type, and squared Euclidean distance is chosen as the dissimilarity criterion:

$$d(x_i, x'_i) = \sum_{j=1}^p (x_{ij} - x'_{ij})^2 = \|x_i - x'_i\|^2$$

The Euclidean distance between two points is the length of a line segment between the two points. In three dimensions, for points given by their Cartesian coordinates, the distance is

$$d(p, q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + (p_3 - q_3)^2}$$

Each observation is uniquely labeled by an integer $i \in \{1, \dots, N\}$. A prespecified number of clusters $K < N$ is postulated, and each one is labeled by an integer $k \in \{1, \dots, K\}$. Each

observation is assigned to one and only one cluster. Moreover, the clustering method seeks to group the data points based on a specific similarity.

This criterion characterizes the extent to which observations assigned to the same cluster tend to be close to one another. It is sometimes referred to as the “within cluster” point scatter. (Hastie, Tibshirani, & Friedman, 2008)

The within-point scatter can be written as

$$W(C) = \frac{1}{2} \sum_{k=1}^K \sum_{(i)=k} \sum_{C(i)=k} \|x_i - x_{i'}\|^2$$

$$= \sum_{k=1}^K N_k \sum_{C(i)=k} \|x_i - \bar{x}_k\|^2$$

$x_k = (\bar{x}_{1k}, \dots, \bar{x}_{pk})$ is the mean vector associated with the k th cluster and $N_k = \sum_{i=1}^N I(C(i) = k)$.

This criterion can be minimized by assigning the n observations to the k clusters in such a way that the association of cluster points within each cluster minimizes the average dissimilarity of observations. A measure of the variability of the observations within each cluster is the Within-cluster Sum of Squares. The sum of squares becomes larger as the number of observations expands. In general, a cluster that has a small WCSS is more compact than a cluster that has a large WCSS. Clusters with higher values show greater variability within the cluster in the observations.

Classification of Variables

The monetary policy framework is classified as follows:

Exchange rate anchor:

The monetary authority buys or sells foreign currencies to maintain the exchange rate at a predetermined point. Therefore, the exchange rate serves as the nominal anchor of monetary policy. These systems can adopt the following structures: no separate legal tender, agreements for the currency board, pegs related to bands, stabilized arrangements, independently floating, or other managed arrangements.

Monetary aggregate target:

The monetary authority uses its resources to reach the target growth rate for a monetary aggregate, such as reserve money (M1 or M2). Therefore, the targeted aggregate becomes the nominal anchor or intermediate target of monetary policy.

Inflation-targeting framework:

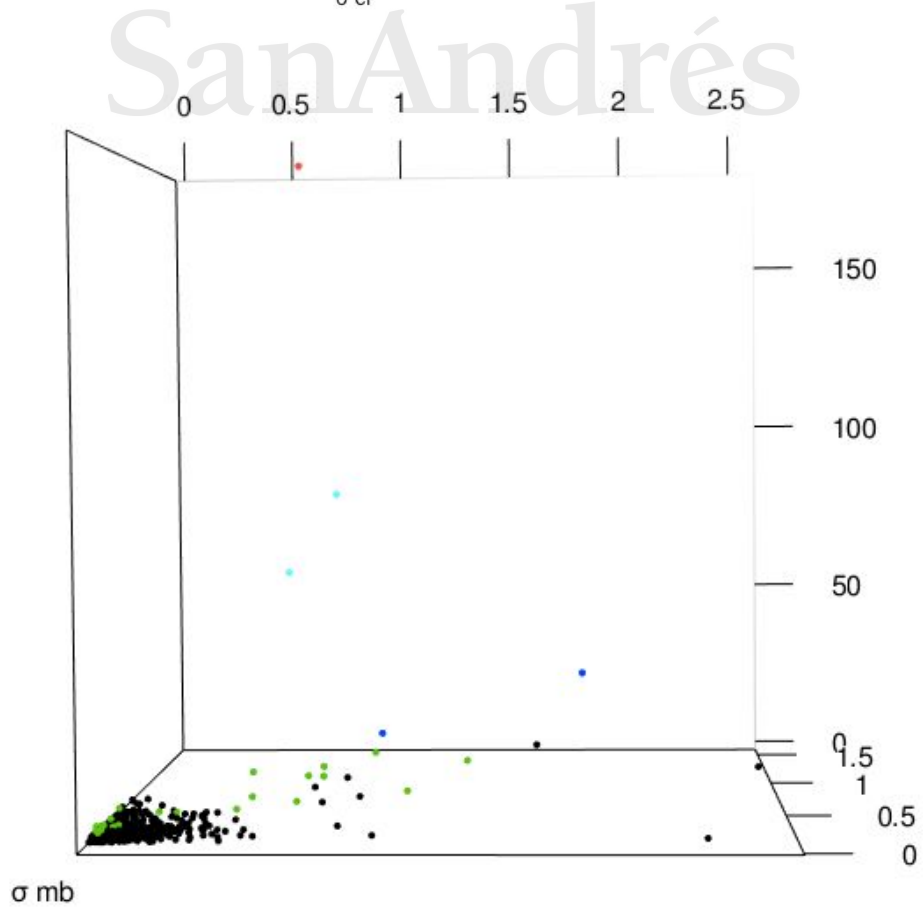
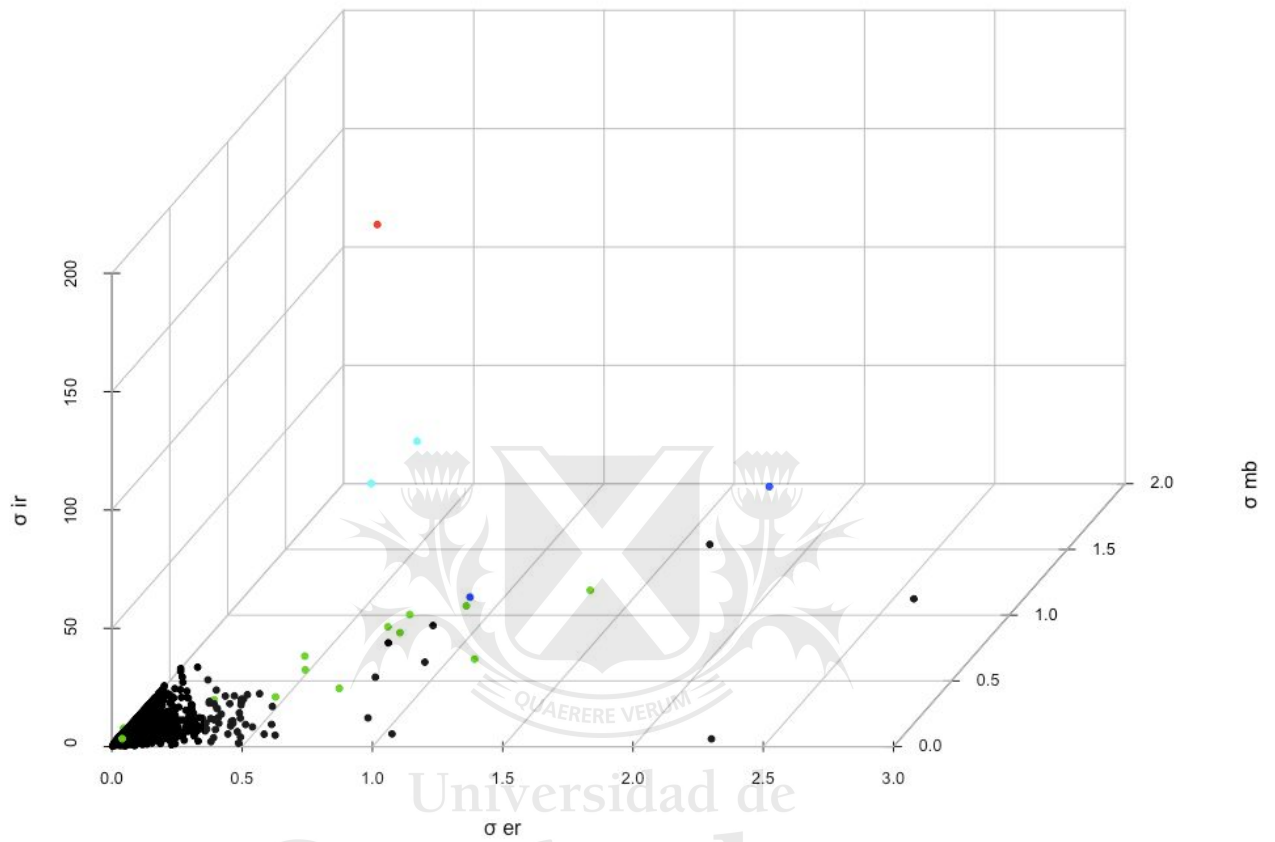
It includes the public declaration of numerical inflation targets, usually over a medium-term period in which monetary authorities are committed to achieving such aims. Certain main features usually include increased contact with the public and markets about monetary policymakers' intentions and priorities and increased central bank transparency for achieving its inflation targets. Monetary policy decisions are often guided by the deviation of future inflation forecasts from the announced inflation target, with the inflation forecast acting, implicitly or explicitly, as the intermediate target of monetary policy (International Monetary Fund, 2019). Monetary policy decisions are frequently driven by deviating potential inflation projections from the stated inflation target, with the inflation projection acting (implicitly or explicitly) as the monetary policy's intermediate goal.

Unclassified

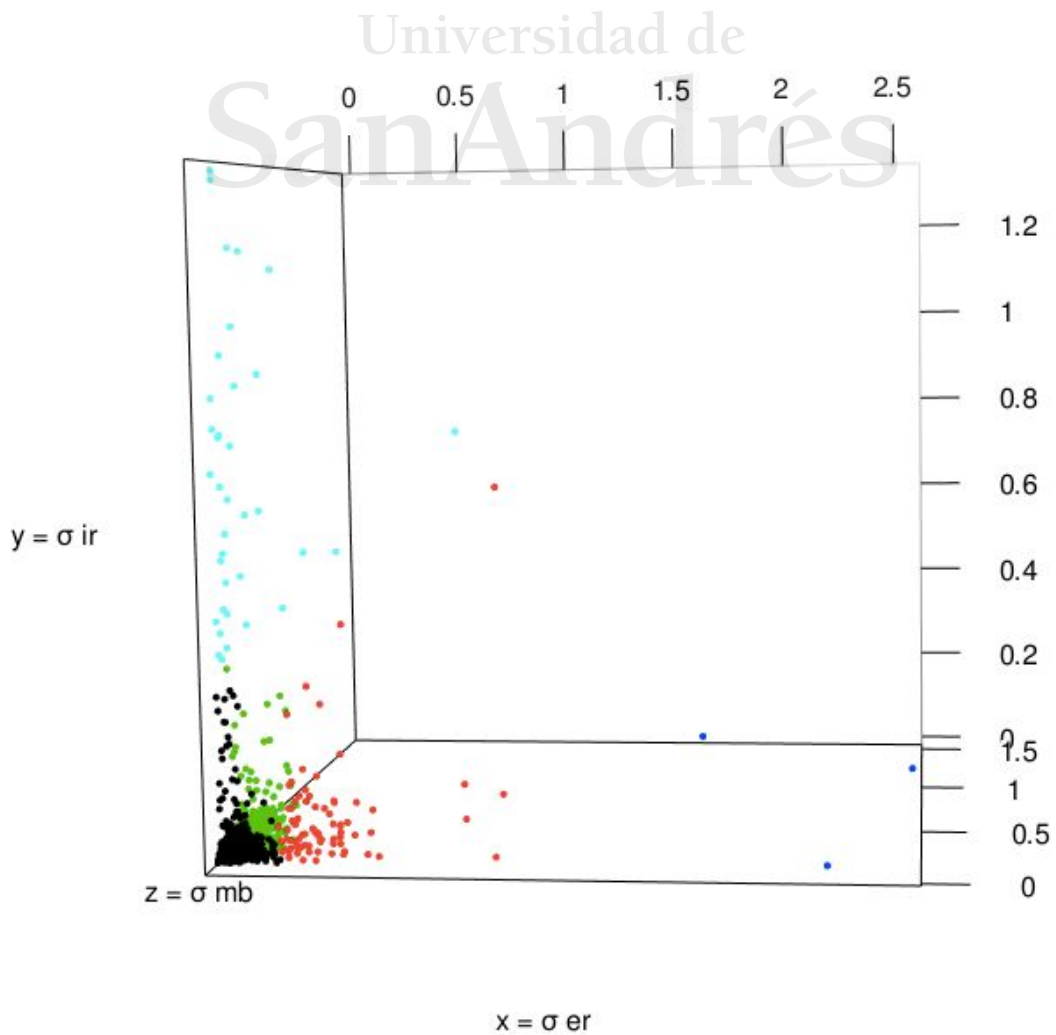
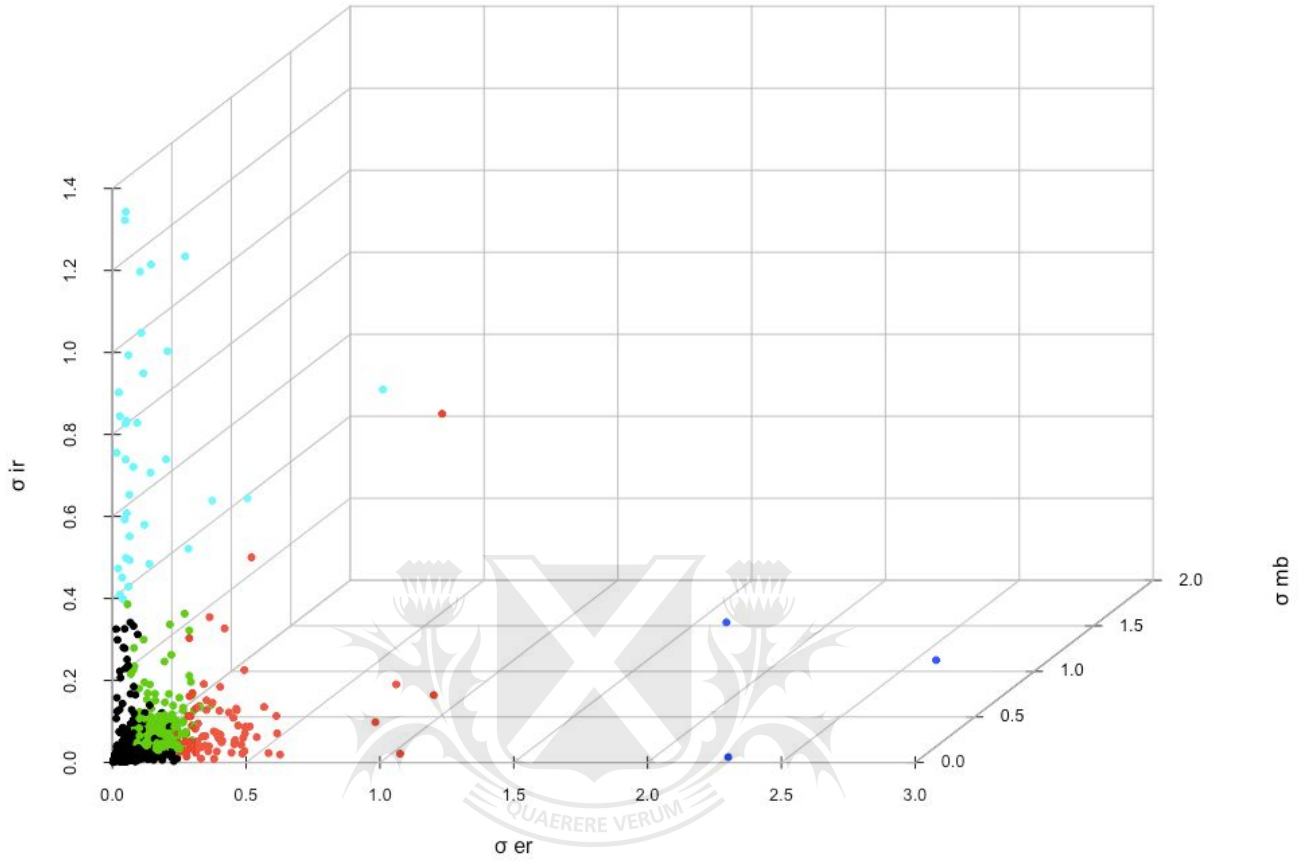
The country has no explicitly stated monetary policy; rather, it monitors various indicators in conducting monetary policy. This category is also used when information on one of the three variables for the country is not available.

Clustering Results

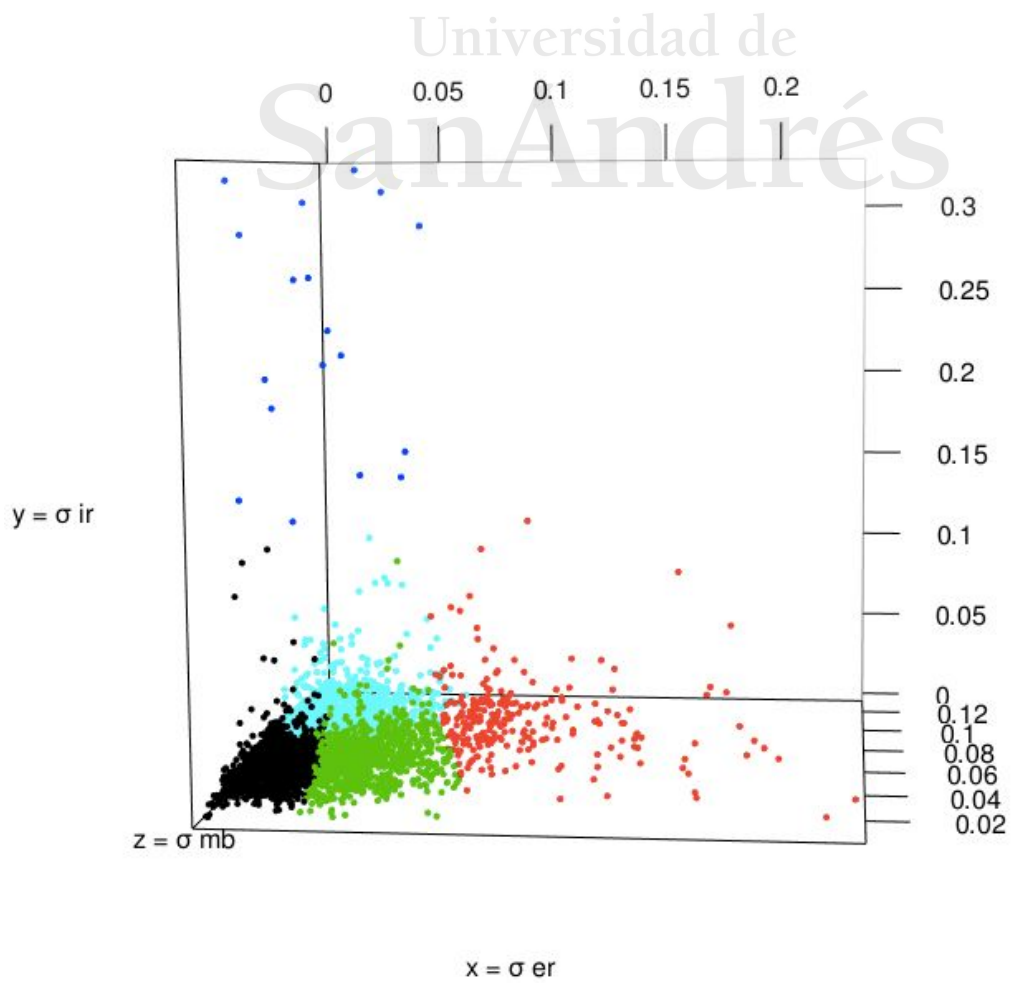
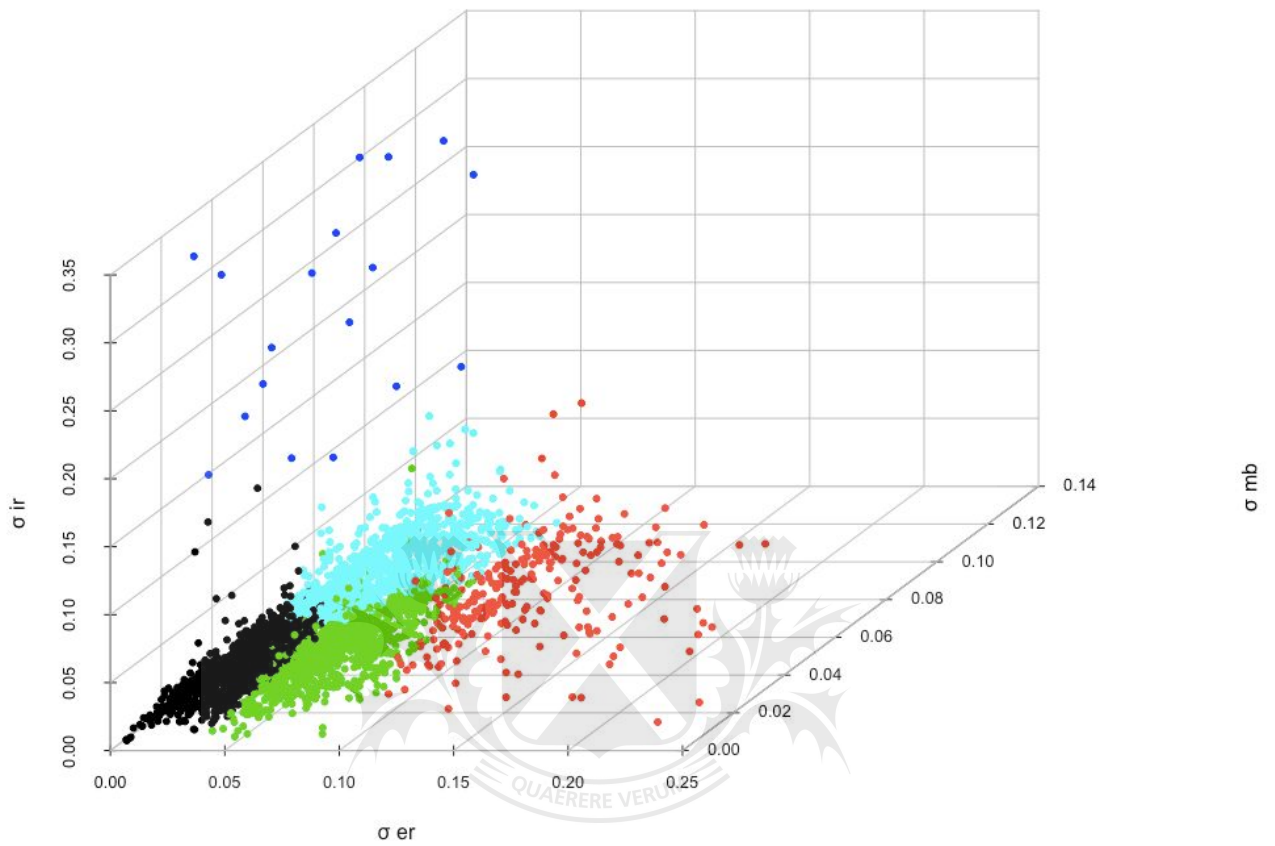
First Stage



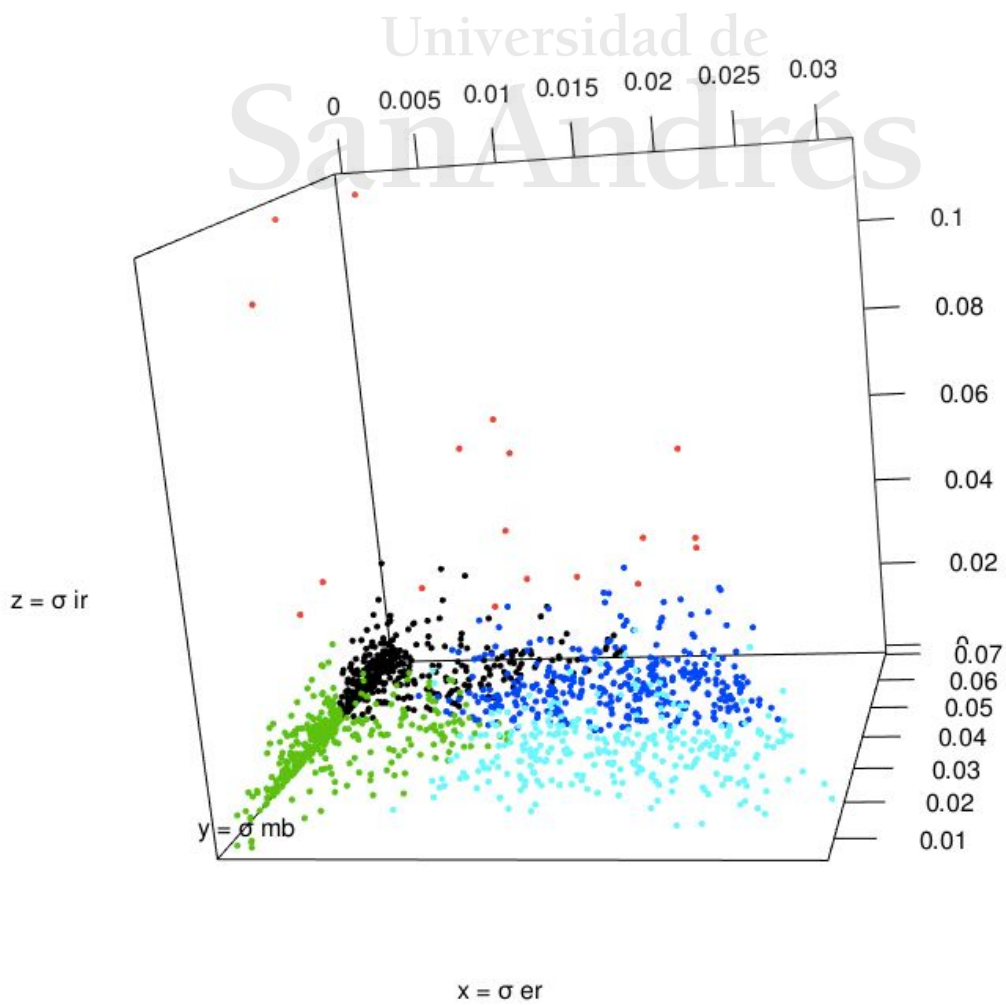
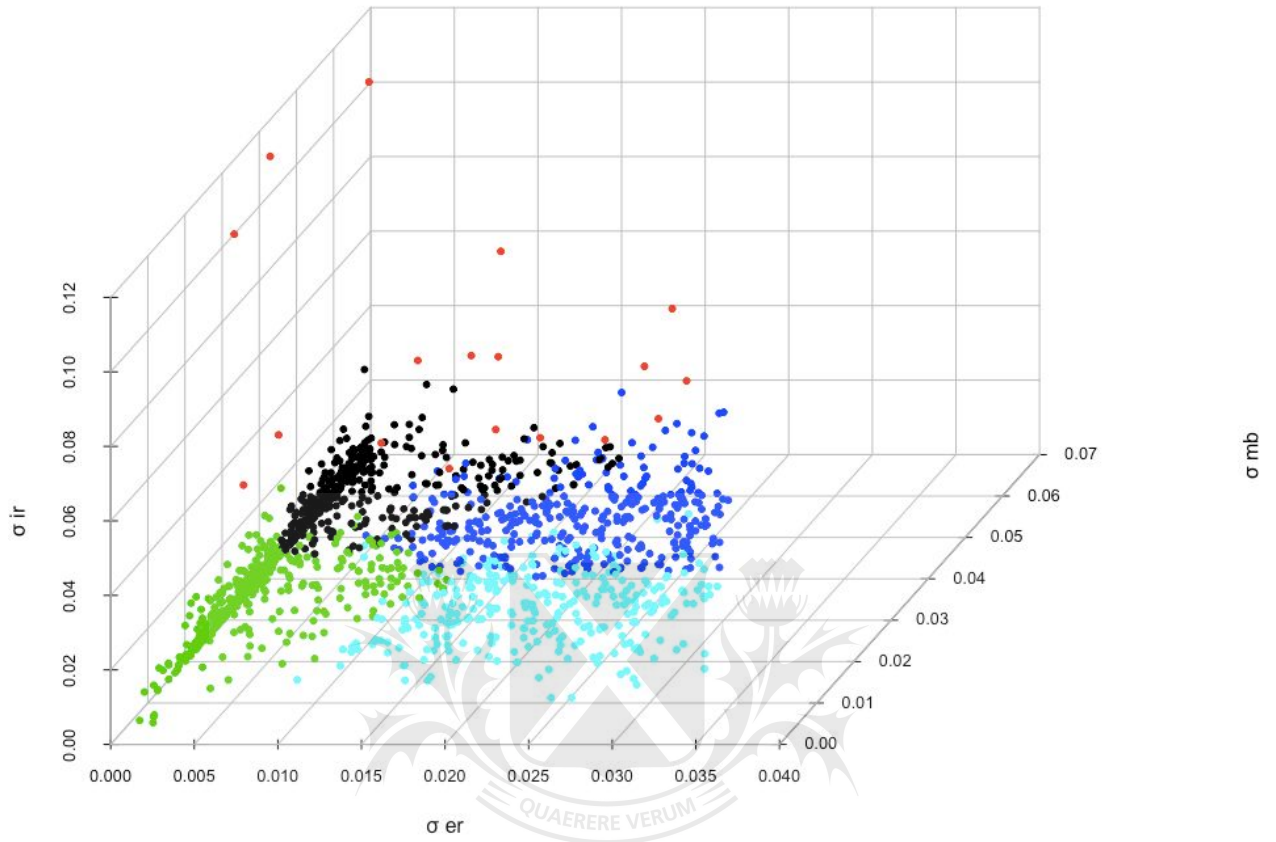
Second Stage



Third Stage



Fourth Stage



1st Round Boundaries

	Average yearly volatility in the exchange rate	Average yearly volatility in the monetary base	Average yearly volatility in the interest rate	Within cluster sum of squares by cluster
Cluster 1	0.0349	0.0829	0.0829	6.8821
Cluster 2	0.6674	0.7906	176.047	0.000
Cluster 3	0.3414	0.3614	2.7995	89.2319
Cluster 4	1.4012	1.2328	18.0642	35.5049
Cluster 5	0.6979	0.8679	71.9168	266.1352

2nd Round Boundaries

Cluster 1	0.0248	0.0614	0.0063	6.8821
Cluster 2	0.3415	0.2048	0.0566	4.7386
Cluster 3	0.0449	0.1867	0.0161	5.4831
Cluster 4	2.1548	0.9072	0.000	1.6533
Cluster 5	0.0613	0.1626	0.7289	3.8107

3rd Round Boundaries

Cluster 1	0.0084	0.0441	0.0039	0.4997
Cluster 2	0.0979	0.0756	0.0125	0.4642
Cluster 3	0.0437	0.0506	0.0049	0.4578
Cluster 4	0.0216	0.0665	0.2331	0.0928
Cluster 5	0.0153	0.0921	0.0057	0.6337

4th Round Boundaries

Cluster 1	0.0022	0.0581	0.0027	0.0349
Cluster 2	0.0109	0.0467	0.0523	0.0184
Cluster 3	0.0016	0.0336	0.0028	0.0378
Cluster 4	0.0169	0.0501	0.0047	0.0331
Cluster 5	0.0189	0.0297	0.0035	0.0283

A yearly figure for each classification variable for all 218 countries that report to the IMF was computed. The period of the analysis is 1973-2018, in which there are in total 4,701 out of 10,246 classifiable country-year data points. This means that there are 5,545 data points lacking data for one of the classifying variables and were therefore classified as “Unclassified.” The classification was constructed for the remaining observations, only considering the cases in which country-year data for all three reference variables could be computed.

Each cluster was categorized into one of the three regimes at each stage according to their volatility and position on the graph. The cluster with the lowest average yearly volatility in each of the three conditions was reclusterized on the forward stage. This procedure was repeated four times until all data points were assigned correspondingly, following the below criteria.

	σ_e	σ_m	σ_r^{11}
Exchange Rate	Low	High	High
Monetary Base	High	Low	High
Interest Rate	High	High	Low

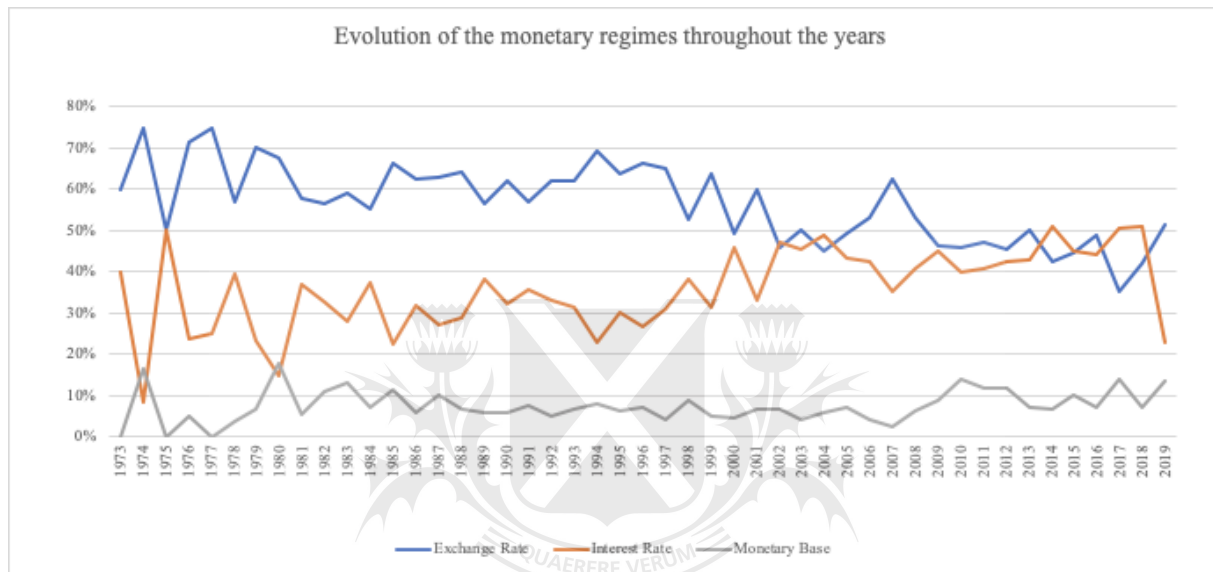
Clusters that exhibit a low standard deviation on the exchange rate volatility will be classified as exchange rate regimes. Those that present a low standard deviation on the monetary base volatility will be categorized as monetary targeting. Consequently, those that present low standard deviation in the interest rate will be assorted to the inflation-targeting regimes.

This methodology allows discriminating, albeit crudely, the intensity of the shocks to which each regime is subject, something that qualitative indexes previously employed did not allow for.

¹¹ See Appendix II

EVOLUTION OF MONETARY REGIMES

The following graph describes the evolution of monetary regimes employed by every country over the years. The Y-axis indicates the percentage of countries that implemented the regimes being analyzed for each year. The objective is to present a graph to clearly visualize the trends taking place over the past decades regarding monetary policy.



Graph 1: evolution of monetary regimes throughout the years

When it comes to analyzing the evolution of the monetary aggregate regime throughout the years, it is relevant to highlight how it has been the strategy least employed for monetary policy. One of the primary ways Central Banks control the monetary expansion in the economy is through the legal banking reserve coefficient (the percentage of deposits that commercial banks are required to keep as cash according to the central bank's directions). In previous decades, most countries from Latin America, such as Colombia, Brazil and Mexico, had set reserve requirements very high, meeting up to 40-50% of the deposits. Nevertheless, monetary authorities have decreased its use throughout the past years and set the reserve coefficient requirements under the 30%. Using the reserves coefficient as a mechanism to control the monetary expansion hinders and adds uncertainty to the banking system. Experience has proven that when the legal banking reserve coefficient is too high, banks develop new methods to capture resources and escape the requirements, resulting in more complex banking supervision and making the reserve requirements established by the Central Bank inoperant.

Moreover, the evolution of monetary policies that target exchange rate regimes exhibit how this variable has been the most employed one but gradually began to decline throughout time. Consistently with previous literature reviewed, countries began to shift from fixed exchange rate regimes to floating or pegged arrangements.

Finally, inflation targeting has demonstrated consistent growth since the early 1990s and gained more strength and approval throughout the years as consciousness on the role that expectations play has gained attention and respect. Several countries that adopted IT for monetary policy have experienced significant progress in macroeconomic performance. However, numerous literature that analyzes the consequences of implementing IT sustain that there is no empirical evidence available to endorse that the increasing performance resulted from nothing other than inflation targeting.



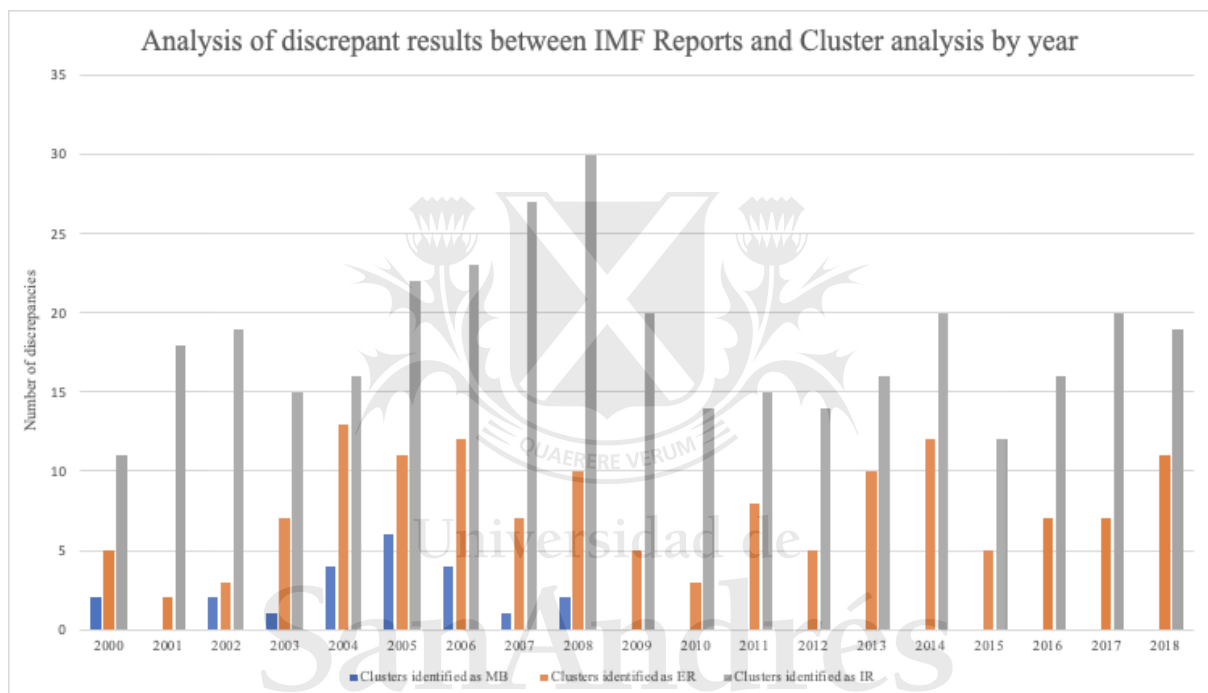
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ANALYSIS ON DISCREPANT CLUSTER RESULTS

A significant amount of information has been compiled and processed for this investigation through cluster analysis. The results are presented in appendix I, where a large table classifies all the 218 countries according to what monetary policy has been dominant throughout the years. Nevertheless, when comparing the results obtained to the ones published yearly in the IMF reports, the following discrepancies were found: out of all 4701 observations, 512 were inconsistent. Attempting to find an explanation to this phenomenon, two different analyses were performed.

In the first place, a comparative bar graph was elaborated to visualize each country with its respective number of discrepant observations (these can be found signalized with red font color on the table of results presented in appendix I). The objective is to identify any trend between the geographical location and the number of discordant observations. As it can be observed, countries positioned closer to the left side of the x-axis are mostly located in Africa and are considered part of the developing and third world countries. There is not enough evidence on this investigation to establish a decisive correlation between geographical location and published data transparency; however, it seems interesting to present this interpretation.

On the other hand, a similar analysis was conducted to display differing observations categorized according to the year they took place. The bar graph reveals that the highest number of conflicting classifications occurred in 2008, followed by 2007. A possible reason behind the escalating number of discrepancies can be attributed to the financial crisis that took place in 2008. It is likely that several countries were forced to shift strategies that impacted the monetary policy and ended up altering the results obtained through this analysis. Once again, this interpretation has not been proved correct and there is not enough information available to guarantee that the assumption is appropriate.



Graph 3: Analysis of discrepant results between IMF reports and cluster analysis by year

In addition, both graphs I and II reveal that the observations classified as IR (Interest Rate) have been the ones with the highest number of discrepancies with IMF reports. No possible explanations for this outcome were yet achieved.

CONCLUSION

The aim of this investigation has been accomplished by presenting a *de facto* classification of monetary regimes using the available information from the IMF reports regarding all 218 countries in the world. The classification was strictly based on analyzing the volatility of past figures and raw data. The methodology employed allowed to discriminate the intensity of the variable to which regimes are subject, something that *de jure* indexes cannot grant. In addition to the classification conferred, the evolution of monetary policies was presented and analyzed. The literature reviewed endorsed the consistency of the results and is aligned with the evolution of the trends presented in *Graph 1*. Finally, discrepant outcomes have been studied according to the year they took place and the countries' geographical location that presented the highest number of disparities.

While the method proposed has successfully assigned a dominant monetary regime to a large number of countries, the fact that 5,545 data points remained unclassified implores the questions as to why no additional information was compiled from each country's Central Bank. Analyzing this possibility drove to the conclusion that compiling data from external resources other than the IMF would engender obstacles that could deviate the investigation from its final objective. Additionally, there would be no possible way to certify whether the data published belongs to the *de facto* or *de jure* regimes, tainting the whole investigation. As a result, no additional information from external sources has been considered to preserve the analysis's accuracy and consistency.

In conclusion, the essential contribution from this investigation is the construction of the *de facto* classification of monetary regimes. The future implementation of the results presented in this study will only be limited by the countless number of questions that can be resolved through it. Furthermore, the rigorous and meticulous handling of data carried out throughout the analysis validates the accuracy of the final outcome.

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Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
United Arab Emirates	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
United States of America	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
United Kingdom	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	IR	IR	IR	IR	IR	IR	IR	IR	IR
USSR	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Uruguay	Unclassified	Unclassified	Unclassified	Unclassified	ER	ER	ER	ER	IR	MB	ER	IR	ER	ER	ER	ER	IR	IR	ER	ER	IR	IR	IR
Uzbekistan, Rep. of	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Vanuatu	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	IR	ER	ER	ER	IR	ER	ER	ER	ER	ER	IR	ER	ER	ER
Venezuela, Rep. Bolivariana de	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	ER	ER	IR	ER	ER	IR	ER	ER	IR	IR	IR	IR
Vietnam	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	ER	Unclassified	Unclassified
Yemen Arab Rep.	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Yemen, People's Dem. Rep. of	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Yemen, Rep. of	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Yugoslavia	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Zambia	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	IR	IR	ER	ER	ER	IR	IR	IR	IR	MB	ER	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	ER
Zimbabwe	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	MB	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified





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Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
United Arab Emirates	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	
United States of America	Unclassified	Unclassified	Unclassified	Unclassified	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	Unclassified
United Kingdom	IR	IR	ER	IR	IR	IR	IR	IR	IR	IR	IR	Unclassified	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	MB
USSR	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Uruguay	IR	IR	IR	ER (3)	ER (3)	IR	IR	ER	MB	ER	ER	IR	MB	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	Unclassified
Uzbekistan, Rep. of	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	MB	MB	MB	IR	IR	ER	IR	IR	MB	IR	IR
Vanuatu	IR	IR	ER	ER (2)	IR	MB	IR	ER (8)	IR	IR	ER (8)	IR	IR	ER (6)	IR	IR	IR	IR	IR	ER	ER	ER	MB	ER (2)	IR
Venezuela, Rep. Bolivariana de	IR	ER	ER	ER (3)	ER (3)	ER (8)	IR	ER (8)	ER (8)	ER (8)	ER (8)	ER (8)	ER (8)	ER (2)	ER (2)	ER (2)	ER (2)	ER (2)	ER (2)	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Vietnam	Unclassified	IR	IR	Unclassified	Unclassified	IR	ER (3)	ER	ER	ER (8)	ER (8)	ER (8)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	ER (5)	Unclassified
Yemen Arab Rep.	Unclassified	Unclassified	Unclassified	IR	IR	ER	IR	IR	Unclassified	ER (11)	Unclassified	Unclassified	ER	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Yemen, People's Dem. Rep. of	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Yemen, Rep. of	IR	IR	IR	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	ER	Unclassified	ER (8)	ER (8)	Unclassified	IR	MB	ER	MB	MB	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Yugoslavia	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified
Zambia	ER	ER	ER	ER (9)	ER	ER	ER	IR	ER	ER (11)	ER	IR	ER	IR	IR	IR	IR	ER	ER	IR	IR	IR	IR	ER	ER
Zimbabwe	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified	Unclassified

REFERENCES

- (1) Currency Board
- (2) Conventional Peg
- (3) Crawling peg
- (4) No separate legal tender
- (5) Stabilized arrangement
- (6) Other Managed arrangement
- (7) Pegged exchange rate within horizontal bands
- (8) Conventional Fixed Peg arrangement
- (9) Independently Floating
- (10) Exchange rates within crawling bands
- (11) Managed floating with no preannounced path for the exchange rate

 Cluster does not match classification from the IMF

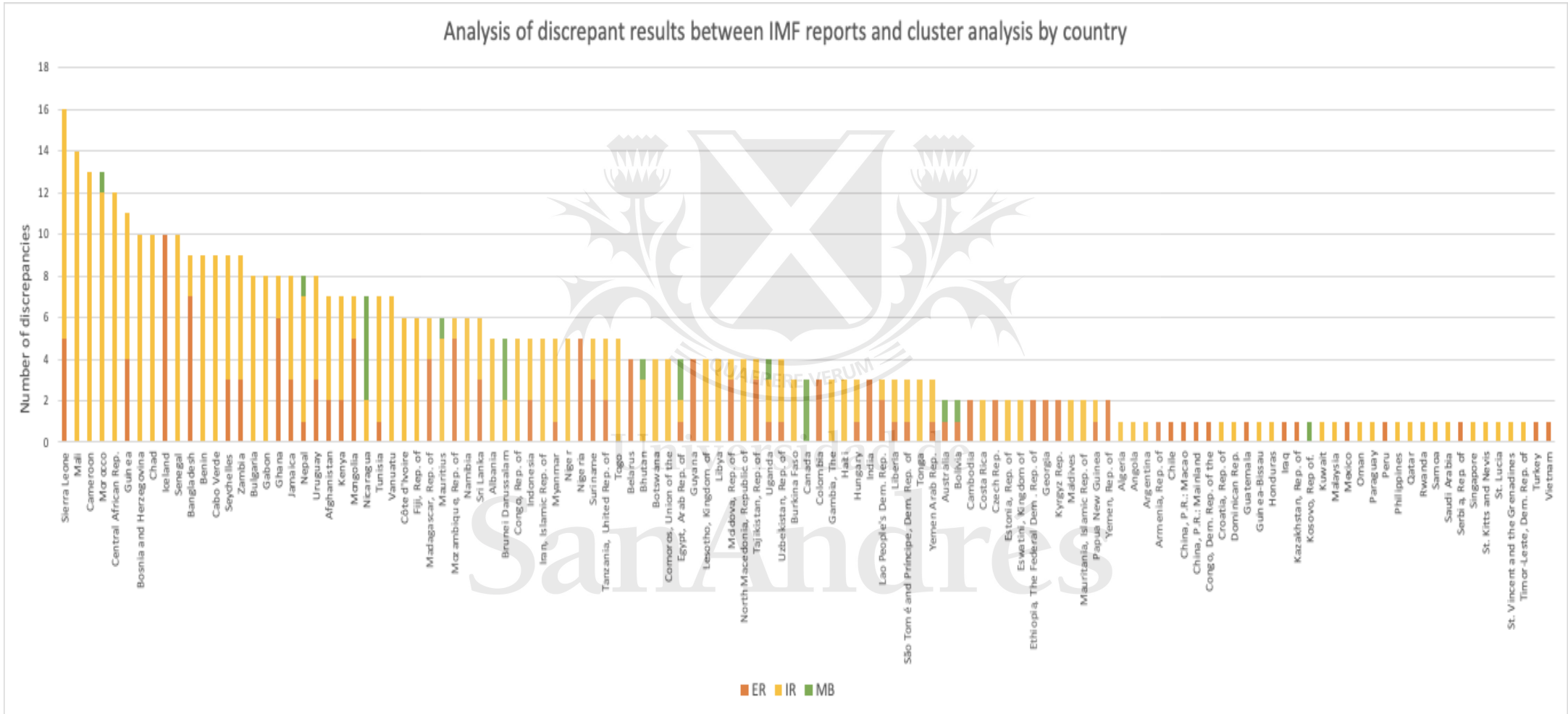
 Classified in the IMF as "other"



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APPENDIX II: Analysis of Discrepant Results



Graph 2: Analysis of discrepant results between IMF Reports and cluster analysis by country

APPENDIX III - Cluster boundaries

First Stage:

Cluster means:

	EXCHANGE RATE	MONETARY BASE	INTEREST RATE
1	0.03491242	0.08292416	0.01427218
2	0.66735381	0.79055357	176.70467520
3	0.34135469	0.36143347	2.79945426
4	1.40122542	1.23275313	18.06419040
5	0.69792662	0.86793193	71.91684697

Within cluster sum of squares by cluster:

[1] 74.92013 0.00000 89.23916 35.50940 266.13520
(between_SS / total_SS = 98.9 %)

Second Stage:

Cluster means:

	EXCHANGE RATE	MONETARY BASE	INTEREST RATE
1	0.02484387	0.06144873	0.006313991
2	0.34151848	0.20476413	0.056604192
3	0.04491702	0.18666290	0.016086762
4	2.15477549	0.90719212	0.000000000
5	0.06128411	0.16260823	0.728890990

Within cluster sum of squares by cluster:

[1] 6.882084 4.738562 5.483147 1.653333 3.810698
(between_SS / total_SS = 69.9 %)

Third Stage:

Cluster means:

	EXCHANGE RATE	MONETARY BASE	INTEREST RATE
1	0.008441438	0.04409989	0.003904067
2	0.097907436	0.07567473	0.012521032
3	0.043688104	0.05062541	0.004934506
4	0.021560556	0.06655087	0.233075498
5	0.015289573	0.09207485	0.005713414

Within cluster sum of squares by cluster:

[1] 0.49967420 0.46421770 0.45778658 0.09276919 0.63369369
(between_SS / total_SS = 68.8 %)

Fourth Stage

Cluster means:

	EXCHANGE RATE	MONETARY BASE	INTEREST RATE
1	0.002183255	0.05809075	0.002741520
2	0.010960104	0.04674857	0.052282166
3	0.001563903	0.03358933	0.002779197
4	0.016919905	0.05007728	0.004738681
5	0.018936275	0.02971499	0.003460236

Within cluster sum of squares by cluster:

[1] 0.03485804 0.01837816 0.03782487 0.03314397 0.02831201
(between_SS / total_SS = 69.5 %)

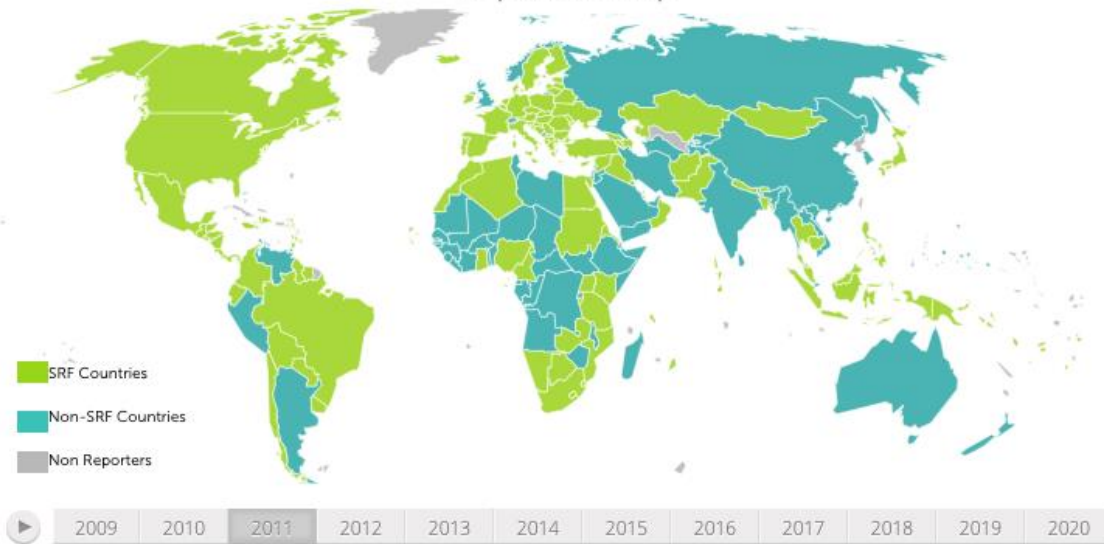


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APPENDIX IV - Maps showing the evolution of the monetary SRF countries



Reporters Map



Reporters Map



Reporters Map



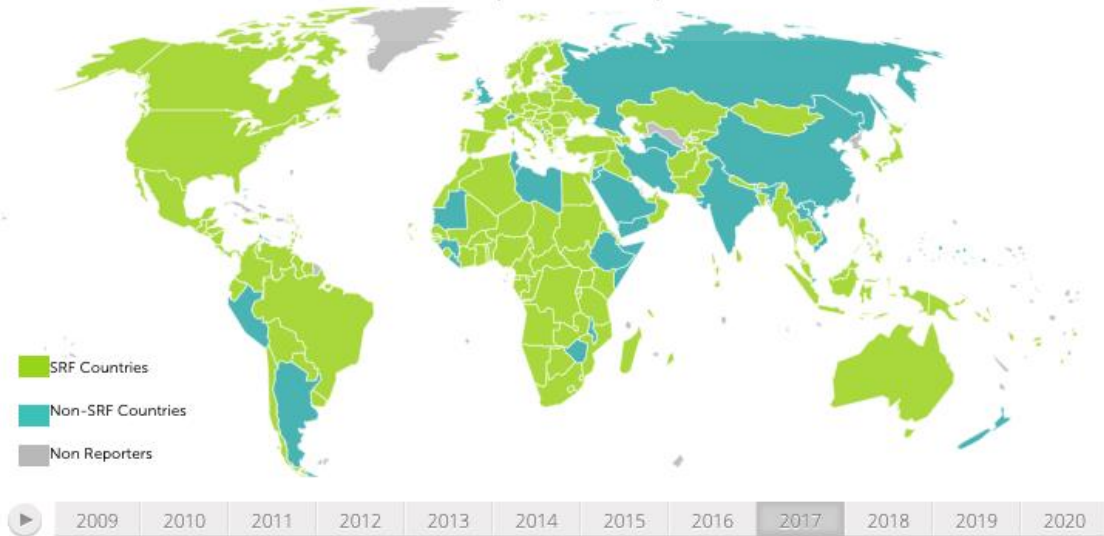
Reporters Map



Reporters Map



Reporters Map



Reporters Map



Reporters Map

