Analysis on the Swiss National Bank policies in regards to international economic fluctuations

1st Bob Bobga Nti
x23187654
Msc in AI
National College of Ireland

2nd David Oluwatimilehin Bamikole
x22179640
Msc in AI
National College of Ireland

3rd Omar Eduardo Gutiérrez García
x23168307
Msc in AI
National College of Ireland

***Abstract*—This work revolves around utilizing programming and data analysis tools to obtain, process, visualize, and analyze publicly available data sets from the Swiss National Bank (SNB). The objective is to uncover evidence and correlations within the data that support the notion of the SNB making significant policy decisions in recent years, particularly during global economic crisis, to mitigate their impact on the Swiss economy. By systematically processing and examining the historical financial data, this study aims to highlight the effectiveness of these policies and provide insights into the dynamics of banking operations within the context of economic stability and growth.**

***Index Terms*—SNB, Switzerland, Economy, Crisis, SQL, NeoJS, MongoDB, Python, Data analytics, Data processing, Data Visualization, Swiss National Bank, Financial Data Analysis, Economic Policy Evaluation, Time-Series forecasting, Data Visualization in Banking, Predictive Analytics in Finance, Currency Evaluation and Trends, Risk Mitigation in Banking.**

I. Introduction

Switzerland is known as one of the strongest economies in Europe and the world. Stability has been a hallmark throughout the years, helping the country flourish and its citizens enjoy a prosperous and stable way of life. This research aims to explore the actions and decisions that have brought the country to its current state. Given the factors that contribute to a robust economy, we will focus on visualizing specific data publicly provided by the Swiss National Bank (SNB) through website. Like other central banks worldwide, the SNB's role has been to maintain national economic stability by making pivotal decisions to prevent crises and other economic uncertainties [1].

In this paper, we primarily focus on the management of international currencies, trade, and how the constant fluctuation of exchange rates translates into changes within the Swiss banking system and policies. To delve deeper into this topic, we pose the following research question:

How does the global economic events and the SNB monetary policies influenced the Swiss economy, and how do them manifest in the context of exchange rates, investment positions and the dynamics of foreign trade?

We will utilize a yearly period for this analysis to encompass a wide range of global economic situations, from recessions to periods of significant economic growth. Two specific events have significantly impacted the Swiss economy: the US financial crisis of 2007-08 and the subsequent Eurozone crisis. [2].

For our analysis, four data sets will be utilized. The first is the Swiss international investment position, divided by currency. The second is the internal composition of Swiss banks. The third is foreign currency exchange rates from the perspective of the Swiss franc, and finally, Swiss foreign trade statistics. All these data sets are obtained from the Swiss National Bank website
Furthermore, it is important to clarify that this research utilizes various programming tools within the realm of data analysis to demonstrate their application to the mentioned datasets. Therefore, the economic analyses are not in-depth and do not make use of advanced tools specific to macroeconomics.

II. Related Work

The Swiss National Bank has been the subject of numerous economic analyses and studies, as it is the central bank's role to devise solutions when crises strike. On multiple occasions, Switzerland has navigated and emerged far better than its neighboring countries [1]. However, the SNB does not work in isolation; major banks in the country, such as UBS and Credit Suisse, have also played significant roles during crises. These banks are among the world's largest, and their combined balance sheet exceeds the country's GDP [1]. However, the challenge is that by being private institutions, data on their policies are not as readily available as that of the central bank, making the SNB a focal point for researchers.

Several papers highlight that Switzerland operates in a unique situation, surrounded by the European Union, one of the world's largest economic powers but also a more unstable one. Thorn describes this as a "David and a volatile Goliath" scenario, wherein Switzerland must carefully align its monetary policies with the EU to avoid being dragged down with it [3]. Consequently, Switzerland has consistently sought close cooperation with European countries, even attempting to anchor the Swiss Franc to German Mark – a strategy that led to increased inflation and reinforced Switzerland's desire for monetary independence [1]. Nonetheless, Switzerland has

continued to maintain international ties with other institutions, a necessity given the presence of its two large international banks and the repercussions that they can cause in the country´s economy [1].

These international ties are particularly evident in the related work focusing on the time period we aim to analyse (2004 – 2022), marked by two major events that originated abroad but significantly impacted the Swiss economy. The first is the US financieal crisis, which led to substantial losses for Swiss banks heavily invested in the US market and decreased lending from Switzerland to other countries [2]. The second is the Eurozone crisis, which prompted significant capital inflows to Switzerland as investors sought to safe haven for their money [2].
The literature review concludes that the actions undertaken during these crises by the independent SNB were precise and effective, preventing severe repercussions on the Swiss economy to such an extent that they were referred to as "The Swiss Miracle" by Hirt [1]. This research takes those concussions into account when exploring the data to ensure it is viewed in the appropriate context.

III. Methodology

As mentioned in the introduction, the aim of this research is to apply the programming knowledge gained from a course, as opposed to delving into financial or economic theories. Consequently, this section will focus on the technical aspects of the tools used to retrieve, manipulate, process, and store public datasets for subsequent financial and economic analysis.

Drawing upon the concepts taught in the programming for artificial intelligence course [4], we employed a diverse set of database management systems (DBMSs), including SQL (MySQL), NoSQL (MongoDB), and Graph (Neo4j). All operations were managed through Python 3 code, consistent with common practices in AI and data analytics industries. Below are the steps undertaken in the research process:

1) **Retrieval of raw data and Storage**: This research entailed the use of three distinct database management systems (DBMS) to store and process data from the Swiss National Bank (SNB), each chosen to best fit the nature and use-case of the respective data sets:
   - MongoDB for data set 1:
     - Retrieval and Initial Storage: Dataset 1 was retrieved using the SNB's API and stored as a single compressed document of byte type in MongoDB. This approach was selected to manage the data compactly and efficiently due to its size and structure.
     - Processing and Storage of Processed Data: After retrieval, the dataset was decompressed, processed, and the resulting structured data was stored back into MongoDB as multiple documents. Each document represents a single record from the original CSV, facilitating granular query and analysis capabilities.
   - Neo4j for Processed data set 2: :
     - Retrieval and Initial Storage: Dataset 2 was handled identically to Dataset 1, utilizing MongoDB for initial compressed storage.
     - Processing and Neo4j Storage: Once processed, the structured data from Dataset 2 was stored in Neo4j, a graph database. This choice capitalizes on the relational nature of the data, allowing for intricate network-based queries and analyses.
   - MySQL for data set 3 and 4: :
     - Retrieval and Initial Storage: Datasets 3 and 4 were directly retrieved and stored in a MySQL database, a relational database management system, due to its structured and tabular nature, making it well-suited for SQL-based querying and manipulation.
     - Processing and Final Storage: After processing, the refined data was stored in another table designed to facilitate complex queries and enable efficient access for further analysis and reporting.

   In all cases, the retrieval process was designed with efficiency and reliability in mind, especially for large datasets. Scripts developed in Python facilitated automated, consistent, and error-resilient downloading and storage. Each database choice reflects a strategic decision to align with the data's characteristics and the research's analytical needs.

2) **Data processing**: In this research, each dataset underwent specific processing and transformation steps to prepare it for analysis. The procedures were tailored to the nature of the data and the requirements of the subsequent analysis and storage systems. The processing steps included:
   - Data Cleaning and Normalization: Common initial steps involved cleaning the data to remove or correct any inaccuracies, inconsistencies, or irrelevant information. This included handling missing values, removing duplicates, and correcting errors. Data normalization involved adjusting values measured on different scales to a common scale, particularly important for numerical data that would later be used in analytical models.
   - Feature Engineering: New features were derived from existing data to provide more insightful analysis. This included creating categorical variables from continuous variables, generating date-related features from timestamps, and aggregating data at different levels to support various analytical perspectives.
   - Dimensionality Reduction: For datasets with a high number of features or dimensions, dimensionality

reduction techniques were employed to simplify the models without sacrificing significant information. This step is crucial in enhancing the performance of machine learning models and facilitating easier visualization and interpretation.
- One-Hot Encoding for Categorical Variables: Categorical variables were transformed into a format that could be provided to machine learning algorithms. This typically involved one-hot encoding, which converts categorical variables into a form that could be fed into the models.
- Data Compression: Given the large volume of data, compression techniques were applied to some datasets before storage to save space and improve efficiency in retrieval and processing.

Each step in the data processing and transformation phase was carefully documented and reproducible, ensuring transparency and reliability in the research. The processed data was then systematically stored in the respective databases, ready for the next stage of the research.

3) **Data analysis and insights**: The core of this research lies in the analysis of the processed data, aiming to extract meaningful insights, detect patterns, and support or refute hypotheses related to the Swiss National Bank's policies and their impact. The following are the key components of the data analysis phase:

   - Descriptive Statistics: Initial analysis began with descriptive statistics to summarize the central tendency, dispersion, and shape of the dataset's distribution. This included metrics like mean, median, mode, standard deviation, and range for numerical data.
   - Time-Series Analysis: All our datasets have a temporal component, time-series analysis was conducted to understand trends, cycles, and seasonal variations over the years. This was particularly relevant for understanding the impact of financial policies and market changes over time.
   - Correlation and Causal Analysis: The research investigated the relationships between different variables, especially the impact of various economic indicators and policies on the Swiss economy. This involved correlation analysis and, where possible, causal inference to understand the direction and strength of these relationships.
   - Visualization: Data visualization played a crucial role in the analysis, helping to illustrate trends, patterns, and relationships in a clear and intuitive manner. This included the use of plots like line charts for time series, scatter plots for relationships, bar charts for distributions, and more complex visualizations like heatmaps for correlation matrices.

4) **Limitations**: While this research provides valuable insights into the Swiss National Bank's policies and their impact on the economy, it is important to acknowledge certain limitations that might influence the interpretation and generalizability of the findings:

   - Data Availability and Transparency: The analysis is primarily based on public datasets provided by the Swiss National Bank and other institutions. While these data sets are comprehensive, they might not capture all dimensions of the economic phenomena or internal decision-making processes, especially concerning private banking institutions like UBS and Credit Suisse, where data might be less accessible.
   - Scope of Economic Indicators: The research focuses on a select set of economic indicators and datasets. While these were chosen to best represent the aspects under study, there are numerous other variables and metrics in economics that could influence or clarify the results. The chosen scope might limit the depth and breadth of the conclusions.
   - Methodological Constraints: The methodologies and tools used, while robust, have inherent limitations. For example, certain predictive models might make assumptions about data distribution or relationships that are not fully met. Similarly, the compression and decompression of large datasets might lead to minor losses or inefficiencies that could affect data integrity.
   - Temporal Boundaries: The study covers a specific period, which, while extensive, might not account for longer-term trends or more recent developments. Economic systems are dynamic, and the findings might not fully apply to future or past periods not covered in the study.
   - Generalisability: The focus on Switzerland's economy, particularly its unique position in Europe and the world, means that the findings might not be directly applicable to other countries or economic systems without considering the specific context and differences.
   - Technological Constraints: The reliance on certain technologies and programming languages, while necessary, might limit the research's adaptability or reproducibility in different environments or with newer tools that emerge.

By acknowledging these limitations, this research invites further inquiry and refinement in understanding the complex dynamics of national banks and their role in economic stability and growth. Future studies might expand on the data sets, methodologies, or scope to overcome these limitations and provide more comprehensive insights.

IV. Results and evaluation

After gathering all the information and storing it in the mentioned databases, we proceed to analyse the meaning of the data in regards of the fluctuations of the global economy. We heavily rely on the related work to drive the story of global events, with the purpose of evaluating our retrieved data against them.

As mentioned in the introduction, there is a focus in two major events during the selected time period; the US crisis of 2007-08 and the proceeding Eurozone crisis. We start our analysis in 2004, the previous mayor global economic event was the 9/11 terrorist attack that created uncertainty among financial markets. The SNB and the US Federal reserve ordered to decrease the LIBOR rate (a specific interest for inter-bank loans), this had the envisioned effect of diminishing the over-valuation of the franc [1]. After uncertainty was deal with, the SNB started to re-stablish the LIBOR rate from 2004 on-wards, with the purpose of stimulating growth [1]. And this is how we start our concerning period. When Switzerland, as a financial center, had large gross capital flows [2]. In Figure 1, we can observe how the capital of "Banks in Switzerland" grew from 2004 to 2007.

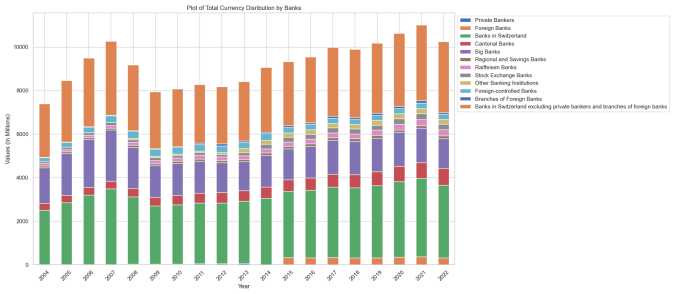

Fig. 1. Time-series of Swiss bank distribution by type

By 2007 when the subprime crisis was becoming evident, the SNB had already analyzed the crisis situation and with the IFM had established that the Switzerland economy was secure [1]. Nevertheless, it was still affected. The crisis signified a great decrease in capital flows, specially banks capital flows [2]. We are talking about both types of flows: the Swiss banks investments abroad and the foreign banks investments in Switzerland. The SNB managed to raise and offer money to its banks which had strong positions on the subprime market (mainly UBS), and kept providing liquidity, in US Dollars throughout the crisis [1]. A bankruptcy of UBS like the one of Lehman Brothers would become a very strong blow to the Swiss economy, that is why the SNB decided to support its assets [5], for UBS and other swiss banks. A very risky move that could have generated big losses for the SNB. In the 2, we can see a decline of the Swiss assets from 2007 to 2008 due to the support it provided for its banks.

In 2009, after the crisis, Switzerland stood as one of the less affected countries in comparison with other European

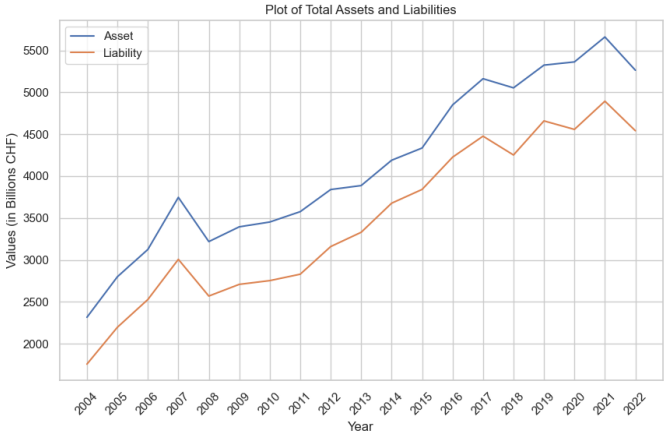

Fig. 2. Time-series of Swiss Assets vs Liabilities

countries and the US. The problem was the banking sector, which represents a big part of the country's GDP and was very affected by the crisis [1]. Cantonal and regional banks were the only ones that seemed unaffected (Figure 1). As Switzerland stood less affected, it strengthened its position as a being financially safe. Because of that, a high demand of francs was foreseeable in the near future, the SNB acted promptly and purchased euros with francs to prevent the currency to be overvalued [1]. In the Figure 3 we can see how the Swiss Franc (CHF) grew more valuable against EUR and USD from 2007 to 2011. On the years that followed, the economy stayed contracted but capital flows little by little slowed down its contraction, all the way to 2011. At this time, other SNB policy was to regrow its reserves [2]. The Figure 4, shows how the reserves start to grow back from 2011.

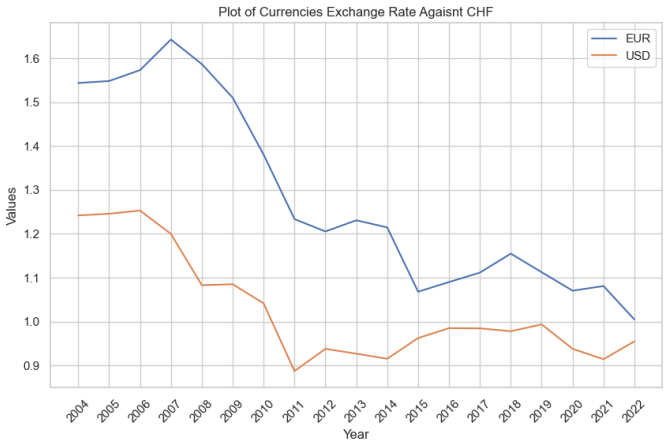

Fig. 3. Time-series of Swiss Frank exchange rate against Euro and US Dollar

The second crisis stuck not long afterwards, in 2010, when Greece fell into nonpayment of its debt. Other European countries also disclosed the possibility that they could default (Portugal, Italy, Ireland and Spain) [1]. This again meant

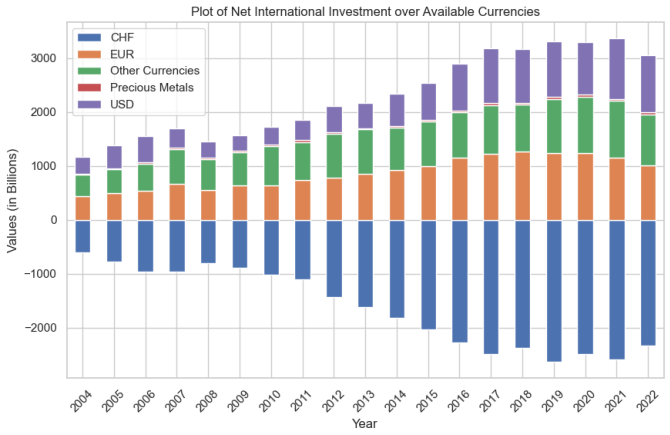

Fig. 4. Time-series of Swiss international investment positions

pressure on the Swiss Franc due to the high demand as a source of safety. In figure 5 (from 2010 to 2011) we can see the consequence of this in the foreign trade, since a stronger Franc translates into less exporting and more importing, and this severely affects Swiss industries. This flight-to-safety generated another pattern, the growth of inflow of foreign investments to domestic banks (SEE SOME FIGURE) [2]. At the same time this made another problem foreseeable: a housing market bubble [1] and inflation. The decision of the SNB was to put a floor of 1.2 to the Euro exchange rate (Figure 3 from 2011 to 2014) by heavily buying euros with swiss francs [1]. But this did not last long, capital kept flowing into Switzerland and the national reserves kept growing heavily in euros (Figure 4), which posed a risk. In 2015, the monetary policy was dropped [1].

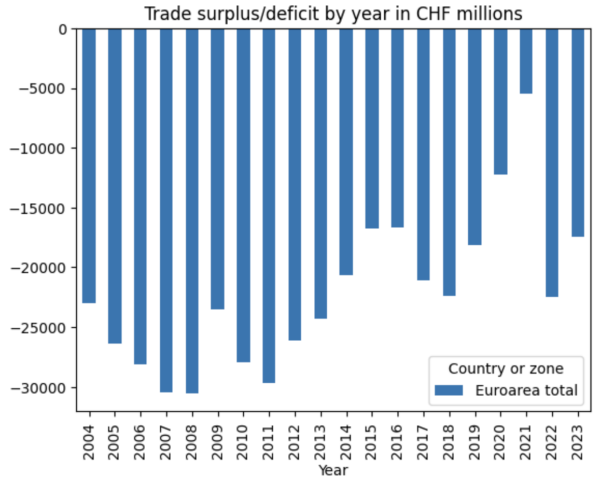

Fig. 5. Time-series of Swiss Trade deficit against Euroarea

As the world was coming out of this long period of crisis and global economy was stabilizing, the safe-haven Switzerland became less attractive to investors. But, to be able to reverse and stabilize the great capital inflows that had happened during the crisis, the SNB needed to put one more monetary policy into practice. It decided to make its interest rates negative, following the European Central Bank [1]. This had the desired effect and drove the country to the next years of economic stability.

V. Conclusions and Future Work

With the previous evaluation, it becomes evident that the data retrieved from the SNB portraits precisely the monetary policies undertaken by themselves. This was totally expected. SNB is a well respected institution with a high degree of trustworthiness and reliability.

The objective of the paper is accomplished too. We have put in practices several programming techniques and tools that have help us manipulate, process, store and automate the flow of data. With this goals achieved, we can conclude that programming skills are a valuable tool set that can be utilized in any sort of data analysis. Tools like Python, SQL, MongoDB, NeoJs prove to be practical in a wide range of ways, it is dependant on the data structure and the circumstances to decide which becomes the best of them.

As future work, we propose a longer or wider analysis of the SNB datasets. Longer in the time frame or wider in the quantity of datasets utilized. Or even both. Regarding the code, future work can involve generating automation in the generation of plot visualization and greater user interaction. This can mean that the user is able to select from different options of plots, time periods and data types to visualize. Any other automation, optimization or expansion of the code can also be consider for future work.

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