Independence and Crises How Central Bank Independence is Affected by Financial Crises

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Abstract

Title: Independence and Crises: How Central Bank Independence is Affected by Financial Crises
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Keywords: Central Bank Independence; Financial Crises; Banking Crises; Debt Crises; Currency Crises.

This study examines the impact of different types of financial crises—banking, debt, and currency—on changes in Central Bank Independence (CBI), revealing that the effects vary depending on the crisis type. Using data on financial crises and central bank independence, this analysis introduces an innovative approach that accounts for the duration and dynamics of crises. Banking crises are found to reduce independence, particularly in areas such as the formulation of monetary policy, the institution's financial independence, and a shift away from focusing on price stability. In contrast, currency and debt crises generally enhance CBI. Currency crises primarily strengthen independence in monetary policy formulation, the institution's financial independence, reporting responsibilities, and restrictions on lending to the government. Debt crises, on the other hand, increase reporting responsibilities, reinforce the central bank's focus on price stability, and introduce additional restrictions on government lending. These findings underscore the pivotal role of financial crises in reshaping central banks. Understanding how central banks adapt and respond to financial crises is crucial for explaining their current roles, the evolution of their mandates, and the reasons behind their growing independence and responsibilities over time.

Resumo

Title: Independência e Crises: Como a Independência de Bancos Centrais é Afetada por Crises Financeiras **Author:** Bruno Mendes
Palavras-chave: Independência do Banco Central; Crises Financeiras; Crises Bancárias; Crises de Dívida; Crises de Moeda.

Este estudo examina o impacto de diferentes tipos de crises financeiras—bancária, de dívida e cambial—nas mudanças na Independência do Banco Central (CBI), revelando que os efeitos variam consoante o tipo de crise. Usando dados sobre crises financeiras e o Índice de Independência do Banco Central, esta análise introduz uma abordagem inovadora que contabiliza a duração e as dinâmicas das crises. As crises bancárias reduzem a independência, particularmente em áreas como a formulação da política monetária, a independência financeira da instituição e o desvio do foco para objetivos adicionais em vez da estabilidade de preços. Em contraste, as crises cambiais e de dívida tendem a aumentar a independência. As crises cambiais reforçam principalmente a independência do banco central na formulação da política monetária, a independência financeira da instituição, as responsabilidades de reporte e as restrições ao crédito ao governo. Por outro lado, as crises de dívida aumentam as responsabilidades de reporte, reforçam o foco do banco central na estabilidade de preços e adicionam restrições ao crédito ao governo. Estas conclusões sublinham o papel crucial das crises financeiras na transformação dos bancos centrais. Compreender como os bancos centrais evoluem e respondem às crises financeiras é fundamental para explicar os seus papéis atuais, a evolução dos seus mandatos e as razões por detrás do seu crescente nível de independência e responsabilidades ao longo do tempo.

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List of Acronyms and Abbreviations

Acronym/ Abbrev.	Definition
CB	Central Bank
CBI	Central Bank Independence Index
CBIE	Central Bank Independence Index Extended
CBLD	Central Bank Legislation Database
CBs	Central Banks
CWN	Cukierman, Webb, and Neyapti Index
FDI	Foreign Direct Investment
FE	Fixed Effects
GDP	Gross Domestic Product
GDPpc	Gross Domestic Product per capita
GMT	Grilli-Masciandaro-Tabellini
HINF	High Inflation
IBC	Independência de Bancos Centrais
IMF	International Monetary Fund
MA	Moving Average
MOID	Monetary Operations and Instruments Database
MONA	Monitoring of Fund Arrangements
OECD	Organisation for Economic Co-operation and Development
SE	Standard Error
U	Unweighted
UK	United Kingdom
W	Weighted
WB	World Bank

1 Introduction

Financial crises have a profound impact on society, and institutions are no exception. Crises often create opportunities for governments to implement institutional reforms, as economic downturns can, for example, weaken influential groups, reducing their ability to resist changes (Waelti, 2015). This popular hypothesis suggests that financial crises can lead to reforms by lowering the costs associated with implementing them. Do Central Banks (CBs) escape this? Using new measures of Central Bank Independence (CBI) and a comprehensive dataset of financial crises, this thesis focuses on understanding if financial crises are a driver of changes in CBI - answering the question "*How Central Bank Independence is affected by Financial crises*", using an empirical approach.

The extent to which Central Bank Independence is affected by financial crises, and whether such effects are positive or negative, remain unsettled. Some argue that, following the 2007 crisis, the roles of CBs have changed and their independence is under threat (Buiter, 2016). However, Blinder et al. (2017) survey indicates that central bank governors believe there has been minimal changes, while academics are more concerned.

This study focuses on addressing the unsettled question of whether financial crises affect Central Bank Independence and, if they do, whether the effect increases or decreases CBI. We employ a large panel dataset that includes measures of CBI, detailed data on financial crises, and controls for economic, financial, political, and external factors.

We consider three types of crises: banking, debt and currency. Following Nguyen et al. (2022), systemic banking crises are identified when two conditions are met: significant financial distress in the banking system and substantial government interventions in response. Debt crises occur when total sovereign defaults exceed either 1% of GDP for at least three consecutive years or 7% of GDP in a single year. Currency crises are defined by a domestic currency depreciation of at least 30% against the US dollar within a year, with the depreciation exceeding the previous year's rate of change by at least 10 percentage points.

The first significant mention of Central Bank Independence likely comes from Friedman (1962), who argued that it should be structured with the "objective of a monetary structure

that is both stable and free from irresponsible government tinkering".[1] However, it was in the following decades that the concept gained traction among economists. This was driven by several simultaneous factors: the high inflation of the 1970s, the establishment or reconstitution of central banks in many countries, the rational expectations revolution in macroeconomics which reshaped views on monetary policy and empirical evidence suggesting that more independent central banks achieve lower inflation. These developments solidified central banks as key players in economic policy, especially in ensuring price and financial stability (Buch, 2023).

This evolution has been accompanied by a trend towards increasing *de jure* central bank independence, defined as the legal framework that establishes the relationship between policymakers and the central bank's responsibility for implementing monetary policy (Masciandaro & Romelli, 2023).[2] CBI comprises two main dimensions: political independence, referring to the ability to design and implement policies without government interference, and economic independence, denoting the freedom to choose the set of instruments consistent with monetary policy objectives (Andrieș et al., 2022). In essence, independence implies freedom from both political instruction and market pressures (Goodhart & Lastra, 2018). This perspective has been endorsed at the highest levels of policymaking; for instance, the White House has emphasized the importance of the Federal Reserve's independence (Economic Advisers, 2024).

According to Romelli (2024), over the last five decades, two main drivers have propelled the trend toward greater CBI. First, there has been a progressive narrowing of central bank mandates to focus on achieving price stability, emphasizing the importance of delegating monetary policy decisions to a central banker who prioritizes inflation control over other goals.[3] An independent policymaker can implement credible monetary policies that help lower inflation rates, thereby addressing the time inconsistency problem inherent in government policies. Second, globalization has significantly boosted the independence of monetary authorities. As

[1] An intriguing aspect of Friedman's influential work on defining CBI is his ultimate rejection of the concept. He argues that it is unacceptable in a democracy for such significant power to be concentrated in an institution that lacks direct and effective political oversight (Wachtel & Blejer, 2020).

[2] *De jure* measures, which assess legislative reforms, might not always accurately reflect the actual level of central bank independence. For example, in developing countries, where formal rules might be frequently bypassed in practice the *de jure* independence may differ from *de facto* independence. An example of a *de facto* measure of independence is the turnover rate of central bank governors.

[3] According to CBI indexes, narrower mandates focused on price stability translate into higher independence, in contrast to broader mandates that include responsibilities such as banking supervision, financial stability, and others.

a result, this increased exposure to foreign trade, investments, and international capital markets has underscored the importance of CBI as a signal of macroeconomic responsibility to both domestic and international investors. These are drivers of CBI outside the scope of financial crises.

This intense focus on CBI promoted a limited perspective on the role of central banks. Consequently, central banks were largely unaware of financial stability risks and unprepared to effectively address the challenges posed by financial crises (Wachtel & Blejer, 2020). Thus, they have evolved to encompass a broad range of objectives, including maintaining price stability, ensuring financial stability, promoting full employment, fostering sustainable economic growth, managing interest rate and exchange rate stability, and overseeing efficient and secure payment systems. Some central banks now also pursue objectives related to financial integrity, financial inclusion, consumer protection, fintech, and even climate change (Adrian, 2024). To fulfill these mandates, central banks have expanded their policy tools beyond traditional monetary policy to include instruments like macroprudential policy (Buch, 2023).

Measuring CBI has been a focal point of recent research. In this work we use the Central Bank Independence Index (CBIE) developed by Romelli (2024) that is built on Cukierman (1982) (CWN) and Grilli et al. (1991) (GMT) works. Garriga (2016), Garriga (2024) and Jácome & Vazquez (2008) also adapt and extend the Cukierman (1982) approach. Adrian et al. (2024) introduces a new index for assessing *de jure* central bank independence, utilizing data from the IMF's Central Bank Legislation Database (CBLD) and Monetary Operations and Instruments Database (MOID); Dincer & Eichengreen (2023) uses machine learning techniques, while Unsal et al. (2022) provides a multidimensional characterization of monetary policy frameworks across independence and accountability, policy and operational strategy, and communications. Additionally, Bodea & Hicks (2015) also offers new extensions in this area.

These measures have been instrumental in quantitatively assessing the effects of CBI. Specially relevant for this work, the literature on the relationship between financial crises and CBI is not conclusive. Romelli (2022) considers four types of shocks that might impact the design of central banks: banking crises, currency crises, debt crises, and inflation episodes, finding that financial crises (banking, debt and currency) do not notably enhance CBI[4] [5]; how-

[4]Romelli refers to financial crises as systemic banking crises.

[5]The only sub-component that appears to be affected is financial independence, which is negatively impacted

ever, banking crises appear to increase the probability of its reduction. This observation aligns with Masciandaro & Romelli (2018), who found that financial crises raise the likelihood of central banks being tasked with financial sector supervision, decreasing its independence.

The primary aim of this study is to investigate whether financial crises are determinants of changes in Central Bank Independence. By incorporating a new approach on measuring the financial crises impact, addressing limitations in prior research, this thesis contributes to a more comprehensive understanding on the effects of financial crises on CBI.

The CBIE Index is divided into six key components: governor and central bank board; monetary policy and conflict resolution; objective; limitations on lending to the government; financial independence; and reporting and disclosure. Each of these categories contain additional detailed metrics. We expect that different financial crises might impact these components differently, suggesting that an analysis limited to the aggregate index may overlook important nuances; thus, a closer examination of each component is essential.

We find evidence that different financial crises have different impacts on CBI through the sub-components. Specifically, banking crises are associated with a decline in CBI, particularly affecting the monetary policy formulation and conflict resolution, financial independence, and objective sub-components. In contrast, currency and debt crises tend to increase CBI, with stronger effects observed in the areas of monetary policy formulation and conflict resolution, financial independence, reporting, and lending. These findings highlight that the relationship between financial crises and CBI is nuanced and highly dependent on the type of crisis and the sub-components through which it operates.

Unlike Romelli (2022), which examines broader factors influencing central bank design (with crises as one hypothesis), this work focuses specifically on financial crises, using a larger panel, more recent data, and a revised methodological approach to capture crisis effects. While Romelli (2022) finds little connection between most financial crises and independence—likely due to methodological shortcomings—this study introduces a refined strategy that produces more insightful results.

Central banks are traditionally slow-moving institutions, characterized by infrequent changes over long periods, holding immense power. This work suggests that they adapt in the

solely by banking crises.

aftermath of financial crises, likely driven by the perception that existing frameworks failed or that additional tools could have been used. After financial crises—some stemming from their own shortcomings, others beyond their control, a discussion for another context—they often emerge with even greater responsibilities and independence. However, the limits of their independence have increasingly come under scrutiny, sparking debates about accountability and balance. Understanding how central banks evolve and respond to financial crises is essential for explaining their current roles, the reasons behind their expanded responsibilities, and their increasing independence over time.

Additional Literature While not directly within the scope of this study, several contributions from the literature provide valuable context on matters related to Central Bank Independence (CBI) and its implications.

Garriga (2024) highlights two important phenomena — the great moderation and the global financial crisis — as significant factors shaping contemporary views on CBI. Despite a general trend toward greater independence during the great moderation, central banks autonomy has faced increasing challenges, particularly after the Global Financial Crisis, driven by rising populism and expanding central bank responsibilities (Goodhart & Lastra, 2018). More recently, CBI has been at the center of public discourse. For instance, Adrian (2024) notes, "We must recognize that many central banks are under tremendous pressure," reflecting concerns following the pandemic and recent inflationary periods. Similarly, CBI has gained attention in the media (Breuninger, 2019; Smith, 2024).

These discussions are supported by quantitative studies assessing the effects of CBI on macroeconomic outcomes. For example, Klomp & Haan (2009) find that central bank objectives focused on price stability contribute to reducing financial instability. Likewise, Quintyn & Taylor (2003) argues that regulatory and supervisory independence are essential for achieving and maintaining financial stability. However, there is ongoing debate regarding these benefits. Aklin & Kern (2018) suggests that the growing financialization of the economy may be an unintended consequence of CBI. Similarly, Berger & Kißmer (2013) challenges conventional views, arguing that more independent central banks may be less inclined to adopt preemptive monetary tightening to safeguard financial stability.

The relationship between financial crises and CBI has also been explored in other studies. For example, Gökmen et al. (2021) challenges the notion that financial crises necessarily

spur structural reforms. Meanwhile, Alesina & Stella (2010) builds on the theoretical models developed by Lohmann (1992) (extensions of Rogoff (1985)), showing that the degree of CBI fluctuates with economic conditions—remaining high during normal times but diminishing during crises, only to recover once the crisis has subsided.

Outline The structure of this study is as follows: First we present the Data and Methods sections, where we explore the data, methods, models and limitations. Next, we present, interpret and discuss the results, including simulations and country-specific illustrations. Finally, we conclude with a summary of the findings.

2 Data

Several data sources are used in this study. The key variables of interest are drawn from the CBIE dataset by Romelli (2024) and from the financial crises dataset by Nguyen et al. (2022). The former provides data on the Central Bank Independence (CBI) Index and its sub-measures, disaggregated by country and year. With its extensive temporal and spatial coverage and its detailed characterization of central bank independence—enabled by the disaggregation of all criteria composing the index—it is the dataset of choice for this analysis. The detailed structure allows for a more precise examination of the various components of CBI. The latter contains dummy variables indicating the occurrence of various financial crises, including banking crises, currency crises, and debt crises. The control variables used in this analysis are elaborated upon in the following sub-section.

Numerous researchers have tried to quantify CBI, resulting in the development of various datasets. Figure 1 illustrates the mean annual value of CBI according to different indexes. The minimum possible value is 0, representing the least independent status, while the maximum value is 1, indicating the highest possible level of independence. The CBIE (Central Bank Independence Extended) measure from Romelli (2024) (red line) builds upon the two most widely recognized indexes — CWN (Weighted, shown in bright green) and GMT (shown in yellow) — while introducing additional characteristics of central bank independence.[6] Romelli (2024) further extends these indexes by extending their coverage to 155 countries, spanning a comprehensive period from 1923 to 2023. Garriga (2016) (Garriga(Weighted), shown in dark green) adapts the approach of CWN, using four dimensions — personnel independence, objective independence, policy formulation independence, and limits on lending, covering 182 countries from 1970 to 2012.[7] [8] While these measures differ in levels, they generally exhibit similar trends over time.

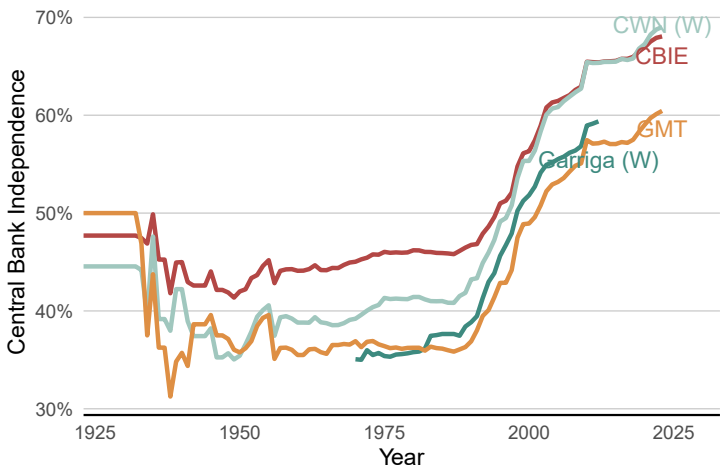
This study specifically employs the CBIE measure (represented by the red line) due to its superior granularity and comprehensiveness providing detailed data on six distinct sub-components and their corresponding sub-components.

[6] Romelli (2022) explains in better detail the new features of CBIE.

[7] A more recent extension is provided by Garriga (2024), which builds on these efforts and includes 190 countries over the extended period from 1970 to 2023.

[8] In appendix A are also shown the indexes from Jácome & Vazquez (2008) (CWNE), and the weighted versions of CWN and Garriga.

Figure 1: Different measures of central bank independence

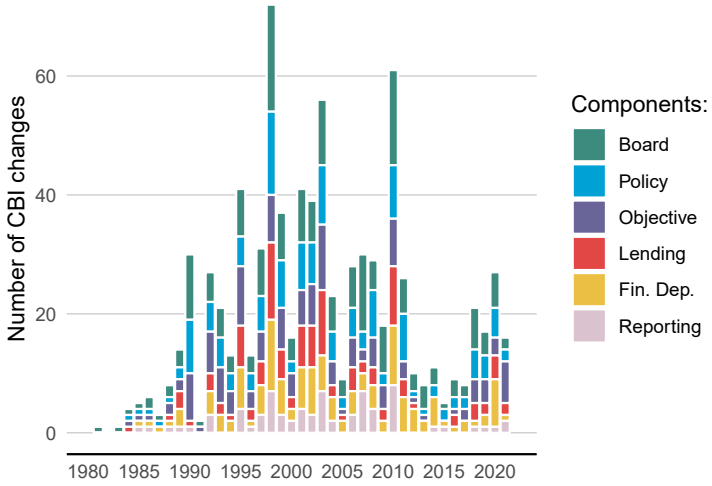


Notes: This figure illustrates the evolution of mean values for various measures of Central Bank Independence (CBI) over time, with each measure represented by a distinct color. The Grilli, Masciandaro, and Tabellini (1991) (GMT) index is shown in orange, the Cukierman, Webb, and Neyapti (1992) (CWN(W)) index in green, the Garriga (2016) index in dark green, and the CBIE index in red. These measures are derived from unbalanced panels, utilizing the full samples available. Consequently, the inclusion of new countries occurs as data becomes available, leading to variations in the number of countries represented across different time periods.

The Central Bank Independence Extended (CBIE) Index is an aggregate measure capturing the independence of central banks, comprising six equally weighted components: *(i)* Monetary Policy and Conflict Resolution (denominated as $Policy$ in this work), which pertains to the central bank's authority over policy decisions free from government interference, as well as its role in overseeing the banking sector and making decisions related to the government budget. *(ii)* Financial Independence ($Fin.Ind.$), which evaluates the ability to manage resources autonomously, maintain financial stability of the institution, and avoid reliance on government funding. *(iii)* Reporting and Disclosure ($Report$) emphasizes transparency through regular reporting on policy outcomes and independently audited financial statements, enhancing institutional credibility. *(iv)* The Objectives ($Objectives$) sub-component assesses the clarity and prioritization of central bank goals, particularly focusing on price stability. *(v)* The Limitations on Lending to the Government ($Lending$) sub-component ensures restrictions on central bank financing of government operations to protect independence. *(vi)* Governor and Central Bank Board ($Board$) component evaluates governance criteria such as appointment methods, term lengths, and dismissal conditions, which collectively safeguard independence from political influence.

Figure 2 shows the number of changes in the CBI index per sub-component, providing an overview of how central bank independence has evolved over time. The graph reveals an initial upward trend, followed by notable spikes in certain periods, such as around 1998 and 2010-2011, indicating moments of significant changes in central bank independence across various components.

Figure 2: Number of central bank independence changes by year



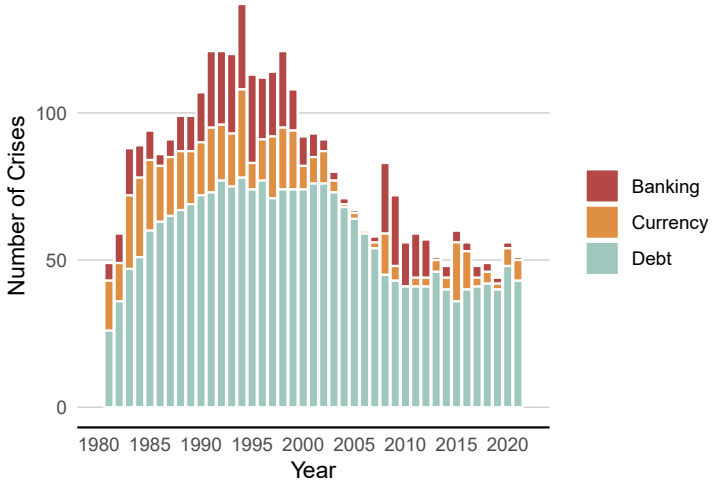
Note: This figure presents the number of Central Bank Independence (CBI) changes, according to the CBIE measure, by component, over the period 1980–2023.

The financial crises dataset from Nguyen et al. (2022) defines a systemic banking crisis by two criteria: (1) significant financial distress, such as bank runs, losses, or liquidations, and (2) major government intervention. A currency crisis occurs when the domestic currency depreciates by over 30% in a year and exceeds the prior year's depreciation by at least 10 percentage points, using both average and end-of-period exchange rates. Sovereign debt crises are defined as either (1) defaults exceeding 1% of GDP for three consecutive years or (2) defaults exceeding 7% of GDP. A crisis ends when defaults fall below 1% of GDP. The existing literature broadly agrees on these three types of financial crises, which form the basis for their use in this study.

Figure 3 illustrates the annual number of financial crises by type, offering insights into their frequency and evolution. The graph highlights a notable increase in crises during the late 1980s and 1990s, peaking around the mid-1990s. Following this peak, there is a general

decline in the number of crises, although debt crises remain relatively persistent over time. The post-2008 period sees a smaller spike, likely related to the global financial crisis, after which crisis occurrences appear to stabilize at lower levels.

Figure 3: Number of financial crises by year



Note: This figure the annual number of crises per by type, categorized into banking (red), currency (orange), and debt (green) crises. Debt crises are the most common type, followed by Currency Crises and Banking Crises. The discrepancy between Debt Crises and other types is likely attributable to their persistence over time.

2.1 Descriptive Statistics and Controls

Table 1 shows the main descriptive statistics for the variables used in the analysis. It is divided into three sections. The first section reports statistics for the measures of central bank independence. The CBI sub-components, similar to the aggregate index, range from 0 (indicating the minimum level of independence) to 1 (indicating the maximum level of independence). The second section provides statistics for variables related to financial crises, including debt, currency, and banking crises, each represented as dummy variables. The third section includes the control variables. We observe that the overall Central Bank Independence (CBI) index has a mean of 0.55, with the Report sub-component showing the highest mean at 0.67 and the Board sub-component the lowest at 0.48. Additionally, Debt crises have a higher mean (0.19), indicating they occur more frequently compared to currency crises (0.05) and banking crises (0.04).

Table 1: Descriptive statistics

Variable	Mean	Median	Std. Dev.	Min	Max	Obs.	Countries
CBIE Measures							
CBI	0.55	0.52	0.18	0.10	0.93	8094	155
Policy	0.48	0.57	0.21	0.00	0.80	8094	155
Fin. Ind.	0.66	0.67	0.17	0.00	1.00	8094	155
Report	0.67	0.62	0.22	0.00	1.00	8094	155
Objective	0.48	0.50	0.34	0.00	1.00	8094	155
Lending	0.51	0.47	0.31	0.00	1.00	8094	155
Board	0.48	0.48	0.19	0.00	0.94	8094	155
Financial Crises							
Debt Crises	0.19	0.00	0.39	0.00	1.00	14016	192
Currency Crises	0.05	0.00	0.23	0.00	1.00	11774	189
Banking Crises	0.04	0.00	0.20	0.00	1.00	12033	191
Controls							
FDI	3.50	1.55	13.00	-394.47	449.08	8370	189
Inflation	5.97	5.58	841.82	-72.73	65374.08	9137	190
Growth	1.91	2.08	6.68	-64.43	150.43	13889	217
Openness	76.36	66.10	48.84	0.02	437.33	8095	180
Political	1.36	1.00	1.07	0.00	3.00	9873	173
Program Start	0.01	0.00	0.11	0.00	1.00	14641	200

Notes: This table presents the main descriptive statistics for the variables used in the analysis. It is divided into three sections. The first section reports statistics for the measures of central bank independence. The second section provides statistics for variables related to financial crises, including debt, currency, and banking crises, each represented as dummy variables. The third section includes control variables, capturing economic, financial, political, and external influence factors.

Several sources are used for the control variables. Inflation data is obtained from the IMF Data Portal. The political regime variable is sourced from the Lührmann et al. (2018) classification and estimated by Herre (2022).[9] Data on IMF programs with conditions comes from the Monitoring of Fund Arrangements (MONA) database and its archives.[10] Openness, FDI and GDP per capita (GDPpc) are taken from the World Bank Database. Additional data on

[9]The classification distinguishes between closed autocracies (score 0), electoral autocracies (score 1), electoral democracies (score 2), and liberal democracies (score 3).

[10]Variables derived from this are construed, not taken as given. IMF conditional programs, denominated as $Programs$, is a dummy variable equal to 1 if a given country, in a given year, starts an IMF program that imposes some type of Condition related to it's Central Bank. For more details see appendix A.

inflation and GDPpc is sourced from the World Economic Outlook.[11] Openness is calculated as the sum of a country's imports and exports relative to its GDP, expressed as a percentage. Foreign Direct Investment (FDI) is similarly expressed as a percentage of GDP. GDPpc serves as the basis for creating the GDPpc growth variable, referred to as "Growth" in this work, which is measured in percentage terms. A detailed summary of these sources is provided in Table 2, with additional explanations in appendix A, while descriptive statistics are presented in Table 1.

Table 2: Sources and variables used in the dataset

Source	**Variable**
Garriga (2016)	Central bank independece index (Weighted (W) and Unweighted(U))
IMF	Inflation, Region
Lührmann (2018)	Political regime
MONA	IMF Conditional Programs
Nguyen (2022)	Financial crises, Banking crises, Currency crises, Debt crises
Romelli (2024)	Central bank independece index extended (CBIE) and sub components; Grilli, Masciandaro and Tabellini (1991) (GMT) index; Cukierman, Webb and Neyapti (1992),(CWN(Weighted (W) and Unweighted(U))); Jacome and Vazquez (2008) (CWNE)
WB	Openness, FDI in GDP relative terms, GDPpc, inflation
WEO (2024)	Inflation, GDPpc

Note: This table shows the source of the variables used on the construction of the dataset used in this work.

The final sample, after merging the datasets and excluding missing values, consists of 5,440 observations across 137 countries. The time span covers up to 55 years, ranging from 1970 to 2022.

3 Methods

The primary aim of this study is to investigate whether financial crises are determinants of changes in Central Bank Independence (CBI). Different types of financial crises, as well as variations across countries and years, can have diverse effects on the aggregate CBI. To better

[11] Different sources for the same variables are used to ensure minimum missing data problems and robustness checks.

distinguish these impacts, this analysis examines the influence of crises on each individual sub-component of the CBI Index: monetary policy and conflict resolution, financial independence, reporting and disclosure, objectives, limitations to lending to the government, and governor and central bank board design. A change in any one of these components implies, *ceteris paribus,* a change in the aggregate CBI measure.

We measure the effect of financial crises while controlling for economic, financial, political, and external pressure factors, as well as country and year fixed effects. Year fixed effects account for global shocks or trends and the uniform responses of countries to those shocks, whereas country fixed effects capture idiosyncratic shocks and variations in how individual countries respond to shared global shocks. To analyze the role of financial crises in determining the sub-components or the aggregate index changes, it is necessary to propose a specific timing for these effects. A priori, it is not expected that a crisis will have a strong immediate impact on independence in the present year, but rather that the most significant effects will manifest with some lags. The subsequent subsection details how this timing issue was addressed.

3.1 Compound Variables

Lags of financial crisis dummies are unlikely to be the best way of capturing the effects of crises, for several reasons. First, employing a dummy variable for each country and year introduces a high-dimensional specification that can lead to inefficiencies in estimation, particularly in models with limited observations or where multicollinearity arises. Moreover, such an approach fails to account for the persistence of crises, as the effect is restricted to a single period (if using just one lag), thereby overlooking the potential for prolonged adjustments triggered by crises. If the effect is likely to happen for a substantial number of periods, as we should test whether this is the case, a lag strategy would need to employ a high number of lagged variables. Including many lagged variables increases the risk of multicollinearity, making it difficult to disentangle the effects of individual lags and undermining the reliability of coefficient estimates. Such a specification also would make model interpretation more complex, as it becomes harder to capture the broader dynamics of crises and their lingering effects without overloading the model with terms. Following this, potential non-linearities in the impact

of crises would be harder to capture and interpret, such as varying intensities of their effects through time.

To address these potential limitations, we propose the use of a set of compound variables for financial crises rather than relying on lagged dummy variables. When a crisis occurs, the immediate aftermath is unlikely to directly affect central bank independence - "(…) central banking (…) are slow-moving institutions generally." (Blinder, 2023); rather, institutional responses typically unfold over time. Consequently, the peak effect of a financial crisis on CBI is likely to occur some periods after the crisis event. Over time, however, the effect of the crisis may dissipate, either because its economic and institutional consequences have fully materialized or because the crisis itself proved inconsequential to institutional design.

Each type of crisis—$Banking$, $Debt$, and $Currency$—is represented by three compound variables (denoted with superscripts $Comp1$ to $Comp3$) designed to capture the persistent and potentially non-linear effects of crises over multiple periods. These are created as:

$$\mathbf{C}_{i,t} = \begin{bmatrix} \text{Banking}_{i,t}^{comp1} = \sum_{k}^{P} (t-k) \times D_{t-k}^{b} \\ \text{Banking}_{i,t}^{comp2} = \sum_{k}^{P} (t-k)^2 \times D_{t-k}^{b} \\ \text{Banking}_{i,t}^{comp3} = \sum_{k}^{P} (t-k)^3 \times D_{t-k}^{b} \\ \text{Debt}_{i,t}^{comp1} = \sum_{k}^{P} (t-k) \times D_{t-k}^{d} \\ \vdots \\ \text{Currency}_{i,t}^{comp1} = \sum_{k}^{P} (t-k) \times D_{t-k}^{c} \\ \vdots \\ \text{Currency}_{i,t}^{comp3} = \sum_{k}^{P} (t-k)^3 \times D_{t-k}^{c} \end{bmatrix}^{T},$$

where $k = 1$ and $D_{i,t-k}^{b,d,c}$ are indicator functions defined as:

$$D_{i,t-k}^{b} = \begin{cases} 1 & \text{if a banking crisis occurs at time } t-k \text{ for country } i, \\ 0 & \text{otherwise,} \end{cases}$$

$$D^{d}_{i,t-k} = \begin{cases} 1 & \text{if a debt crisis occurs at time } t-k \text{ for country } i, \\ 0 & \text{otherwise,} \end{cases}$$

$$D^{c}_{i,t-k} = \begin{cases} 1 & \text{if a currency crisis occurs at time } t-k \text{ for country } i, \\ 0 & \text{otherwise.} \end{cases}$$

The parameter k represents the lag between the onset of a crisis and the activation of the constructed compound variable, which persists for P periods. In this specification, k is fixed at 1 because a crisis occurring at time t is unlikely to immediately affect Central Bank Independence (CBI). Instead, the effect may begin to materialize after a short delay, with its peak impact likely occurring several periods later. Over time, the influence of the crisis may diminish and eventually cease, rendering the compound variable zero. For this analysis, we set $P = 10$, allowing the crisis effects to persist for up to 10 periods after their onset.[12]

To illustrate, consider the effect of financial crises on Central Bank Independence (CBI). It is reasonable to assume that the relationship may not be linear; for instance, the impact of crises on CBI might initially grow over time, reach a peak, and then diminish. To capture this potential curvature, a typical strategy involves including the crisis variable and its square as explanatory variables. This is a similar strategy, equivalent if a crisis duration is just 1 period. Following this approach in my analysis, we introduce an additional term to act as a stabilizer. This third term ensures that the concave curve representing the relationship between crises and CBI does not reverse direction too abruptly or cross into a different sign territory, preserving the expected dynamics and interpretability of the relationship.

3.2 Model

Consider a sample that has N countries and T years. To capture the effect of financial crises on the changes of CBI, we estimate the following equation:

[12]The choice of $P = 10$ is deliberate. Adjusting this value does not significantly alter the results, as demonstrated in Appendix C.

$$\Delta Y_{i,t} = \rho \Delta Y_{i,t-1} + \mathbf{C}_{i,t}\theta + \mathbf{X}_{i,t-1}\beta + \alpha_i + \gamma_t + \epsilon_{i,t} \tag{1}$$

with Y taking different measures of the CBI index, where i denotes a country, t denotes a year, C is the vector of crisis-related regressors, X is the vector of control variables, α captures country fixed effects, γ represents year fixed effects, and ϵ denotes the error term.

The vector $\mathbf{C}_{i,t}$ is the set of crises variable defined in the last section, of dimension 9×1.

The vector $\mathbf{X}_{i,t-1}$ is of dimension $n \times 1$, where n represents the number of control variables, all lagged for consistency with the rationale outlined above, because the CBI is unlikely to be changed in period t due to changes in this same period. The term α_i denotes a $N \times 1$ vector representing country-level fixed effects, while γ_t is a $T \times 1$ vector capturing time fixed effects, where N is the number of countries and T is the number of years.

In the main specification $n = 5$ with the control variables consisting of the three-period moving averages of $GDP\,per\,capita\,growth$, $FDI\,as\,a\,percentage\,of\,GDP$, $Openness$, and $Political$ and a dummy variable, $Program$, indicating whether an IMF program with conditions related to central bank matters was implemented within the past three periods.

The coefficients of interest, represented by the matrix θ, correspond to the (9×1) $\mathbf{C}_{i,t}$ vector, which includes nine regressors capturing the compound crisis variables. The parameter ρ reflects the persistence of changes in Central Bank Independence (CBI) over time. Specifically, it quantifies the extent to which changes in the CBI index (or its sub-components) in the previous period influence changes in the current period. While ρ holds significance from an econometric perspective, its economic interpretation is limited. However, the inclusion or exclusion of this parameter does not materially affect the results, indicating robustness (see appendix C).

Figure 1 underscores the issue of non-stationarity (due to it's clear trend), which presents a critical concern for the analysis. Addressing non-stationarity necessitates adjustments to the model specification and estimation techniques, as implemented in this study. Given the limited variability in the data, first differencing is adopted as a necessary, albeit last-resort, approach to address this issue. Applying second-generation panel tests (Im et al., 2003; Pesaran, 2007) and the Maddala-Wu (MW) Fisher-type test (Maddala & Wu, 1999), also referred to as the

P-test by Choi (2001), which aggregates p-values from Augmented Dickey-Fuller (ADF) tests across panels, provides statistical evidence to reject both stationarity and stationarity around a trend for the variables of interest. Consequently, the presence of unit roots justifies the use of the difference approach.

Seven distinct models are estimated, with Y representing: $CBI\ Index$, $Policy$, $Financial\ Independence$, $Report$, $Objective$, $Lending$, and $Board$, using the first difference as mentioned above. In each specification, the dependent variable and its lagged regressor are expressed in first differences to address non-stationarity. An example equation estimated under this approach is provided below, with its results presented in Column 1 of Table 3.

$$\begin{aligned}\Delta\text{CBI Index}_{i,t} = \rho\Delta\text{CBI Index}_{i,t-1} + \\ \theta_1\text{Banking}_{i,t}^{\text{comp1}} + \theta_2\text{Banking}_{i,t}^{\text{comp2}} + \theta_3\text{Banking}_{i,t}^{\text{comp3}} + \\ \theta_4\text{Debt}_{i,t}^{\text{comp1}} + \theta_5\text{Debt}_{i,t}^{\text{comp2}} + \theta_6\text{Debt}_{i,t}^{\text{comp3}} + \\ \theta_7\text{Currency}_{i,t}^{\text{comp1}} + \theta_8\text{Currency}_{i,t}^{\text{comp2}} + \theta_9\text{Currency}_{i,t}^{\text{comp3}} + \\ \beta_1\text{Growth}_{i,t-1}^{MA3} + \beta_2\text{Openness}_{i,t-1}^{MA3} + \\ \beta_3\text{FDI}_{i,t-1}^{MA3} + \beta_4\text{Political}_{i,t-1}^{MA3} + \beta_5\text{Program}_{i,t-1}^{Last3} + \\ \alpha_i + \gamma_t + \epsilon_{i,t}\end{aligned} \tag{2}$$

3.3 Limitations

Endogeneity might, arguably, pose a challenge in this context, stemming from two primary sources. First, incorporating a lagged dependent variable as a regressor in a panel model introduces endogeneity concerns, as demonstrated in appendix B. Second, the relationship between changes in central bank independence (CBI) and financial crises may be bidirectional, with reverse causality.

Regarding the first issue, the large sample size of the panel reduces the likelihood of significant bias, making it arguably negligible. As for the second issue, there are two main

reasons why this is a lesser concern: the model specification employed and the limited literature exploring this direction of the relationship.

First, the specification used assumes a lagged effect of crises on CBI, meaning that changes in CBI are influenced by crises from previous periods rather than those occurring in the same period. This approach eliminates the possibility of contemporaneous effects, ensuring that a change in CBI at time t cannot influence the likelihood of a crisis at time $t-1$ or earlier. Consequently, this approach might help avoid issues of reverse causation within this framework.

Second, existing literature on the determinants of financial crises, for example Demirgüç-Kunt & Detragiache (1998), generally attributes their causes to factors beyond central banking institutions, with exception of currency crises, since there's evidence on the positive effect of CBI on price stability.[13] While this does not categorically rule out a reverse relationship, it underscores the absence of clear evidence either supporting or refuting such a link for banking and debt crises.

Another limitation of this study is its focus on the broader trends across a large sample of countries. While this approach provides insights into average effects, it lacks the specificity required to understand causal relationships in individual countries. Establishing such relationships would necessitate event studies or in-depth case studies tailored to specific contexts. This lack of specificity limits the ability to fully comprehend unique cases, highlighting an area where further research can contribute to a more nuanced understanding.

In conclusion, while endogeneity poses a potential challenge, the model employed in this study help mitigate its impact. The specification assumes a lagged effect of crises on CBI, reducing the risk of reverse causation by eliminating contemporaneous effects. Furthermore, the limited evidence in the literature supporting a bidirectional relationship, particularly for banking and debt crises, suggests that endogeneity concerns are not significant.The lack of country-specific insights in the estimates can also be regarded as a limitation.

[13] Demirgüç-Kunt & Detragiache (1998) highlights that systemic banking crises often occur under conditions of low economic growth, with high real interest rates and balance of payments pressures playing significant roles.

4 Results

This section presents the findings on how financial crises affect central bank independence (CBI). Looking at the aggregate index sub-components, we investigate the sub-components through which distinct types of financial crises — currency, banking, and debt — impact CBI.

The estimation results of Equation 1 are presented in Table 3, where the primary focus is on the estimated values of the parameters for the crisis regressors. For clarity, control variables have been omitted from the table. The interpretation is not direct due to the nature of the variables, which are constructed as a set of compounded measures. Remember, as outlined in the previous section, compound variables are crisis variables that capture the persistence of their impact over time and allow for non-linear effects. The sequence of coefficient signs for each crisis type provides the key idea for understanding the results. For instance, a sequence such as $\widehat{\theta}_1^b < 0$ (for the first compound variable), $\widehat{\theta}_2^b > 0$ (for the second compound variable), and $\widehat{\theta}_3^b < 0$ (for the third compound variable), where the superscript b denotes coefficients related to the banking variable, indicates that the estimated effect of a banking crisis on changes in CBI is negative, forming concave-up curve.[14] Conversely, an opposite sequence of signs would suggest a positive impact, represented as a concave-down curve.

The results presented in Table 3 indicate that several sub-components—Policy, Financial Independence, Reporting, Objective, and Lending—are significantly influenced by different financial crises.[15] In contrast, the Board sub-component consistently shows no statistically significant response. This lack of significance is not entirely unexpected; for example, Haan et al. (2018) finds that central bank governor turnover rates have generally remained stable since the Global Financial Crisis.

[14] After controlling for economic, financial, political, and external determinants, as well as controlling for both year and country fixed effects, alongside the inclusion of the lagged dependent variable.

[15] Table 3 presents the results of estimating Equation 1 using the sample discussed. The sample presented before is filtered to include only countries with 10 or more years of observations. Other observations are also "lost" due to the use of lags, moving averages and construction of compound variables.The complete output and additional control variables (used as robustness tests) are shown in appendix C.

Table 3: Preferred Model of Financial Crises Effects.

Dependent Variables:	Δ CBI Index$_t$	ΔPolicy$_t$	ΔFin. Ind.$_t$	ΔReport$_t$	ΔObjective$_t$	ΔLending$_t$	ΔBoard$_t$
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Banking$_t^{comp1}$	-0.144**	-0.148**	-0.174***	-0.071	-0.291**	-0.068	-0.105
	(0.063)	(0.069)	(0.051)	(0.075)	(0.148)	(0.117)	(0.073)
Banking$_t^{comp2}$	0.032**	0.030*	0.041***	0.014	0.074*	0.011	0.022
	(0.016)	(0.017)	(0.013)	(0.020)	(0.041)	(0.030)	(0.018)
Banking$_t^{comp3}$	-0.002*	-0.002	-0.002***	-0.0008	-0.005*	-0.0006	-0.001
	(0.001)	(0.001)	(0.0008)	(0.001)	(0.003)	(0.002)	(0.001)
Debt$_t^{comp1}$	0.076**	0.032	0.008	0.058**	0.193**	0.121**	0.039
	(0.037)	(0.039)	(0.029)	(0.029)	(0.094)	(0.056)	(0.033)
Debt$_t^{comp2}$	-0.017**	-0.007	-0.003	-0.014**	-0.042**	-0.026**	-0.008
	(0.008)	(0.009)	(0.007)	(0.006)	(0.020)	(0.012)	(0.008)
Debt$_t^{comp3}$	0.0008**	0.0004	0.0001	0.0007**	0.002**	0.001**	0.0004
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0010)	(0.0006)	(0.0004)
Currency$_t^{comp1}$	0.270***	0.202**	0.221**	0.251**	0.326	0.507***	0.105
	(0.096)	(0.098)	(0.090)	(0.100)	(0.247)	(0.172)	(0.100)
Currency$_t^{comp2}$	-0.071***	-0.050*	-0.055**	-0.072**	-0.079	-0.130***	-0.039
	(0.027)	(0.029)	(0.025)	(0.030)	(0.066)	(0.048)	(0.029)
Currency$_t^{comp3}$	0.005**	0.003	0.003*	0.005**	0.005	0.008**	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Dep. Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects							
year (50)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country (134)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics							
Observations	4,813	4,813	4,813	4,813	4,813	4,813	4,813
Dependent variable mean	0.499	0.411	0.179	0.423	0.867	0.697	0.418
R^2	0.064	0.049	0.060	0.047	0.056	0.047	0.070

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This output presents the results of the seven estimated equations described in the previous section. The models incorporate control variables, including three-period moving averages of GDP per capita growth, openness, FDI in GDP relative terms, political regime, and a dummy variable indicating whether the country initiated an IMF program with central bank-related conditions in the last three periods. Additionally, the models include the lagged dependent variables, year and country dummies.

Examining each financial crisis type, the results are that banking crises appear to diminish independence, particularly affecting the Policy, Financial Independence, and Objective sub-components. Debt crises, by contrast, tend to enhance CBI, most notably through improvements in Reporting, Objective, and Lending dimensions. Currency crises also produce

positive effects, particularly on the Policy, Financial Independence, Reporting, and Lending sub-components.[16] While some of these outcomes align with expectations, others are less straightforward.

Banking crises negatively affect the CBI Policy sub-component.[17] This result can be explained by the fact that, in the face of such crises, central banks may be tasked with broader responsibilities over the banking sector, potentially introducing conflicts that undermine their independence.[18] This idea is reflected, for example, in Jordan (2022), who notes that when central banks are entrusted with such supervision, their independence may quickly come under scrutiny due to potential conflicts of interest.[19] This also relates to the objective sub-component, where banking crises seems to also have a negative effect. Haan et al. (2018) and Cerutti et al. (2017) highlight that, since the financial crisis, central banks have increasingly looked at financial stability. This shift is partly due to being explicitly tasked with macroprudential supervision and partly because financial stability is now viewed as integral to achieving broader macroeconomic stability. This is in line with Adrian & Khan (2019) highlighting that after the global financial crises CBs broadened their functions on top of their mandate of price stability, helping to explain this result.

In contrast, currency crises affect positively the Policy sub-component. We can also suggest a rationale for this result. These crises might stem from misguided or misused monetary policy, which might happen because of political interference on the formulation of monetary policy or policy rate setting, for example. This can create pressure on central banks to consolidate authority over monetary policy, potentially reducing government and political interference and get the final word on the resolution of conflicts. For example, governments focused on re-election may attempt to implement expansionary monetary policies to temporarily lower debt financing costs and boost economic activity, that could, ultimately, create currency problems, so, to avoid this, independence plays an important role (Jordan, 2022).

[16] The mentioned sub-components are the ones the coefficients show statistical significance at the 5% level for, at least, one of the compound variables.

[17] Policy refers to the sub-component of monetary policy and conflict resolution.

[18] For example, if banking supervision is entrusted to the central bank, the CBI framework interprets this as a lower level of independence compared to a scenario where banking supervision is not within the central bank's mandate.

[19] Jordan (2022) also mentions conflicts of interest arising from political groups that force the central bank to pursue additional goals, leading to problems on the ability or willingness of the central bank to ensure price stability. Less authority in conflict resolution with the government and greater government intervention in monetary policy formulation could also reduce the central bank's independence.

Banking crises also affects negatively the Financial Independence sub-component. This is less straight forward to interpret, but some rational can be suggested. During a banking crisis, central banks frequently engage in emergency lending, liquidity support, and other stabilization measures that can increase reliance on government relationships. Over time, this dependency can grant fiscal authorities greater leverage over the central bank's budgetary decisions, capitalization policies, and profit allocation. As a result, the central bank's financial autonomy and its capacity to operate without direct government influence are undermined. Such an environment, where fiscal and monetary spheres become intertwined, diminishes the central bank's insulation from political pressures.

The positive association between currency crises and financial independence is less straight forward but may stem from a post-crisis reform dynamic. After a currency crisis, reinforcing the central bank's financial autonomy can be part of a broader strategy to restore credibility. Ensuring that the central bank can manage its balance sheet, profits, and reserves independently signals to investors, markets, and the public that monetary policy will not be subordinated to fiscal imperatives. While this interpretation remains somewhat speculative, it highlights the potential for currency crises to trigger reforms that strengthen the central bank's financial arm's-length relationship with the government.

Currency crises positively influence the lending sub-component. A reason for this might be that excessive lending can lead to inflationary pressures, something that has some correlation with currency crises. Also, implementing prudent fiscal policies that maintain debt sustainability is essential to mitigate the risk of fiscal dominance—where the central bank faces pressure to finance government spending at low costs, ultimately fueling inflation (Georgieva, 2024), which might create currency problems. More CBI in lending restriction to the government can be a tool to control those problems.

On the other hand, debt crises increase the independence of the CB on the objective sub-component. This can be explained by Kaehler & Weber (2023) finding that debt crises raise inflation rates, which might be a rational on why, in the aftermath of debt crises, the CB focuses its objectives more on price stability. Moreover, Debt crises positively affects the Lending sub-component, and a similar argument can be made. Historically when central banks have close relationships with the fiscal authority, expansionary monetary policy might be overused used to finance government deficits. Time and again, this has ended in high inflation Jordan (2022). Bodea (2013) and Bodea & Higashijima (2017) show that independent central banks

are associated with lower fiscal deficits. This independence does not imply avoiding fiscal deficits in a counter cyclical fashion, but brings political neutrality on election years.

Finally, for the Reporting and Disclosure sub-component, debt and currency crises both appear to foster greater transparency and accountability. In the aftermath of such crises, there is often a heightened demand for information, scrutiny, and clearer communication from public institutions, including central banks. By improving their reporting standards, providing more frequent and detailed disclosures, and adhering to transparent operational frameworks, central banks can rebuild trust, enhance credibility, and demonstrate their commitment to sound policy practices. As Adrian & Khan (2019) and Adrian (2024) underscore, transparency and reliable reporting can reinforce a central bank's legitimacy and position it more favorably in the eyes of both policymakers and the public. South African Reserve Bank Governor Lesetja Kganyago's remark—stressing the need for central banks to "take society along"—captively illustrates that openness and engagement can shield central bank independence from political backlash, as it clarifies policy intentions and highlights the institution's role in preserving macroeconomic stability.

4.1 Simulation and Examples

In this section we present the results of the estimated model through visualizations. For this we conduct a simulation and provide examples that focus on specific countries.

For the simulation, for each type of financial crisis, we set a crisis to begin at time $t = 0$, individually, meaning that there's just one type of crises happening and that crisis duration is just one period. Using the compound variable algorithm, the three compound variables for each crisis type are calculated. With these computed compound variables and the estimated coefficients from Table 3, we trace the temporal impact of each type of crisis, for each independence sub-component.

Figure 4 presents the simulation results for the aggregate index, derived using the estimates from Table 3, Column 1, for the three types of crises. The simulation assumes that each one of the three crises begins at time $t = 0$, where the initial impact is zero. We observe that, in subsequent periods, the impact increases (in absolute terms), reaches a peak, and then gradually decreases and dissipates over time. As expected, banking crises exhibit a negative

effect on Central Bank Independence (CBI), while currency and debt crises show a positive impact. The confidence intervals, depicted by shaded bands, demonstrate that the effects of banking and currency crises are statistically different from zero in several periods, whereas the impact of debt crises appears less consistent.[20] Notably, when the fitted line crosses zero (for example, in the currency case) and changes the sign of the impact, it is never statistically different from zero.

Figure 5 tells a similar story, highlighting that the effects of different types of crises vary both in direction and magnitude. Banking crises consistently exhibit a negative impact across all sub-components, while currency and debt crises generally show positive effects, although these are not always statistically significant, particularly in the case of debt. When the fitted line crosses zero and changes the sign of the impact, it is never statistically significant, except for debt on the reporting sub-component and currency on the board sub-component—two cases that neither align with intuition nor the general results.

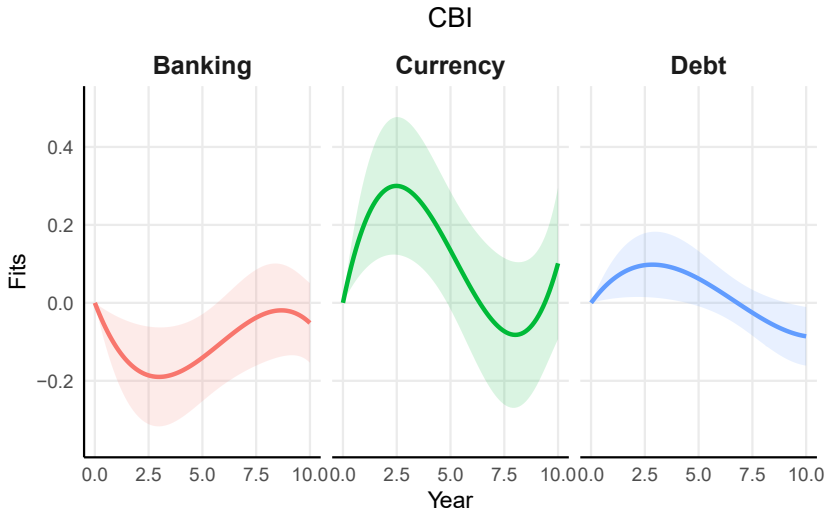


Figure 4: Simulation of crises impact on the aggregate central bank independence

Notes: This simulation illustrates the fitted values generated from three sets of compound variables on the CBI Index, for the three types of crises. Shaded bands indicate confidence intervals at the 5 percent level.

[20]The confidence intervals, displayed at the 5% level, are calculated using the delta method, as detailed in Appendix D.

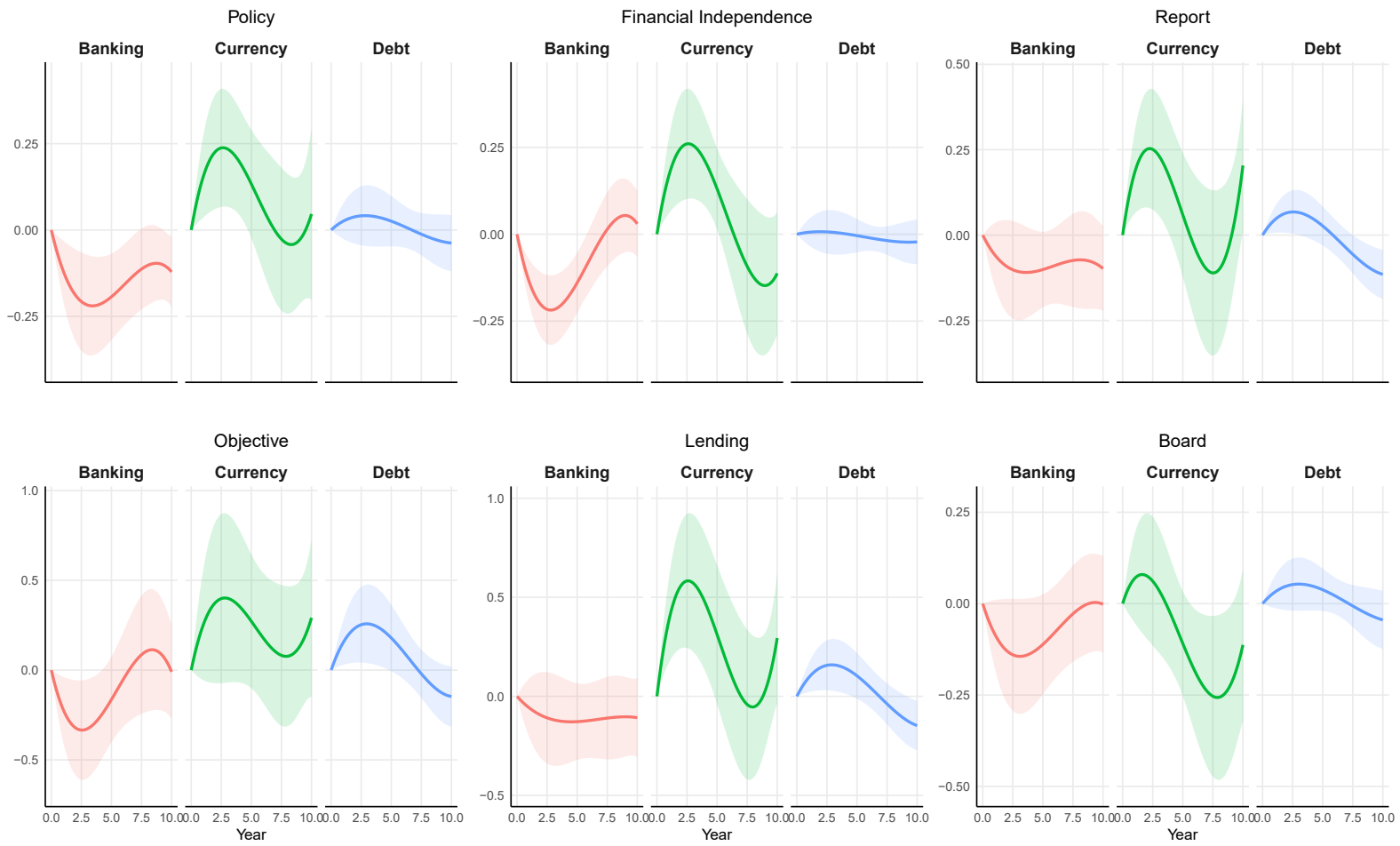


Figure 5: Simulation of the crises impact on central bank independence sub-components

Notes: This simulation illustrates the fitted values generated from three sets of compound variables across the six subcomponents of the CBI Index, analyzed for the three types of crises. Shaded bands indicate confidence intervals at the 5 percent level. As expected, some curves display a concave-up shape, while others show a concave-down pattern, capturing the nonlinear temporal effects of crises on CBI. Detailed explanations of the simulation methodology and computations can be found in the appendix.

Figure 6 illustrates six examples of specific countries and time periods where changes in central bank independence (CBI) coincided with different financial crises fitted impacts. In these cases, the direction of the CBI change—whether an increase or decrease—aligns with the expected direction of the crisis's impact, as suggested by the model. We begin by identifying the types and frequency of crises that occurred in each country, then we calculate the estimated effects on CBI that are represented by blue lines for banking crises, orange lines for debt crises, and green lines for currency crises. Note that vertical green dashed lines indicate positive changes in CBI (as seen, for example, in the case of South Africa), while red dashed lines represent negative changes (as seen, for example, in the case of Hungary).

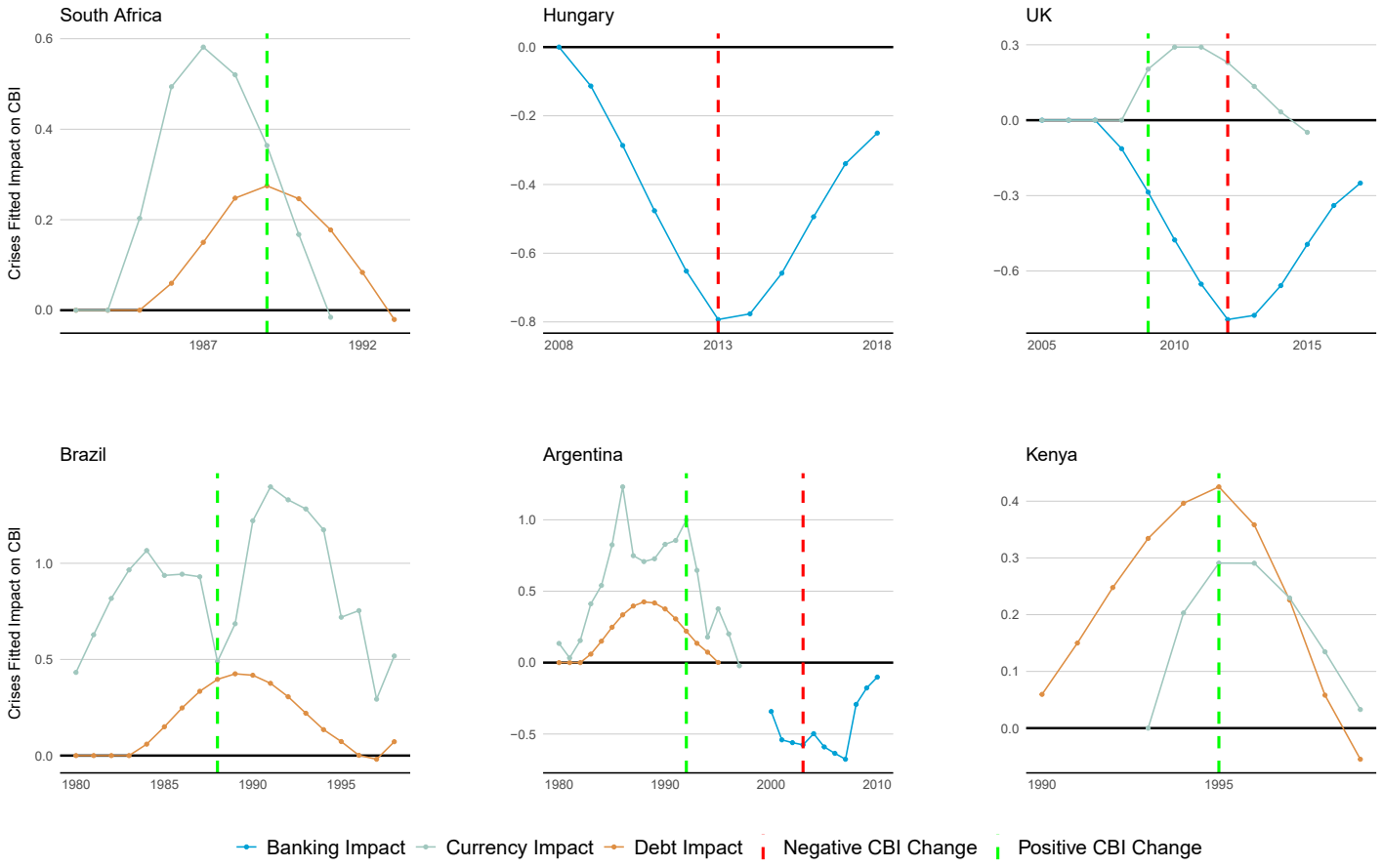


Figure 6: Crises fitted impacts on central bank independence changes

Notes: This figure illustrates the estimated impact of banking, currency, and debt crises for selected countries during specific time periods, alongside the years when changes in CBI occurred. While these examples align with the estimated results, establishing a direct causal relationship for each case would necessitate a detailed case study approach.

It is important to note that this figure serves as a visual illustration of the broader idea rather than a formal demonstration of causal relationships. While these examples effectively materialize the theoretical ideas, establishing an individual causal relationship for each case would require a detailed case study approach, which is not done here.

In 2009, the UK increased its Central Bank Independence due to changes in the governor and the central bank board composition. This adjustment occurred near the peak of the currency crisis, just one period after its onset. Table 3 indicates a positive, though statistically insignificant, impact of currency crises on this sub-component. In 2012, the UK experienced a decrease in CBI due to a decrease in the monetary policy and conflict resolution component. This was due to banking supervision responsibilities being fully transferred to the central bank, which previously did not hold this role. This change coincided with the peak of the estimated impact of the banking crisis.

Brazil, in 1989, significantly increased its Central Bank Independence (CBI) from 12.15 to 26.50.[21] This rise was driven by changes that strengthened limitations on lending to the government, enhancing the central bank's independence across all dimensions of this sub-component. This increase occurred during a period of heightened estimated impact of debt and currency crises, aligning with the findings presented in Table 3.

In 1992, Argentina's CBI rose significantly from 52 to 80. The governor and central bank board strengthened, and the policy formulation process shifted from the central bank advising the government to being solely responsible. Conflict resolution also changed, granting the central bank authority over issues defined by law as its objectives. Additionally, the bank's primary objective transitioned from mixed goals to prioritizing price stability. Restrictions on government lending were tightened, including limits on advances, maturity, interest rates, and financing conditions. Report standards also improved. These changes align with results, since happen when the estimated impact if debt and currency crises was high.

However CBI decreased during a period of high estimated impact from banking crises, as it would be expected considering the model results. Policy formulation reverted from central bank control to only advising the government, and conflict resolution shifted back to the executive branch having unconditional priority. The central bank's sole focus on price stability was diluted, incorporating conflicting or secondary objectives, reducing its independence.

[21] For better visualization, the range of 0–1 in the CBI index is represented as 0–100.

In Hungary, CBI decreased in 2013. The decline was driven by changes in the board and monetary policy and conflicts resolution: the central bank's banking supervision role changed from having no responsibility to being solely entrusted with this task. This adjustment, reflecting a reduction in policy independence, coincided with the peak estimated impact of a banking crisis, consistent with expected dynamics.

In 1995, Kenya's CBI increased from 58 to 63 due to reforms across governor and central bank board, objectives and Limitations on lending to the government sub-components. The objectives improved as the focus shifted from price stability alongside conflicting goals to price stability with non-conflicting objectives. Significant changes were also made in the limitations on lending to the government, including stricter restrictions on advances, tighter lending conditions, greater central bank authority in defining financing terms, shorter maturity periods for advances, and adjustments to align interest rates on advances with market levels. This, as expected, happened in the peak of the impact of debt and currency crises.

In 1989, South Africa's CBI increased from 42 to 51 due to changes in governor and central bank board, monetary policy and conflicts resolution and objectives. The formulation of monetary policy shifted, granting the central bank full responsibility, from having no say, and the central bank gained authority in conflict resolution, moving from the executive branch having conditional priority to the central bank having the final word on defined objectives. Additionally, objectives improved slightly, as price stability was introduced. These reforms occurred close to the peak of both currency and debt crises, reflecting the heightened pressures of the time.

5 Conclusion

This study investigates the impacts of financial crises—banking, debt, and currency—on changes in Central Bank Independence (CBI), offering new evidence that financial crises affect CBI and that different financial crises impact sub-components in distinct ways. Banking crises are shown to erode CBI, particularly in monetary policy formulation and conflict resolution, financial independence, and central bank objectives, reflecting the expanded responsibilities and fiscal dependencies that can arise during such crises. In contrast, currency and debt crises are associated with an enhancement of CBI, with currency crises strengthening monetary policy formulation and conflict resolution, financial independence, lending and reporting, while debt crises drive improvements in reporting, objectives, and lending restrictions.

A contribution of this study is the introduction of a set of compound variables, which enable a more accurate representation of crisis dynamics and their effects on CBI over time. Employing this set of compound variables to capture the prolonged and non-linear impacts of crises, this study addresses limitations in previous research, which often relied on lagged dummy variables and overlooked the delayed and dissipating effects of crises.

Beyond the immediate findings, this research emphasizes the importance of disaggregating the effects of crises to understand the mechanisms driving institutional reforms. While crises often act as catalysts for change, the direction and magnitude of these changes are deeply context-dependent. Future research could explore the heterogeneity of crisis impacts and investigate specific case studies to provide a more nuanced understanding. Additionally, it would be valuable to further examine the bidirectional relationship between CBI and crises, including how central bank independence might influence the onset or severity of financial crises.

By elucidating how financial crises shape central bank independence, this study contributes to a deeper understanding on how central banks evolve and respond to financial crises and explaining their current roles, the reasons behind their responsibilities and independence over time.

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A Appendix

A.1 Appendix A: Data

This section outlines further details on the data utilized in this study, including its sources, construction where applicable, and visual representations to aid in understanding its characteristics and trends.

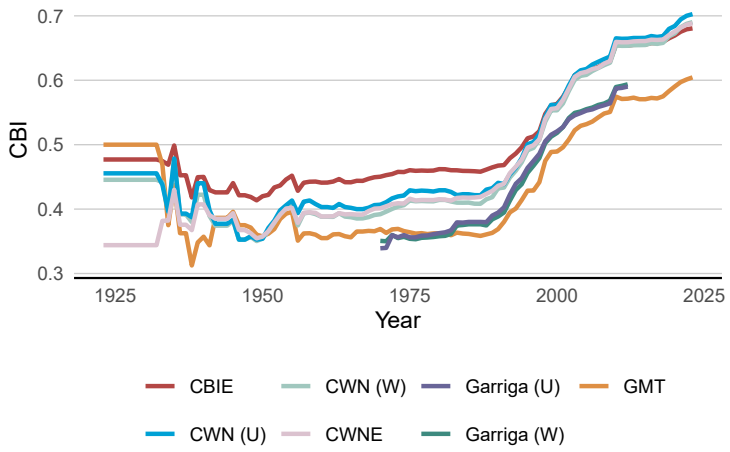
A.1.1 Different measures of CBI

Table 4: Correlation matrix for the central bank independence measures

	CBIE	CWNE	CWN (W)	GMT	Garriga(W)
CBIE	1.00	0.95	0.94	0.84	0.73
CWNE	0.95	1.00	0.96	0.84	0.76
CWN (W)	0.94	0.96	1.00	0.85	0.74
GMT	0.84	0.84	0.85	1.00	0.68
Garriga(W)	0.73	0.76	0.74	0.68	1.00

Notes: The table shows the correlation matrix between the central bank independence variables. Missing obseravtions are not included. As expected, the variables are highly correlated, with the exception of the Garriga index, that, despite the high correlation, still lags behind the other variables.

Figure 7: Different measures of CBI complete



Notes: This figure illustrates the evolution of mean values for various measures of Central Bank Independence (CBI) over time, with each measure represented by a distinct color. The Grilli, Masciandaro, and Tabellini (1991) (GMT) index is shown in orange, the Cukierman, Webb, and Neyapti (1992) (CWN(W)) index in green and CWN (U) in blue, the Garriga (W) (2016) index in dark green and (U) in purple, the CBIE index in red and the CWNE from Jacome and Vazquez (2008) in pink. These measures are derived from unbalanced panels, utilizing the full samples available. Consequently, the inclusion of new countries occurs as data becomes available, leading to variations in the number of countries represented across different time periods.

A.1.2 Crises compound variables

To incorporate the persistence of crises over time, we constructed compounded variables that try to capture the cumulative effect of crises over time. Those variables will be used in the empirical analysis to give more stuctered results. The compounded variables are constructed as follows:

$$\mathbf{C}_{i,t} = \begin{bmatrix} \text{Banking}_{i,t}^{comp1} = \sum_{k}^{P} (t-k) \times D_{t-k}^{b} \\ \text{Banking}_{i,t}^{comp2} = \sum_{k}^{P} (t-k)^2 \times D_{t-k}^{b} \\ \text{Banking}_{i,t}^{comp3} = \sum_{k}^{P} (t-k)^3 \times D_{t-k}^{b} \\ \text{Debt}_{i,t}^{comp1} = \sum_{k}^{P} (t-k) \times D_{t-k}^{d} \\ \text{Debt}_{i,t}^{comp2} = \sum_{k}^{P} (t-k)^2 \times D_{t-k}^{d} \\ \text{Debt}_{i,t}^{comp3} = \sum_{k}^{P} (t-k)^3 \times D_{t-k}^{d} \\ \text{Currency}_{i,t}^{comp1} = \sum_{k}^{P} (t-k) \times D_{t-k}^{c} \\ \text{Currency}_{i,t}^{comp2} = \sum_{k}^{P} (t-k)^2 \times D_{t-k}^{c} \\ \text{Currency}_{i,t}^{comp3} = \sum_{k}^{P} (t-k)^3 \times D_{t-k}^{c} \end{bmatrix}^{T}$$

Where $D_{i,t-k}^{b,d,c}$ are indicator functions defined as:

$$D_{i,t-k}^{b} = \begin{cases} 1, & \text{if a banking crisis occurs at time } t-k \text{ for country } i, \\ 0, & \text{otherwise.} \end{cases}$$

$$D_{i,t-k}^{d} = \begin{cases} 1, & \text{if a debt crisis occurs at time } t-k \text{ for country } i, \\ 0, & \text{otherwise.} \end{cases}$$

$$D_{i,t-k}^{c} = \begin{cases} 1, & \text{if a currency crisis occurs at time } t-k \text{ for country } i, \\ 0, & \text{otherwise.} \end{cases}$$

The parameter k represents the lag between the onset of a crisis and the activation of the constructed compound variable, which persists for P periods. In this specification, k is fixed at 1 because a crisis occurring at time t is unlikely to immediately affect Central Bank Independence (CBI). Instead, the effect may begin to materialize after a short delay, with its peak impact likely occurring several periods later. Over time, the influence of the crisis may diminish and eventually cease, rendering the compound variable zero.

The following table exemplifies the computations for this variable when $P = 4$, (δ_1) = 1.032, (δ_2) = -0.2689, (δ_3) = 0.018 and k (lags) equal to.

Table 5: Compound Variable Computation

Country	crises	lag(1)	lag(2)	lag(3)	lag(4)	comp1	comp2	comp3	Effetc
A	0	0	0	0	0	0	0	0	0
A	1	0	0	0	0	0	0	0	0
A	0	1	0	0	0	1	1	1	0.7811
A	0	0	1	0	0	2	4	6	1.0964
A	0	0	0	1	0	3	9	27	**1.1619**
A	0	0	0	0	1	4	16	64	0.9776
A	0	0	0	0	0	0	0	0	0
B	1	0	0	0	0	0	0	0	0
B	1	1	0	0	0	1	1	1	0.7811
B	0	1	1	0	0	3	5	7	1.8775
B	0	0	1	1	0	5	13	35	**2.2943**
B	0	0	0	1	1	7	25	91	2.1395
B	0	0	0	0	1	4	16	64	0.9776
B	0	0	0	0	0	0	0	0	0

A.1.3 IMF program conditionality

A crucial aspect of institutional development, particularly with regard to central banks, stems from external pressures. One significant source of such pressures comes from the programs that countries sign with international institutions like the International Monetary Fund (IMF). These programs are designed to provide financial assistance to countries facing economic difficulties, and in return, countries commit to implementing a set of policy measures—known as conditionalities. These conditions aim to address the underlying structural economic issues and promote long-term sustainable growth and macroeconomic stability. This information might serve as a proxy for external pressure.

To analyze the influence of IMF programs on central banks, we utilize the Monitoring of Fund Arrangements (MONA) database. International Monetary Fund (2024) is a comprehensive IMF-maintained database that tracks the objectives, conditionalities, and economic outcomes of IMF-supported arrangements across countries. It allows for an assessment of

IMF programs on a yearly basis at the country level, with specific focus on those programs that included measures affecting central banks.

For this analysis, it is essential to distinguish between two distinct periods: pre-2002 and post-2002. This division is based on the quality and completeness of the available data. While post-2002 data are more robust and detailed, the pre-2002 data from the MONA archives are still invaluable for tracing earlier IMF programs and their conditionalities, despite some limitations in the comprehensiveness of the documentation. The methodology employed here makes use of both periods, allowing for a broader historical analysis of the IMF's influence on central bank development.

Post 2002

For the post-2002 period, we make use of the Program Goals and Reform Strategies section of the MONA database, which contains detailed information on program conditionalities. Specifically, we extract a dummy variable that indicates whether a program includes central bank-related conditionalities. This variable allows us to identify and flag programs where central banks were explicitly targeted as part of the policy conditions imposed by the IMF.

In this analysis, the focus is not only on whether a program included central bank conditions, but also on when such programs started. To achieve this, we generate a variable that captures the start year of each program conditional on central bank involvement. The variable is coded as 1 only for the year in which the program, conditional on central banks, began. In subsequent years or for programs without central bank conditionalities, the value is set to 0. This approach ensures that the analysis focuses on the initial imposition of central bank-related conditionalities, rather than the presence of any program in general.

Pre 2002

For the pre-2002 period, the level of detail in the MONA data is not as comprehensive as the post-2002 period. Detailed information on program conditionalities is often missing. However, to account for the influence of IMF programs on central banks in this earlier period, we adopt a text-based approach. Specifically, we manually filter program descriptions to identify references to central banks. If the description of a program includes the phrases "central bank" or "Central Bank", we assume that the program contained central bank-related conditionalities.

While this method lacks the precision and granularity of the post-2002 data, it serves as a useful proxy for identifying central bank-related interventions in earlier IMF programs. Programs that include these terms in their descriptions are flagged with a dummy variable, marking them as having central bank-related conditions. In cases where program descriptions lack these references, the program is considered not to have targeted central banks.

A.2 Appendix B: Endogeneity problem

Considering the following model with a lagged dependent variable:

$$Y_{it} = \alpha Y_{i,t-1} + \beta X_{it} + u_{it}$$

Where: - Y_{it}: dependent variable for individual i at time t,

- $Y_{i,t-1}$: lagged value of the dependent variable,
- X_{it}: exogenous regressor,
- $u_{it} = \eta_i + \epsilon_{it}$: composite error term with:
- η_i: time-invariant individual effect,
- ϵ_{it}: idiosyncratic error term.

Here, we assume that η_i and ϵ_{it} are uncorrelated with X_{it}, but they introduce a problem when we add $Y_{i,t-1}$ as a regressor.

Since $Y_{i,t-1}$ depends on past values of u_{it}, it will generally be correlated with the error term u_{it} through the individual effect η_i. To show this mathematically, consider the following steps.

Now, rewriting the model using the lagged error term, by substituting $u_{it} = \eta_i + \epsilon_{it}$ into the model:

$$Y_{it} = \alpha Y_{i,t-1} + \beta X_{it} + \eta_i + \epsilon_{it}$$

Now, lagging the equation by one period:

$$Y_{i,t-1} = \alpha Y_{i,t-2} + \beta X_{i,t-1} + \eta_i + \epsilon_{i,t-1}$$

To demonstrate endogeneity, we calculate the correlation between $Y_{i,t-1}$ and the composite error term $u_{it} = \eta_i + \epsilon_{it}$. Substitute $Y_{i,t-1}$ from the lagged equation into the current error term:

$$\text{Cov}(Y_{i,t-1}, u_{it}) = \text{Cov}(\alpha Y_{i,t-2} + \beta X_{i,t-1} + \eta_i + \epsilon_{i,t-1}, \eta_i + \epsilon_{it})$$

Notice that $Y_{i,t-1}$ includes η_i, which is also part of u_{it}. This implies that:

$$\text{Cov}(Y_{i,t-1}, u_{it}) \neq 0$$

Specifically, $Y_{i,t-1}$ and η_i share a common component, so they are correlated. This correlation violates the assumption of exogeneity required for OLS, as OLS assumes that regressors are uncorrelated with the error term.

A.3 Appendix C: Robustness tests

A.3.1 Include Inflation

Some studies include inflation measures to study "inflation crises". Here the goal is to study financial crises. Evidently the distinction might be hard to make in some cases, since inflationary processes might be related (originated by, or even originate) this financial crises. Currency crises might be more concerning. First we look at the correlations and then to the impact of adding or not inflation to the model by looking at the regressions. We expect the correlation between inflation and currency crises to be higher than with other crises.

Table 6: Inflation and crises correlation matrix

	Banking	Currency	Debt	Inflation	HINF
Banking	1.00	0.15	0.08	0.13	0.15
Currency	0.15	1.00	0.13	0.35	0.44
Debt	0.08	0.13	1.00	0.12	0.10
Inflation	0.13	0.35	0.12	1.00	0.59
HINF	0.15	0.44	0.10	0.59	1.00

Notes: Spearman correlation is used as it handles ranked data and is robust to outliers, making it appropriate for dummy variables. The within-entity correlation focuses on variations over time within each country, removing cross-entity differences.

As expected, currency crises have a correlation of 0.35 with Inflation and 0.59 with the High Inflation dummy. Despite this higher correlation (comparing with other crises types), it is clearly far from being collinear.

To further investigate the impact of including inflation in the model, we ran the models with inflation. There are minimal changes in the magnitudes of the coefficients. The inclusion or exclusion of Inflation has no significant consequences on the results, thus in the main specification is not included.

Table 7: Preferred Model of Financial Crises Effects Without Lagged Dependent Variables

Dependent Variables:	Δ CBI Index$_t$	ΔPolicy$_t$	ΔFin. Ind.$_t$	ΔReport$_t$	ΔObjective$_t$	ΔLending$_t$	ΔBoard$_t$
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Banking$_t^{comp1}$	-0.144**	-0.149**	-0.174***	-0.071	-0.288*	-0.067	-0.107
	(0.063)	(0.070)	(0.051)	(0.075)	(0.149)	(0.117)	(0.073)
Banking$_t^{comp2}$	0.032**	0.030*	0.041***	0.014	0.074*	0.011	0.023
	(0.016)	(0.018)	(0.013)	(0.020)	(0.041)	(0.030)	(0.018)
Banking$_t^{comp3}$	-0.002*	-0.002	-0.002***	-0.0008	-0.004*	-0.0005	-0.001
	(0.001)	(0.001)	(0.0008)	(0.001)	(0.003)	(0.002)	(0.001)
Debt$_t^{comp1}$	0.074**	0.032	0.008	0.056*	0.188**	0.116**	0.040
	(0.038)	(0.040)	(0.030)	(0.029)	(0.095)	(0.057)	(0.034)
Debt$_t^{comp2}$	-0.016**	-0.007	-0.002	-0.014**	-0.041**	-0.025**	-0.008
	(0.008)	(0.009)	(0.007)	(0.006)	(0.020)	(0.012)	(0.008)
Debt$_t^{comp3}$	0.0008**	0.0004	0.0001	0.0007**	0.002**	0.001**	0.0004
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.001)	(0.0006)	(0.0004)
Currency$_t^{comp1}$	0.262***	0.215**	0.220**	0.245**	0.282	0.480***	0.122
	(0.095)	(0.100)	(0.093)	(0.098)	(0.249)	(0.161)	(0.100)
Currency$_t^{comp2}$	-0.070***	-0.053*	-0.055**	-0.071**	-0.070	-0.124***	-0.043
	(0.027)	(0.030)	(0.026)	(0.029)	(0.067)	(0.046)	(0.029)
Currency$_t^{comp3}$	0.004**	0.003	0.003*	0.005**	0.004	0.008**	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
lag(INF_gMA3,1)	0.0005	-0.0002	8.11×10^{-5}	0.0003	0.002	0.001	-0.0005
	(0.0006)	(0.0005)	(0.0004)	(0.0005)	(0.002)	(0.002)	(0.0005)
Inflation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Dep. Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects							
year (50)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country (133)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics							
Observations	4,795	4,795	4,795	4,795	4,795	4,795	4,795
Dependent variable mean	0.501	0.413	0.180	0.425	0.871	0.700	0.419
R^2	0.064	0.049	0.060	0.047	0.056	0.047	0.070

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This output presents the results of the seven estimated equations described in the previous section with the Inflation added as a control. The models incorporate control variables, including three-period moving averages of GDP per capita growth, openness, FDI in GDP relative terms, political regime, inflation, and a dummy variable indicating whether the country initiated an IMF program with central bank-related conditions in the last three periods. Additionally, the models include the lagged dependent variables, year and country dummies. The results do not change significantely when adding the inflation term.

A.3.2 Lagged Dependent Variable

In this section we present the models without the lagged dependent variables as regressors. While these variables hold significance from an econometric perspective, the economic interpretation is limited. However, the inclusion or exclusion of this parameter does not materially affect the results, indicating robustness.

Table 8: Preferred Model of Financial Crises Effects with Inflation

Dependent Variables:	Δ CBI Index$_t$	ΔPolicy$_t$	ΔFin. Ind.$_t$	ΔReport$_t$	ΔObjective$_t$	ΔLending$_t$	ΔBoard$_t$
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Banking$_t^{comp1}$	-0.139**	-0.143**	-0.168***	-0.071	-0.282*	-0.069	-0.102
	(0.063)	(0.069)	(0.050)	(0.075)	(0.148)	(0.117)	(0.073)
Banking$_t^{comp2}$	0.032*	0.029*	0.040***	0.014	0.072*	0.012	0.022
	(0.016)	(0.017)	(0.013)	(0.020)	(0.040)	(0.030)	(0.018)
Banking$_t^{comp3}$	-0.002*	-0.002	-0.002***	-0.0008	-0.004*	-0.0006	-0.001
	(0.001)	(0.001)	(0.0008)	(0.001)	(0.003)	(0.002)	(0.001)
Debt$_t^{comp1}$	0.074**	0.032	0.008	0.057**	0.188**	0.119**	0.039
	(0.037)	(0.039)	(0.029)	(0.029)	(0.093)	(0.056)	(0.033)
Debt$_t^{comp2}$	-0.016**	-0.007	-0.002	-0.014**	-0.041**	-0.026**	-0.008
	(0.008)	(0.009)	(0.007)	(0.006)	(0.020)	(0.012)	(0.008)
Debt$_t^{comp3}$	0.0008**	0.0004	0.0001	0.0007**	0.002**	0.001**	0.0004
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0010)	(0.0006)	(0.0004)
Currency$_t^{comp1}$	0.265***	0.201**	0.217**	0.246**	0.317	0.501***	0.105
	(0.096)	(0.098)	(0.090)	(0.100)	(0.248)	(0.172)	(0.100)
Currency$_t^{comp2}$	-0.070**	-0.051*	-0.054**	-0.071**	-0.077	-0.129***	-0.039
	(0.027)	(0.029)	(0.025)	(0.030)	(0.066)	(0.048)	(0.029)
Currency$_t^{comp3}$	0.004**	0.003	0.003*	0.005**	0.005	0.008**	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
l(GDP_PC_G_MA3,1)	0.0001	0.0001	-1.73×10^{-5}	0.0001	0.0002	0.0002	-5.74×10^{-5}
	(0.0001)	(0.0001)	(5.05×10^{-5})	(9.3×10^{-5})	(0.0002)	(0.0002)	(8.68×10^{-5})
l(openness_MA3,1)	-0.002	-0.005	0.002	-0.003	0.003	-0.008	0.001
	(0.004)	(0.004)	(0.003)	(0.004)	(0.008)	(0.007)	(0.004)
l(FDI_GDP_MA3,1)	-0.002	-0.007	0.0009	-0.007	-0.009	-0.013*	0.022
	(0.007)	(0.007)	(0.005)	(0.005)	(0.011)	(0.008)	(0.020)
l(political_MA3,1)	0.005	0.182	0.101	-0.046	-0.069	-0.044	-0.094
	(0.123)	(0.168)	(0.104)	(0.139)	(0.298)	(0.222)	(0.133)
l(Program_Start_Last3,1)	-0.041	0.093	-0.131	0.281	-0.550	0.052	0.005
	(0.241)	(0.291)	(0.192)	(0.310)	(0.569)	(0.486)	(0.216)
Fixed-effects							
year (50)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country (134)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics							
Observations	4,813	4,813	4,813	4,813	4,813	4,813	4,813
Dependent variable mean	0.499	0.411	0.179	0.423	0.867	0.697	0.418
R^2	0.062	0.048	0.059	0.046	0.055	0.046	0.069

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This output presents the results of the seven estimated equations described in the previous section without lagged dependent variables as controls. The models incorporate control variables, including three-period moving averages of GDP per capita growth, openness, FDI in GDP relative terms, political regime, inflation, and a dummy variable indicating whether the country initiated an IMF program with central bank-related conditions in the last three periods. Additionally, the models include the lagged dependent variables, year and country dummies. The results do not change significantely when adding lagged dependent variables as controls.

A.3.3 Crises Duration

The choice of P, the number of periods allowed for a financial crisis to affect changes in CBI, is set to 10. This value serves purely as a reference, based on the assumption that crises may

have an impact over several years, without further specific justification. To test the robustness of the results, the analysis is repeated with P set to 11 and 9. There are some changes in terms of significance, but most coefficients retain similar levels of significance. The sign and magnitude of the estimates remain consistent, indicating robustness to the choice of P.

Table 9: Preferred Model of Financial Crises Effects with P=11

Dependent Variables:	Δ CBI Index$_t$	ΔPolicy$_t$	ΔFin. Ind.$_t$	ΔReport$_t$	ΔObjective$_t$	ΔLending$_t$	ΔBoard$_t$
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Banking$_t^{comp1}$	-0.126**	-0.104*	-0.128***	-0.084	-0.224*	-0.106	-0.103
	(0.052)	(0.057)	(0.043)	(0.056)	(0.125)	(0.090)	(0.069)
Banking$_t^{comp2}$	0.026**	0.017	0.027**	0.017	0.052*	0.021	0.021
	(0.012)	(0.013)	(0.011)	(0.013)	(0.031)	(0.021)	(0.016)
Banking$_t^{comp3}$	-0.001*	-0.0007	-0.001**	-0.0009	-0.003	-0.001	-0.001
	(0.0007)	(0.0007)	(0.0006)	(0.0008)	(0.002)	(0.001)	(0.0009)
Debt$_t^{comp1}$	0.076**	0.031	0.008	0.053*	0.203**	0.128**	0.032
	(0.038)	(0.039)	(0.030)	(0.029)	(0.096)	(0.057)	(0.034)
Debt$_t^{comp2}$	-0.017**	-0.007	-0.003	-0.013**	-0.044**	-0.028**	-0.007
	(0.008)	(0.009)	(0.007)	(0.006)	(0.021)	(0.012)	(0.008)
Debt$_t^{comp3}$	0.0008**	0.0003	0.0002	0.0007*	0.002**	0.001**	0.0003
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.001)	(0.0006)	(0.0004)
Currency$_t^{comp1}$	0.181**	0.121*	0.187**	0.126	0.264	0.338**	0.038
	(0.075)	(0.069)	(0.076)	(0.083)	(0.199)	(0.140)	(0.083)
Currency$_t^{comp2}$	-0.041**	-0.024	-0.044**	-0.030	-0.058	-0.073**	-0.016
	(0.019)	(0.017)	(0.020)	(0.021)	(0.050)	(0.032)	(0.022)
Currency$_t^{comp3}$	0.002**	0.001	0.002**	0.002	0.003	0.004**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Dep. Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects							
year (50)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country (134)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics							
Observations	4,788	4,788	4,788	4,788	4,788	4,788	4,788
Dependent variable mean	0.502	0.413	0.180	0.428	0.872	0.698	0.422
R^2	0.064	0.049	0.059	0.046	0.057	0.046	0.070

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This output presents the results of the seven estimated equations described in the previous section. The models incorporate control variables, including three-period moving averages of GDP per capita growth, openness, FDI in GDP relative terms, political regime, and a dummy variable indicating whether the country initiated an IMF program with central bank-related conditions in the last three periods.

Additionally, the models include the lagged dependent variables, year and country dummies. Here, we set P=11 as a robustness test, which does not significantly alter the results.

Table 10: Preferred Model of Financial Crises Effects with P=9

Dependent Variables:	Δ CBI Index$_t$	ΔPolicy$_t$	ΔFin. Ind.$_t$	ΔReport$_t$	ΔObjective$_t$	ΔLending$_t$	ΔBoard$_t$
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Banking$_t^{comp1}$	-0.212*	-0.389***	-0.258***	-0.054	-0.282	-0.085	-0.195
	(0.114)	(0.128)	(0.097)	(0.127)	(0.303)	(0.210)	(0.131)
Banking$_t^{comp2}$	0.063	0.128***	0.075**	0.012	0.077	0.023	0.059
	(0.041)	(0.045)	(0.034)	(0.043)	(0.113)	(0.073)	(0.047)
Banking$_t^{comp3}$	-0.005	-0.010***	-0.005**	-0.0009	-0.005	-0.002	-0.004
	(0.003)	(0.004)	(0.003)	(0.003)	(0.009)	(0.006)	(0.004)
Debt$_t^{comp1}$	0.080**	0.036	0.016	0.060*	0.208**	0.122**	0.036
	(0.040)	(0.042)	(0.032)	(0.032)	(0.103)	(0.061)	(0.038)
Debt$_t^{comp2}$	-0.019**	-0.009	-0.005	-0.015**	-0.048**	-0.028*	-0.008
	(0.009)	(0.010)	(0.008)	(0.008)	(0.024)	(0.014)	(0.010)
Debt$_t^{comp3}$	0.0010*	0.0005	0.0003	0.0008*	0.003**	0.001*	0.0004
	(0.0005)	(0.0006)	(0.0004)	(0.0004)	(0.001)	(0.0008)	(0.0005)
Currency$_t^{comp1}$	0.270***	0.216**	0.225**	0.243**	0.318	0.501***	0.112
	(0.095)	(0.098)	(0.089)	(0.099)	(0.247)	(0.170)	(0.099)
Currency$_t^{comp2}$	-0.071***	-0.054*	-0.056**	-0.070**	-0.076	-0.128***	-0.041
	(0.027)	(0.029)	(0.025)	(0.030)	(0.066)	(0.047)	(0.028)
Currency$_t^{comp3}$	0.005**	0.003	0.003**	0.005**	0.005	0.008**	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Dep. Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects							
year (50)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country (134)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics							
Observations	4,813	4,813	4,813	4,813	4,813	4,813	4,813
Dependent variable mean	0.499	0.411	0.179	0.423	0.867	0.697	0.418
R^2	0.064	0.050	0.060	0.047	0.056	0.047	0.071

Heteroskedasticity-robust standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This output presents the results of the seven estimated equations described in the previous section. The models incorporate control variables, including three-period moving averages of GDP per capita growth, openness, FDI in GDP relative terms, political regime, and a dummy variable indicating whether the country initiated an IMF program with central bank-related conditions in the last three periods. Additionally, the models include the lagged dependent variables, year and country dummies. Here, we set P=9 as a robustness test, which does not significantly alter the results.

A.4 Appendix D: Simulation

In this section we provide details on the simulation confidence interval bands. For simplicity, since this simulation represents the response to a one-period crisis for a fictitious country, we use the following simplified model to illustrate specific details:

$$\hat{y}_t = h(\hat{\theta}) = \hat{\theta}_1 x_t + \hat{\theta}_2 x_t^2 + \hat{\theta}_3 x_t^3$$

,where x_t would be the corresponding crisis compound variable.

The focus is not on any specific country, rather on three indicative coefficients for a fictitious country, thus the i is not necessary here. Since this is a one-period shock, we can use the squared x_t^2 and x_t^3 powers of the variable directly instead of compound variables, as their values will be equivalent in this specific case. This simplification allows for an easier computation of the approximate standard errors of the fitted values using the Delta Method, as outlined in Wooldridge (2010).

For this function $h(\hat{\theta}_t)$, the variance is approximated as:

$$\text{Var}(h(\hat{\theta})) \approx \nabla h(\hat{\theta})^\top \text{Var}(\hat{\theta}) \nabla h(\hat{\theta})$$

where $\nabla h(\hat{\theta})$ is the gradient vector of h with respect to $\hat{\theta}$, $\text{Var}(\hat{\theta})$ is the variance-covariance matrix of the estimated parameters.

The gradient vector with respect to $\hat{\theta} = [\hat{\theta}_7, \hat{\theta}_8, \hat{\theta}_9]^\top$ is:

$$\nabla h(\hat{\theta}) = \begin{bmatrix} \frac{\partial \hat{y}_t}{\partial \hat{\theta}_1} \\ \frac{\partial \hat{y}_t}{\partial \hat{\theta}_2} \\ \frac{\partial \hat{y}_t}{\partial \hat{\theta}_3} \end{bmatrix} = \begin{bmatrix} x_t \\ x_t^2 \\ x_t^3 \end{bmatrix}.$$

The variance of $\hat{y}_t$ is then:

$$\text{Var}(\hat{y}_t) = \nabla h(\hat{\theta})^\top \text{Var}(\hat{\theta}) \nabla h(\hat{\theta}).$$

Expanding this, we get:

$$\text{Var}(\hat{y}_t) = \begin{bmatrix} x_t & x_t^2 & x_t^3 \end{bmatrix} \begin{bmatrix} \text{Var}(\hat{\theta}_7) & \text{Cov}(\hat{\theta}_7, \hat{\theta}_8) & \text{Cov}(\hat{\theta}_7, \hat{\theta}_9) \\ \text{Cov}(\hat{\theta}_7, \hat{\theta}_8) & \text{Var}(\hat{\theta}_8) & \text{Cov}(\hat{\theta}_8, \hat{\theta}_9) \\ \text{Cov}(\hat{\theta}_7, \hat{\theta}_9) & \text{Cov}(\hat{\theta}_8, \hat{\theta}_9) & \text{Var}(\hat{\theta}_9) \end{bmatrix} \begin{bmatrix} x_t \\ x_t^2 \\ x_t^3 \end{bmatrix}.$$

Simplifying, the variance is:

$$\begin{aligned} \text{Var}(\hat{y}_t) =& x_t^2 \text{Var}(\hat{\theta}_1) + x_t^4 \text{Var}(\hat{\theta}_2) + x_t^6 \text{Var}(\hat{\theta}_3) + \\ & 2x_t x_t^2 \text{Cov}(\hat{\theta}_1, \hat{\theta}_2) + 2x_t x_t^3 \text{Cov}(\hat{\theta}_1, \hat{\theta}_3) + 2x_t^2 x_t^3 \text{Cov}(\hat{\theta}_2, \hat{\theta}_3). \end{aligned}$$

Using this, we calculate the confidence intervals at various levels using the standard formula.