Preliminary and incomplete Draft:

Central Bank Resilience, the VIX and Stock Market Returns

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Abstract

This paper examines how central bank solvency affects the transmission of global financial stress to domestic stock markets. We develop a novel solvency index using principal component analysis, incorporating profitability, capital endowment, and risk exposure. Using data from 46 countries from 2001 to 2023, asset pricing tests reveal that higher central bank solvency mitigates financial stress transmission, while weaker solvency leads to higher excess returns as risk compensation. Panel regressions identify transmission channels, including central bank independence, transparency, and financial system size, showing that lower solvency restricts the lender of last resort function, amplifying financial stress in vulnerable economies.

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1 Introduction

In the mission to achieve their financial stability goals, central banks act as a lender of last resort in order to dampen detrimental shocks to domestic financial markets. Over the last two decades, global markets have experienced significant financial stress, prompting central banks to implement unconventional monetary policies, such as large-scale asset purchasing programs to bolster the pricing of domestic bonds and to reduce capital costs (e.g., Chen et al., 2012; Goldstein et al., 2021). This unprecedented balance sheet expansion, however, comes at the risk of incurring losses. The return of inflation since 2022, along with the associated interest rate hikes and bond price declines, has led to a substantial deterioration in the solvency of major central banks, thereby limiting their ability to function effectively as lenders of last resort. This creates a risk for the financial system, particularly in countries with lower central bank solvency, as their stock markets become increasingly exposed to global financial stress.

The relevance of risks arising from central banks' balance sheet expansion for financial stability is discussed in the current literature (e.g., Cecchetti & Hilscher, 2024; Kiley & Mishkin, 2024). We contribute by analyzing the relevance of central bank solvency for the intensity of global risk transmission to domestic stock markets. The risk of incurring losses may reduce central banks courage to take aggressive monetary policy actions in crisis times (Friedman & Schwartz, 1965). A central bank facing a weakened balance sheet and the challenge of implementing a bond purchase program in a crisis must factor in the long-term evolution of its financial condition. As its balance sheet quality erodes and solvency diminishes, the scope of intervention is constrained due to expected losses from increasing interest rates. This results in policy actions that fall short of optimal outcomes. If central bank decision-makers are cognizant of the risks associated with financial losses, the extent of balance sheet expansion will be influenced by the central bank solvency. We therefore hypothesize that higher central bank solvency reduces the effects of financial stress on domestic stock markets. Additionally, we expect that the effect of central bank solvency can be demonstrated through various transmission channels. We anticipate heterogeneity in its impact between developed and emerging markets, and depending on factors such as central bank independence, transparency, the size of the financial system, the presence of a recapitalization agreement, and potential career concerns of the central bank president.

We propose a novel index of central bank solvency based on a principal component analysis accounting for the level and riskiness of profits as well as the capital endowment. Our dataset consists of 46 countries over the time period from 2001 to 2023. The literature has so far discussed the

relevance of capital endowment and profitability of central banks. We argue that focusing on one single indicator provides a one-sided view of central bank solvency. Because investors should pay special attention to the risk of central bank insolvency during periods of financial stress, we apply our newly developed measure within an asset pricing framework inspired by Fama & MacBeth (1973). We construct country portfolios based on central bank solvency levels, allowing us to detect systematic differences in excess returns. First, the results of the time series regression suggest that all country portfolios exhibit a negative exposure to financial stress, as indicated by innovations in the VIX. Second, the results of the cross-section regression indicate that country portfolios, on average, compensate for the risk of lower central bank solvency with higher excess returns. Third, we distinguish between normal times and financial stress. During normal times, the compensation for holding portfolios with lower solvency is more pronounced. However, in times of heightened financial stress, this relationship reverses, as countries with higher central bank solvency exhibit significantly higher excess returns. This finding underscores that high-solvency portfolios are more resilient to financial stress.

This paper empirically tests the channels through which central bank solvency shapes the transmission of global financial stress by employing a panel interaction models. The results point to several key insights: (1) in developing economies, the conditional effect of central bank solvency is more important for global risk transmission to domestic stock markets than for advanced economies; (2) central banks with lower independence become more aggressive in crisis mitigation when their solvency is high, reflecting the propensity for politically salient "bailout"-style measures; (3) lower levels of central bank transparency enhance the stress-mitigating effect of higher solvency, because excessive disclosure during crises may increase uncertainty for investors; (4) smaller financial systems benefit more from higher central bank solvency, as these tend to be less liquid and therefore more reliant on the central bank's function as a lender of last resort; (5) while evidence on recapitalization agreements is mixed, there is a tendency for this channel to help ward off financial stress; and (6) a governor's career concerns appear to correlate with risk aversion, suggesting that central banks led by governors without strong personal incentives to avoid losses may intervene more decisively. Taken together, these findings underscore the multifaceted role of central bank solvency in shaping how effectively the central bank can support domestic stock markets from global financial financial stress.

Related literature. The theoretical literature employs equilibrium models to explore the dynamics of *central bank balance sheets*. Bindseil et al. (2004) demonstrate that central bank equity and profitability recover to positive levels following a temporary shock, as the revenues

from seigniorage surpass the growth rate of operating costs. However, these models inherently assume that losses remain limited, raising the question of the potential magnitude of such losses. Hall & Reis (2015) and Del Negro & Sims (2015) argue that portfolios containing long-term assets are particularly susceptible to significant losses in the case of rising interest rates. If such losses realize, either a fiscal transfer from the government or an equity buffer is required. In the absence of these mechanisms, Benigno & Nisticò (2020) show that equity must be restored through the seigniorage gains of an expansionary monetary policy, which, in equilibrium, leads to higher inflation. Moreover, it is emphasized that the realization of portfolio losses is not a condition for real economic effects, as the underlying assets may in fact default. Gertler & Karadi (2011) and Cúrdia & Woodford (2011) illustrate that the composition and size of central bank balance sheets impact not only financial stability but also macroeconomic outcomes. Their models underscore that adjustments in balance sheet structure can influence interest rate spreads, credit allocation, and overall output.

Equity is a fundamental component of a central bank's balance sheet, serving as a buffer against potential losses (e.g., Perera et al., 2013; Goodfriend, 2014; Reis, 2016). Central banks typically maintain a low equity ratio, which can be attributed to their incentive to generate revenue through seigniorage (Reis, 2015). However, insufficient capital may compromise the long-term objectives of monetary policy (e.g., Ize, 2005; Klueh & Stella, 2008; Perera et al., 2013; Adler et al., 2016). Among these long-term objectives, financial stability is of particular importance. According to Gros & Schobert (1999), a central bank may choose to maintain a higher equity ratio to strengthen its ability to act as a lender of last resort. The provision of large-scale liquidity during financial crises can lead to substantial losses once the crisis subsides and the central bank starts to raise interest rates, possibly requiring government intervention through financial transfers. Stella (1997, 2005, 2008) highlights several determinants of a central bank's equity level, such as macroeconomic conditions, institutional dependence on governmental authorities, accounting regulations, and policies regulating financial transfers.

Recapitalization agreements, which are especially needed when a central bank faces negative equity, outlining the conditions under which governmental financial support may be provided. The primary objective is to ensure that the central bank remains trustworthy even in extreme situations (Stella, 1997). However, Goncharov et al. (2023) argue that a recapitalization can undermine central bank independence, creating an incentive to avoid recapitalization. This behavior is also driven by the government's incentive to secure additional transfers from the central bank, especially during periods of heightened fiscal strain (Reis, 2013). Binder (2021) documents that nearly 10% of central banks, even those with independent status, are subjected to political pressure annually, while 39% experience it at some stage. This pressure is directed to advocate for a more expansive

monetary policy. If a central bank declines to recapitalize and instead attempts to restore equity through significant money supply expansion, this may undermine price stability, as shown by Del Negro & Sims (2015) and Benigno & Nisticò (2020). Stella & Lonnberg (2008) provide evidence from a broad legal review of central bank frameworks, concluding that the willingness to grant fiscal support—at least in formal legal terms—is often weak. Their empirical findings further indicate that actual fiscal support has not occurred regularly.

Several studies highlight the importance of central bank *profitability*. Higher profits, if not entirely transferred to the government, naturally contribute to an increase in central bank capital (Archer & Moser-Boehm, 2013). Reis (2015) describes various options through which a central bank may become economically insolvent, emphasizing that insufficient profitability is a key factor. The criteria for insolvency vary depending on the level of fiscal support provided by the government and can include negative income, failure to comply with dividend transfer agreements, or a negative present value of dividends. Reis (2016) further argues that the absence of fiscal backing from the government increases the risk of economic insolvency, particularly when reserves are no longer adequately supported by assets and post-transfer profits. Hall & Reis (2015) note that the significant expansion of the central bank's balance sheet through asset purchase programs, particularly in bonds, has increased net profit sensitivity to risks such as interest rate fluctuations, default, and exchange rate volatility. According to Cecchetti & Hilscher (2024), the fiscal consequences of losses from purchase programs depend on institutional arrangements. For instance, losses could be recorded on the balance sheet or, in the absence of a buffer, would have to be covered directly by the government. Wellink (2023) highlights the substantial unrealized losses in the ECB's monetary portfolio due to interest rate hikes and argues that its independence could be at risk. According to Kiley & Mishkin (2024), central banks are essential for maintaining financial stability, however, they must also navigate the risks associated with credit exposure and quasi-fiscal activities, which could endanger their autonomy.

Quasi-fiscal measures, which involve policy interventions by the central bank on behalf of the government to support financially vulnerable institutions, exert persistent pressure on profitability (Fry, 1993; Almeida et al., 1996). Klueh & Stella (2008) argue that assets with a quasi-fiscal component can erode profitability and weaken central bank capital over time. Hooley et al. (2023) highlight that the prevalence of monetary policy actions with quasi-fiscal characteristics has increased, particularly since the COVID-19 crisis, with significant implications for central bank profits. Goncharov et al. (2023) take a politico-economic perspective, showing that central banks at the zero-profitability threshold tend to report small profits rather than small losses. Their analysis of profit distribution discontinuities suggests that factors such as career concerns, strong political affiliations, stock market listings, and dividend transfer regulations play a crucial role in

concealing small losses.

This paper is related to a large literature on cross-country variation in stock market returns driven by differences in financial and macroeconomic characteristics, e.g., size and value effect (Asness et al., 1997), asset growth (Wen, 2019), liquidity risk (Liang & Wei, 2012), fiscal policy (Belo et al., 2013), consumption (Li & Zhong, 2005; Darrat et al., 2011), currency risk (Karolyi & Wu, 2021; Bartram & Bodnar, 2012), monetary policy (Ammer et al., 2010), political risk (Gala et al., 2023), geopolitical risk (Zaremba et al., 2022), or climate risk (Hong et al., 2019).

A small body of literature specifically examines the pricing of financial stress in global stock returns. Stock returns generally exhibit a negative relationship with financial stress (e.g., Ang et al., 2006; Adrian & Rosenberg, 2008; Da & Schaumburg, 2011). Assets with a higher exposure to market volatility should command a higher risk premium as investors want to hedge against bad outcomes (Campbell, 1993). Adrian & Rosenberg (2008) establish how the short run component of stock market volatility, representing financial constraints, and the long run component of stock volatility, indicating business cycle risk, are priced. They conclude that both variables result in a negative price of risk suggesting that stocks with a higher exposure to financial constraints or business cycle risk offer higher returns in the long run but perform worse during financial distress. Ang et al. (2006) analyze aggregate volatility risk, measured by the VIX, as a factor to explain the cross section of stock returns. They confirm a negative factor price indicating that stocks lower correlation with aggregate volatility show lower average returns. Chang et al. (2013) support this outcome, taking into account both market skewness and kurtosis. Hollstein & Prokopczuk (2018) expand the two-factor model to include sensitivity to volatility-of-volatility and sort the test assets based on this metric. Their findings also reveal a negative factor price for volatility risk. Da & Schaumburg (2011) use a principal component analysis to determine a non-parametric proxy for volatility risk. In a two-factor model, they then show that the factor price of volatility risk is negative for different portfolios and test assets.

This paper enhances the understanding of the *conditional effect* of global financial stress on domestic stock markets. There is substantial body of literature showing how risk is transmitted through international markets and how macroeconomic or institutional factors can condition this risk transmission. Bekaert et al. (2014) show that during the GFC, domestic portfolios of countries with lower current account deficits, lower fiscal deficits, higher foreign exchange reserves, and stronger sovereign ratings tended to be more resilient. Bonciani & Ricci (2020) investigate the effect of various interactions between financial stress and macroeconomic factors on stock markets using impulse response functions, concluding that financial stress impacts stock markets more sig-

nificantly as trade openness rises. Miranda-Agrippino & Rey (2020) introduce the concept of the "global financial cycle" as a risk factor, largely influenced by U.S. monetary policy, which explains a significant portion of the common variation in international asset cross-sections. Building on that, several papers highlight the significance of central bank features in determining the channels of international risk transmission. For example, higher levels of central bank transparency promotes cross-border banking activity (Eichler et al., 2017) and mitigate exchange rate volatility (Eichler & Littke, 2018) by reducing investors' uncertainty about future monetary policy. Higher central bank independence can foster financial stability (Klomp & de Haan, 2009). Additionally, the stance of monetary policy has been shown to shape the interplay between bank risk and sovereign risk during the GFC (Acharya et al., 2014; Böhm & Eichler, 2020) and the commodity price-sovereign risk transmission (Boehm et al., 2021).

The remainder of the paper is structured as follows: Section 2 presents data on various central bank balance sheet positions, as well as variables for global financial stress and stock market indices. Section 3 outlines the construction of central bank solvency indices. In Section 4, country portfolios are formed based on central bank solvency levels, followed by asset pricing tests using the Fama-MacBeth technique. Section 5 provides a panel regression analysis, examining interactions between financial stress and central bank solvency, with a particular focus on different transmission channels. Finally, Section 6 offers a summary.

2 Data

Central bank balance sheet items. We use the following balance items from BankFocus via Wharton Research Data Services to measure central bank solvency:

- **Equity**: Equity acts as a crucial buffer against losses (Goodfriend, 2014; Reis, 2016). Central banks typically maintain relatively low levels of equity relative to total assets, largely because of their incentive to generate seigniorage revenues (Reis, 2015). Del Negro & Sims (2015) underscore the importance of a capital buffer, particularly in the absence of a fiscal support agreement with the government. Moreover, higher equity is positively associated with enhanced credibility (Bindseil et al., 2004). In BankFocus data, the equity position typically comprises components such as common equity, non-controlling interests, revaluation reserves, and foreign exchange revaluation reserves[1]. We measure this item as ratio to total assets.

- **Return on assets (RoA)**: This item influences the long-term evolution of a central bank's

[1] According to the BankFocus User Guide by Bureau van Dijk March 2018

equity. Even a central bank with low or negative equity can exhibit robust solvency if it maintains a comparatively high RoA. According to Bindseil et al. (2004), a financially vulnerable central bank, characterized by low equity, often experiences recurring losses that erode its balance sheet further. Portfolio losses, in particular, can significantly undermine RoA (Hall & Reis, 2015). Consequently, sustained positive RoA levels can gradually rebuild equity, indicating an underlying capacity to recover from shortfalls.

- **Net interest income (NetII)**: We account for net interest income as the difference between gross interest earnings and total interest costs. This approach excludes portfolio losses from this calculation and emphasizes the long-term quality of income. In scenarios where equity and RoA decline markedly, net interest income may still bolster the central bank's solvency over an extended period. We measure this item as ratio to total assets.

There are additional balance sheet items that can provide insight into a central bank's financial position—such as loan loss provisions, general risk provisions, or transfers to the government. However, BankFocus does not comprehensively record these data points.[2] We also exclude "Other Items Net", an off-balance-sheet position considered in the literature, because in times of crisis, markets are likely to focus on the officially reported balance sheet reserves rather than hidden reserves or liabilities.

The data is primarily provided on an annual basis. However, it is important to mention that, first, the publication months vary between countries and, second, the publication months have changed over time for some countries. Figure A.1 shows a distribution of the publication months. Table 1 presents the summary statistics for the balance sheet items. The average equity ratio across the 46 central banks in the dataset is about 7%. The values of the countries vary widely. For instance, the Bank of Thailand reported an equity ratio of -29.3% in 2019, primarily due to significant losses from the revaluation of foreign assets following the strong appreciation of the Thai Baht[3]. Conversely, the Central Bank of Colombia recorded the highest equity ratio in the sample, at 52.5% in 2003. In 2023, the figure is also comparably high at 33%. This number results from the very broad equity position, which, for instance, includes value adjustments to currency reserves[4]. RoA and NetII show an average positive value of about 1%. Notably, the Central Bank of Chile reported a RoA of -9.19% in 2012, driven by a sharp appreciation of the Chilean peso against the US dollar, which led to a revaluation of foreign assets[5]. In contrast, the National Bank of Pakistan achieved the highest RoA in the sample, at 11.34% in 2007.

Observing the average development of the items in Figure 1 reveals noticeable trends. The equity

[2] Goncharov et al. (2023), for instance, manually collects loan loss and general risk provisions.
[3] Bank of Thailand, 2019, Financial Statement
[4] Central Bank of Colombia, 2023, Financial Statement
[5] Central Bank of Chile, 2012, Annual Report

ratio decreases on average from about 11% to 6% before the global financial crisis. From then on, it fluctuates about 6%. As RoA should precede the equity ratio, a comparable pattern develops. RoA varies between 0 and 2%, with a slight downward trend. NetII exhibits a more pronounced and stable downward trend, indicating a deterioration in portfolio quality. In recent years, the COVID-19 crisis has demonstrated a temporary surge across all items. This was accompanied by expansionary policies, where higher seigniorage resulted in higher RoA, NetII, and, in turn, the equity ratio. Then, in the context of rising interest rates, all items have declined significantly, with RoA recording its first average negative value. This may be attributed to more severe portfolio impairments.

It brings into focus the issue of the comparability of balance sheet items, both among central banks and across time. Central banks are not formally bound by accounting regulations, but a significant number comply with IFRS (Bholat & Darbyshire, 2016). It should be emphasized, however, that deviations from these standards are possible (Goncharov et al., 2023). To address this issue, BankFocus provides consolidation codes in the data, offering information about the type of accounting standard applied. Ensuring that the data are as consistent as possible is crucial to prevent bias in the results. Duprey & Lé (2016) present a consistent approach to handling these codes. Consolidated accounts are preferred to unconsolidated accounts because we are particularly interested in the country aggregates. Additional companion statements are avoided if possible because the balance sheet data might come from various sources (such as the FDIC or SEC), follow different accounting standards (such as local GAAP), use different units (such as inflation-adjusted or nominal values), or be based on different types of data (such as estimated or original figures)[6]. Even with this procedure, there may still be a few cases where multiple values for a country are reported in the same year. Our method for handling these duplicates is detailed in Appendix A.1. Figure 2 displays the final distribution of the consolidation codes in the sample. In our sample, 71% of central banks have the U1 consolidation code, forming a significant majority. In constrast, U* and C* codes combined account for only 4.5%. As a result, the central banks in our dataset are generally comparable.

Global financial stress. We use the Volatility Index (VIX) as our main measure of global financial stress. The VIX estimates the expected volatility of the S&P500 and is considered as the global fear barometer (Whaley, 2000). In times of financial stress, the VIX increases sharply while stock market indices go down. Two alternatives are considered: First, we use the excess bond premium (EBP), motivated by Gilchrist & Zakrajšek (2012). This index describes the risk-bearing capacity of the credit markets. For example, a high excess bond premium suggests that investors

[6]See Bureau van Dijk, March 2018, BankFocus - User Guide.

demand a higher premium for holding corporate bonds, above what would be warranted by the credit risk alone. This often indicates greater risk aversion about the overall economic outlook due to a contraction in the credit supply. Second, we consider the BofA US High Yield Index (BS) tracking the spread between the below investment grade rated corporate debt publicly issued in the United States and the yields on U.S. Treasury securities. Therefore, an increase in this index also represents financial stress because investors sell corporate debt relative to government debt.

Table 1 summarizes the data on the financial stress variables. The data show that changes in stock market volatility and bond credit spreads are typically small, while large innovations are less frequent. For example, the VIX reaches a maximum change of about 21% points at the beginning of the COVID-19 crisis in February 2020. During the global financial crisis in 2008, the EBP and BS record their maximum changes of 1.7 and 5.21% points, respectively.

Stock market returns. We collect MSCI equity index data from Thomson Reuters via Datastream, denominated in US dollars and with a monthly frequency. The final sample includes 46 countries and extends from Jan. 2001 to Sep. 2023. Table A.1 lists the countries. We calculate the excess returns using the log returns of MSCI country indices less the risk-free interest rate of a 4-week Treasury bill from Ken French's data library.

In Figure 3, we present the development of the MSCI U.S. Equity Index and the VIX. Periods of significant financial stress are marked with corresponding text annotations. The data show a pronounced increase in the VIX during times of financial stress, which can be attributed to elevated investor uncertainty. At the same time, the MSCI U.S. Equity Index shows a marked decline during these periods. We focus especially on these moments to analyze the lender of last resort role among central banks and its relationship to central bank solvency.

3 Construction of central bank solvency index

Central bank solvency indices. We use the following measures to capture central bank solvency based on balance sheet items from BankFocus via Wharton Research Data Services:

- **First principal components (PC):** We run a principal component analysis (PCA) with various balance sheet items to form a meaningful factor for central bank solvency and analyse the result using the Kaiser-Meyer-Olkin test. According to Dziuban & Shirkey (1974) and Shrestha (2021), a value of at least 0.6 indicates that the combination of variables used to construct a factor is adequate. We construct two key factors from this analysis. The main measure is the first principal component derived from equity, RoA, and log(Z-Score), linking the aspects of capital adequacy, earnings, and asset quality through risk-adjusted returns.

The second factor incorporates NetII, providing a longer-term outlook on earnings, which can be especially relevant in periods of fluctuating interest rates or divergent income sources. The principal components can be described as

$$CBS_1 = \alpha_1 \cdot Equity + \alpha_2 \cdot RoA + \alpha_3 \cdot log(Z\text{-}Score)$$
$$CBS_2 = \alpha_1 \cdot Equity + \alpha_2 \cdot RoA + \alpha_3 \cdot log(Z\text{-}Score) + \alpha_4 \cdot NetII$$

where α_1, α_2, α_3, α_4 are the factor loadings determined by the PCA, reflecting the relative importance (weights) of each variable. By construction, the first principal component is the linear combination that captures the higher variance in those variables, subject to normalization constraints.

- **log(Z-Score)**: We use natural logarithm of the Z-Score as a direct measure of central bank solvency. This measure is used to assess the insolvency risk of commercial banks (e.g. Boyd & Runkle, 1993; Lepetit & Strobel, 2013; Lepetit & Strobel, 2015; Chiaramonte et al., 2016; Hafeez et al., 2022). It provides a proxy for the risk-adjusted return on assets. We transfer this from commercial banks to central banks. The Z-Score follows the equation

$$log(Z\text{-}Score) = log\left(\frac{Equity + RoA}{\sigma(RoA)}\right)$$

where we use a four-year window to calculate the $\sigma(RoA)$ as standard deviation of RoA.

We favour the principal components over the log(Z-Score) because instead of putting all the weight on risk-adjusted returns, factor loadings as weights can share the impact with equity and earnings. This offers the advantage of being more robust against possible deviations in the accounting rules and provide a broad measure for central bank solvency.

Table 2 indicates that equity, RoA, NetII and log(Z-Score) are sufficiently correlated for the PCA. One might expect the correlation between RoA and NetII to be higher. However, reevaluations can strongly lower RoA. In the case of Thailand in 2019, a portfolio revaluation significantly impacted RoA, turning it strongly negative, whereas NetII remained positive at 0.3%.
We create central bank solvency indices based on principal component analyses. The first measure CBS_1 represents the first principal component of the balance sheet components Equity, RoA, and log(Z-Score), while CBS_2 represents the first principal component of Equity, RoA, NetII and the log(Z-Score). Table 3 indicates that the explained variance of the first principal components λ_1 of CBS_1 is about 60% and of CBS_2 54%. Additionally, the analysis of factor loadings in Table 4 shows that for CBS_1 and CBS_2, the eigenvalues are homogeneous, with positive values for CBS_1

and for CBS_2. Because all the factor loadings on the first principal component are positive, an increase in any of these balance sheet components (Equity, RoA, NetII, Z-Score) raises the value of the solvency index, consistent with the notion that stronger balance-sheet components imply higher solvency.

Figure 4 presents the average central bank solvency, as measured by our primary metric, for the countries included in our sample. Central banks such as those of Colombia, Bahrain and Malaysia rank at the top of the list. According to our hypothesis, these central banks should therefore be in a better position to reduce financial stress. Countries like Australia, Turkey, and the Eurozone are close to the average. In contrast, other countries, such as Chile, the Czech Republic, and Thailand, exhibit negative levels. This implies that the lender of last resort function in these countries is weakened, reducing their ability to absorb economic shocks effectively.

Table 1 provides the summary statistics of central bank solvency measures, comprising the two principal components and the log(Z-score) from January 2001 to September 2023. The data is presented on a monthly basis, first to account for potential intra-year changes in consolidation, and second due to variations in the publication month of annual reports across central banks. We centered the principal components at zero to facilitate the interpretation of which central banks fall below and which exceed the average. While CBS_1 and CBS_2 are broadly comparable, the log(Z-score), displays higher skewness and kurtosis, likely due to the influence of outliers. Such extreme values are especially observable when the standard deviation of returns is exceptionally low. For both CBS_1 and CBS_2, the maximum values of 4.17 and 5.11, respectively, were recorded by the Central Bank of Colombia in 2003. The minimum for CBS_1 is -4.78, observed at the Bank of Thailand in 2019, while for CBS_2, it is -5.13, recorded by the Central Bank of Chile in 2012. The highest log(Z-Score) is recorded by the Bank of Japan in March 2014, while the Polish central bank has registered the lowest value of -4.48 in 2018.

The correlation matrix in Table 5 highlights the consistency between the different solvency measures. CBS_1 and CBS_2 are highly correlated, indicating that the inclusion of NetII in CBS_2 does not substantially alter the overall solvency ranking. Both components are also strongly correlated with log(Z-Score), albeit to a slightly lesser degree. This result suggests that while log(Z-Score) captures central solvency aspects, the principal components provide a more comprehensive view by integrating multiple dimensions, including equity and RoA.

4 Asset Pricing Tests

4.1 Stock market portfolios

We analyze whether VIX changes are priced into stock market returns as a risk factor. By forming stock market portfolios, sorted according to central cank solvency, we can measure systematic differences in the excess returns across the portfolios.

Portfolio creation. Central bank solvency serves as a country characteristic in our portfolio construction. Given the varying publication months of annual reports, the portfolios are rebalanced on a monthly basis. As shown in Figure A.1, the majority of our sample publishes their balance sheets in December. However, 12 countries release their reports in February, March, or June. Additionally, the publication month changes for some countries over time.
To create four equally weighted portfolios, we define the breakpoints based on the first, second, and third quartiles. Table 6 presents the composition of the four portfolios, highlighting the six most frequently occurring countries. For example, Hong Kong appears in Portfolio 1 77.9% of the time, indicating a relatively solvent central bank. By contrast, Israel is assigned to Portfolio 4 in 94.3% of cases, reflecting relatively low central bank solvency. Additionally, an average of 1.6 countries per sample year switch portfolios, resulting in relatively high persistence across portfolios.

Table 7 summarizes how the portfolio return relates to the central bank solvency of the portfolios. Basically, the higher a country is ranked among the portfolios, the higher the risk is indicated for investors. For example, our main measure, CBS_1, declines from 1.46 in Portfolio 1 to -0.161 in Portfolio 4. Furthermore, decreasing solvency is associated with an increasing portfolio return. the average excess returns grow from 0.28% per month in portfolio 1 to 0.54% per month in portfolio 4. The difference between portfolio 4 and 1 is about 0.27% points.

4.2 Methodology

Theoretical foundation. Following Cochrane (2005), asset prices reflect the discounted sum of future payoffs, taking into account all potential risks. In the absence of arbitrage, the Euler equation stipulates that risk-adjusted excess returns must satisfy

$$E_t[M_{t+1} rx^k_{t+1}] = 0,$$

where M_{t+1} represents the stochastic discount factor (SDF) and rx^k_{t+1} is the excess return on the

portfolio k in $t+1$. We assume that the SDF is linear in a set of pricing factors $\mathbf{F}_{t+1}$. Specifically,

$$M_{t+1} = 1 - \mathbf{b}'(\mathbf{F}_{t+1} - \boldsymbol{\mu}),$$

with $\mathbf{b}$ as the vector of factor loadings and $\boldsymbol{\mu}$ referring to the factor averages. This implies a beta-pricing relationship: the expected excess return on portfolio k is given by a vector of factor prices $\boldsymbol{\lambda}$ times the portfolio's factor loadings, $\boldsymbol{\beta}^k$. This linear relationship can be described as

$$E[RX^j] = \boldsymbol{\lambda}'\boldsymbol{\beta}^k.$$

The market price of risk $\boldsymbol{\lambda}$ can be written as

$$\boldsymbol{\lambda} = \boldsymbol{\Sigma}_f \, \mathbf{b},$$

where $\boldsymbol{\Sigma}_f$ is the variance-covariance matrix of the factors $\mathbf{F}_{t+1}$. Each $\boldsymbol{\beta}^k$ is estimated by a time series regression (first-stage) of the excess returns rx^j_{t+1} on the factor innovations $\mathbf{F}_{t+1}$.

Fama-MacBeth regression. We expect a conditional effect of global financial stress depending on the level of central bank solvency. A higher degree of central bank solvency should enhance a portfolio's ability to buffer domestic stock markets against global financial stress. Thus, these portfolios should exhibit low excess returns during normal periods and high excess returns during times of financial stress. In contrast, portfolios associated with less solvent central banks are likely to be less effective in mitigating financial stress and, consequently, should display lower returns during such periods. To test this hypothesis for the cross-section of stock market returns, we follow the Fama & MacBeth (1973) approach. In the first stage, we employ a two-factor model inspired by Ang et al. (2006), Adrian & Rosenberg (2008) and Da & Schaumburg (2011), regressing the excess returns of market return MKT and changes in the VIX index ΔVIX as risk factors on the excess returns of portfolios k with

$$rx_{kt} = \alpha_k + \beta^{\Delta VIX}_{j,k} \Delta VIX_t + \beta^{MKT}_{j,k} MKT^{orth}_t + \epsilon_{it}. \tag{1}$$

For MKT, we use the log difference of the returns of the MSCI All Country Index from Thomson Reuters via Datastream, adjusted by subtracting the 4-week Treasury Bill rate from Ken French's data library. Due to multicollinearity issues between MKT and ΔVIX, we regress MKT on ΔVIX and use the residuals as MKT^{orth}_t. The constant is α_k and the factor loadings of portfolio k are captured by the betas $\hat{\beta^{\Delta VIX}_{j,k}}$ and $\hat{\beta^{MKT}_{j,k}}$. To increase the variance of the betas while

using only novel information, we apply non-overlapping windows j with a duration of about three years. The Newey & West (1987) method is used for the standard errors with optimal lag choice following Andrews (1991).

For the cross-section regression (second-stage), the betas are used to estimate the factor prices λ, described by

$$rx_k = \lambda_j^{\Delta VIX} \hat{\beta_{j,k}}^{\Delta VIX} + \lambda_j^{MKT} \hat{\beta_{j,k}}^{MKT} + \epsilon_k. \tag{2}$$

We obtain the lambdas $\lambda_j^{\Delta VIX}$ and λ_j^{MKT}. Our estimation for the factor prices $\hat{\lambda}^{\Delta VIX}$ and $\hat{\lambda}^{MKT}$ is then obtained as the average across all non-overlapping windows j, which can be described by

$$\hat{\lambda}^{\Delta VIX} = \frac{1}{J}\sum_{j=1}^{J} \lambda_j^{\Delta VIX}, \quad \hat{\lambda}^{MKT} = \frac{1}{J}\sum_{j=1}^{J} \lambda_j^{MKT}, \tag{3}$$

where J is the number of windows. To estimate the standard errors, we use the Newey & West (1987) method with an optimally chosen lag length following Andrews (1991). Additionally, we use the method by Shanken (1992), which minimizes the distortion of the estimated betas by incorporating an adjustment factor, and a block bootstrapping method shown by Horowitz (2019), for instance.

We refine our cross-sectional estimation by conditioning on phases of heightened financial stress. Therefore, we estimate the factor prices λ_j by regressing the portfolio excess returns on the factor loadings during financial stress. By employing this approach, we can emphasize whether the excess returns of highly solvent portfolios surpass those of less solvent portfolios in times of risk materialization.

4.3 Results

Table 8 indicates that all portfolios are significantly negatively exposed to financial stress (ΔVIX). This means that country portfolio excess returns decline as financial stress rises, irrespective of the central bank's solvency level. However, with increasing solvency from P_1 to P_4, a growing exposure can be observed. Given that the VIX is measured in percentage terms, a 1% increase is associated with a drop in excess returns of -0.57% for Portfolio 1, while Portfolio 4 exhibit a more pronounced decline of -0.74%. Concerning exposure to the orthogonalized market factor, the results suggest that the excess returns of all portfolios are significantly and positively related to it. The intercepts (α) are insignificant, implying that sorting portfolios by central bank solvency allows return behavior to be explained by the risk factors MKT and ΔVIX without systematic deviations. Furthermore, the R^2 is relatively high.

Table 9 presents the results of the cross-sectional regressions of country portfolios as test assets across different panels, depending on the selected time. The reported statistics include the market prices of risk λ, the Hansen & Jagannathan (1997) (HJ) distance, the p-values of the HJ distance, and the cross-sectional R^2. The HJ distance represents the maximum pricing errors as a percentage relative to the unit norm. Statistical significance of the factor price λ is determined using the standard errors of Newey & West (1987) (NW), with optimal lag estimation following Andrews (1991). Additionally, standard errors from Shanken (1992) (Sh) are reported, while for Panel C, block bootstrapping standard errors are applied (e.g., Horowitz, 2019) (Boot).

Panel A reports the results based on the full sample, showing that the factor price of financial stress, $\lambda^{\Delta VIX}$, is negative and weakly significant. A one-unit increase in exposure to financial stress, $\beta^{\Delta VIX}$, which becomes less negative with rising central bank solvency, results in a decline in excess returns of -1.21%. This means that, on average, country portfolios with lower central bank solvency earn higher excess returns as compensation for increased risk. Accounting for the Shanken standard errors reveals that $\lambda^{\Delta VIX}$ is not significant. A major advantage of this approach is its ability to address the errors-in-variables issue via the estimated betas. However, it should be noted that the sample period includes both high and low levels of financial stress, which may lead to an averaging-out of effects. The factor price of the orthogonalized market factor lacks significance. The model demonstrates a relatively high cross-sectional fit, with a R^2 of 80%, and a statistically insignificant HJ distance of 4%.

In Panel B, we exclude the cross-section time periods where financial stress is high. This is measured by identifying periods in which VIX increases exceed one standard deviation above the mean. Here, $\lambda^{\Delta VIX}$ is lower and statistically significant at the 1% level (5% under the alternative method). This implies that, in normal times, country portfolios with lower central bank solvency are rewarded with higher excess returns compared to those with higher central bank solvency. The HJ distance and R^2 values remain comparable to those in Panel A, supporting the model's ability to explain the excess returns of country portfolios.

Panel C focuses on periods of high financial stress, covering a small sample with 31 months. Under these conditions, $\lambda^{\Delta VIX}$ turns positive and is statistically significant at the 1% level. This suggests that, in times of financial distress, country portfolios with higher central bank solvency exhibit higher returns relative to those with lower solvency. This implies that high solvency portfolios gain high excess returns when risk materializes. Figure 14 visualizes the evolution of the individual $\lambda^{\Delta VIX}$ over periods of elevated financial stress. However, using Shanken (1992) standard errors, no significance is observed, though these errors tend to inflate considerably in small samples. From an economic standpoint, it can also be argued that significant compensation for low solvency with high excess returns in normal times should be accompanied by lower excess

returns in bad times. To provide an additional benchmark, we employ block bootstrapping as suggested by, e.g., Horowitz (2019). A main advantage of this method over, e.g., NW, is that the estimation of the test statistic remains consistent while relying on weaker assumptions about the data-generating process.[7] As a result, standard errors increase slightly compared to NW, but the factor price remains significant. The factor price $\lambda^{\Delta MKT}$ is significantly negative, aligning with the typical market reaction that, during periods of financial stress, an increasing market risk $\beta^{\Delta MKT}$—which corresponds to lower central bank solvency—is associated with lower excess returns (flight from risky assets). Finally, it can be noted that the HJ distance increases in this model but still supports its pricing power. Moreover, this model explains a substantial share of the variance in excess returns.[8]

5 Stock market returns and exposure to financial stress

This chapter explores the extent to which various channels influence the way central bank solvency affects the transmission of financial stress. For this purpose, we adopt an interaction model framework.

5.1 Baseline results

Basic model. Following a broad body of literature, we employ the VIX as a measure of financial stress. The baseline specification for the panel regression of monthly stock market excess returns $rx_{i,t}$ is given by:

$$rx_{i,t} = \alpha_i + \delta_\tau + \beta_1 CBS_{i,t} + \beta_2 \Delta VIX_t + \beta_3 (\Delta VIX_t \times CBS_{i,t}) + \gamma' X_t + \epsilon_{i,t}, \tag{4}$$

where $CBS_{i,t}$ are our measures of central bank solvency CBS_1, CBS_2 and log(Z-Score) for country i at time t, derived from a principal component analysis of central bank balance sheet items. Financial stress is captured by innovations in the VIX index, denoted as ΔVIX_t. In further specifications, the changes in the Excess Bond Premium (EBP), created by Gilchrist & Zakrajšek (2012), and the bond spread (BS) with data from the Federal Reserve Economic Data (FRED) are used.

The vector X_t contains a set of control variables, including the market excess returns orthogonalized with respect to VIX changes (MKT_t^{orth}), the size factor (Small Minus Big, SMB) and value factor (High Minus Low, HML) from the Kenneth R. French data library, the liquidity risk

[7] We use 10,000 iterations and a block length of 3.

[8] Extensions of the formula (2) with size and value factors from Ken French Library in our model show that more noise than useful information is introduced (similar to Ang et al., 2006), which could be caused by overparameterisation.

measure proposed by Pastor and Stambaugh (2003), as well as the country-specific inflation rate and yearly GDP growth obtained from the World Bank Group. The coefficients associated with these variables are collected in vector γ.

The model includes country fixed effects α_i and year fixed effects δ_τ, and standard errors are two-way clustered by country and month. In addition to using the continuous measure of VIX changes, we also estimate a specification where ΔVIX_t is replaced by a dummy variable equal to one if the monthly mean of ΔVIX_t exceeds one standard deviation. We believe that the timing of a sharp increase is particularly important for the pricing in of solvency. In comparison, a high VIX level can also be accompanied by phases in which the VIX falls again more sharply and equity returns therefore rise again. To confirm our main hypothesis, the interaction term $(\Delta VIX_t \times CBS_{i,t})$ must exhibit a significantly positive coefficient, indicating that countries with solvent central banks experience more resilient stock market performance amid financial stress.

Results. The baseline estimation results are presented in Table 10, which reports three specifications. Column (1) shows the regression of stock market excess returns solely on ΔVIX. Consistent with the established literature, the coefficient on ΔVIX is negative and statistically significant, indicating that heightened financial stress translates into lower stock market returns.

Column (2) introduces our central bank solvency measure (CBS) and its interaction with ΔVIX, while still excluding additional controls. The coefficient of CBS is significant here at the 10% level. Our hypothesis is that CBS does not necessarily have to be significant because the risk behind a low central bank solvency plays a role especially in times of crisis. However, our hypothesis is fulfilled insofar as the interaction between CBS and ΔVIX is positively significant. This finding suggests that the detrimental effect of elevated financial stress on stock market returns is mitigated in countries with more solvent central banks.

Column (3) extends the model by adding the full set of control variables, including orthogonalized market excess returns (MKT_t^{orth}), the size (SMB) and value (HML) factors from the Kenneth R. French data library, liquidity risk as proposed by Pastor and Stambaugh (2003), as well as country-specific inflation rates and annual GDP growth from the World Bank Group. Incorporating these controls does not alter the main finding: the positive and significant interaction effect between CBS and ΔVIX persists. For instance, given a negative standard deviation in central bank solvency, a one standard deviation increase in ΔVIX leads to a 3.58% decline in monthly stock market returns. In contrast, for a positive standard deviation in central bank solvency, this decline is reduced to 2.86%. Hence, excess returns are about 0.72% per month (8.6% p.a.) lower for countries exhibiting stronger central bank solvency. The result is therefore economically significant.

Next, we visualize in Figure 5 how the marginal effects of ΔVIX on stock market returns change depending on central bank solvency with our main measure. The result shows that as central bank solvency increases, the stock market is more resilient to financial stress as the impact of ΔVIX decreases.

Table 11 reports baseline panel regression results for monthly stock market excess returns using alternative measures of central bank solvency. Column (1) employs one alternative solvency measure derived from a principal component analysis that incorporates not only the equity, RoA, and the log(Z-Score)—as in the main specification—but also NetII. The results confirm the earlier insights: while the coefficient on central bank solvency itself is not statistically significant, its interaction with changes in the VIX index (ΔVIX) remains positively significant. Column (2) narrows the solvency measure to the log(Z-Score) alone. The evidence again supports our main conclusion: the interaction term between log(Z-Score) and ΔVIX is positive and highly significant. The values of the coefficients are also comparable. Taken together, these alternative specifications underscore that the mitigating influence of central bank solvency on the effects of financial stress is robust to our different measures of solvency.

Table 12 presents results using two alternative proxies for financial stress, thereby demonstrating that our main findings do not hinge on the VIX. In Column (1), the financial stress proxy is the change in the excess bond premium (ΔEBP). Consistent with our previous results, the coefficient on ΔEBP is significantly negative, indicating that elevated bond market stress corresponds to lower stock market returns. Moreover, while the coefficient on CBS alone is not significant, the interaction between CBS and ΔEBP is significantly positive. This finding suggests that stronger central bank balance sheets mitigate the adverse effects of bond market stress on stock markets. Column (2) replicates the analysis using changes in the bond spread (ΔBS) as the measure of financial stress. The coefficient on ΔBS is negatively significant, consistent with heightened bond market stress dampening equity returns. Again, while the stand-alone CBS effect remains statistically insignificant, the interaction between CBS and ΔBS emerges as positively significant.

Table 13 presents the results of our panel regressions when both the financial stress indicators and central bank solvency are discretized into dummy variables. The use of dummy variables allows us to capture threshold effects and identify distinct states, such as periods of heightened financial stress or high central bank solvency, which may exhibit fundamentally different dynamics than less extreme conditions. This approach simplifies interpretation and enhances comparability across countries and time periods. The financial stress dummy variables for the VIX, EBP, and BS measures are set to one if the respective monthly change exceeds its mean by more than one standard deviation. Similarly, the central bank solvency dummy is equal to one for countries in

the top 50% of the solvency distribution, and zero otherwise.

Column (1) relies on the VIX-based financial stress dummy. Here, the ΔVIX dummy is negative and statistically significant, confirming that high-stress episodes are associated with lower stock market returns. Contrary to our expectations, the coefficient on the central bank solvency dummy is also significantly negative. This suggests that in normal times, markets may perceive more highly capitalized central banks as associated with slightly lower returns. Additionally, the interaction term between the VIX dummy and the central bank solvency dummy is positive but not statistically significant, indicating that the mitigating effect observed in the continuous specification does not carry over when both variables are discretized.

Columns (2) and (3) introduce dummy variables based on the ΔEBP and the ΔBS. Similar to the ΔVIX dummy, both dummies are negatively and significantly associated with stock market returns. The central bank solvency dummy remains significantly negative, mirroring the VIX-based results. However, in these bond market stress scenarios, the interaction terms are now positively significant. These findings imply that while heightened stress in bond markets reduces stock market returns, stronger central bank solvency mitigates these adverse effects. Thus, when bond market stress intensifies, countries with more solvent central banks are better positioned to cushion the impact on their stock markets. Overall, this demonstrates the robustness of our results.

5.2 Channels

The next step is to explore the underlying channels through which the relationship between financial stress and central bank solvency operates. Identifying these channels is important for understanding why certain central banks are better positioned to mitigate the negative effects of financial stress. To do this, we use the formula (4) and integrate a triple interaction term to test the reaction of our main term with different channels. The reduced form equation for this can be described with

$$rx_{i,t} = \alpha_i + \delta_\tau + \beta_4(\Delta VIX_t \times CBS_{i,t} \times A_{i,t}) + \gamma' X_t + \epsilon_{i,t}, \tag{5}$$

where $A_{i,t}$ is a proxy variable for our channels.

Emerging markets. We split the sample according to an emerging markets dummy so that we can compare the effects between developing and developed countries. We use the IMF World Economic Outlook Database for the classification. The countries categorized in our dataset are shown in Table A.1. This dummy is used to represent a set of different characteristics such as institutional quality,

financial market maturity and economic structures. The results are collected in Table 14. Our baseline interaction between central bank solvency and VIX changes is insignificant. However, we observe a positively significant result for the triple interaction, which may now overshadow this effect. This suggests a general tendency for developing countries to rely more on central bank solvency, as the impact of the VIX on stock market returns can be mitigated.

This influence becomes more evident in Figure 6, which illustrates the marginal effects of the VIX across different levels of solvency and the emerging marekts dummy. The point estimates confirm that central bank solvency is particularly crucial for developing countries to counteract the effects of financial stress. We have two arguments for this finding: In line with the "global financial cycle" literature (e.g., Miranda-Agrippino & Rey, 2020), advanced economies appear more tightly linked to U.S.-driven market volatility, while developing countries face partly distinct cycles. Consequently, the triple interaction of central bank solvency, ΔVIX, and the emerging market dummy is both positive and statistically significant, suggesting that in times of elevated global risk, central bank solvency plays a more stabilizing role for equity returns in developing countries. Put differently, higher central bank solvency in these economies can mitigate the downside pressure during risk-off episodes—an effect less pronounced among advanced economies, where broader global factors tend to dominate.

Political independence. Next, we focus on the political independence channel. Central bank independence captures the degree to which monetary authorities can formulate and implement their policies without political influence, allowing them to prioritize long-term objectives—such as price and financial stability—over short-term political gains (e.g., Cukierman et al., 1992; Blinder, 2010). When central bank independence, solvency, and financial stress interact, one might expect that high solvency plus high independence leads to more resilience under financial stress. A strand of literature shows that central bank independence has a fundamentally positive effect on financial stability (e.g., Klomp & de Haan, 2009; Doumpos et al., 2015). We hypothesize the opposite, especially in the short term. An observed negative triple interaction coefficient could indicate that independent central banks—precisely because they are independent—do not respond in the same way as less independent ones when stress rises. We can see two reasons for this: First, while independence typically promotes long-run stability, it can reduce the short-run, politically motivated "rescue" actions that visibly support stock markets. For example, Berger & Kißmer (2013) show with a theoretical model that independence does not promote financial stability. Second, by engaging in lender of last resort interventions, central banks not only expose themselves to potential future losses but also to the risk of compromising their independence (Buiter et al., 2023). The reasons for this are: (i) quasi-fiscal measures may invite governmental influence over

central bank decisions, (ii) reputational risks arise from potential misjudgments regarding short-term measures, (iii) the central bank face a tension between immediate stability objectives and the central bank's long-term mandate. Very independent central banks in particular could have an incentive to maintain this level. Binder (2021) reveal that even very independent central banks regularly face political pressure. In a panel regression with a triple interaction, this dynamic can appear as if independent central banks' high solvency is less effective at mitigating immediate financial stress.

Data from Romelli (2022, 2024) serve as the basis for our analysis. We draw on the well-established index developed by Cukierman et al. (1992), which assesses central bank independence through several dimensions, including the design of the governor's contract, autonomy in monetary policy decisions, and the constraints on lending to the government. As our primary measure, we employ the Romelli (2022, 2024) Index, which extends the Cukierman Index by incorporating additional dimensions such as legal provisions for financial independence and reporting standards. We also consider the sub-index on de jure financial independence as a separate measure to distinguish more clearly between balance-sheet soundness and legal-institutional factors. This covers questions such as financial autonomy, legal agreements on recapitalization or the distribution of profits.

Figure 7 illustrates the average level of the Romelli Index for 43 countries, grouping the distribution into five ascending categories between 0 and 1. Over time, the average level of central bank independence has trended upward, and its distribution is skewed toward higher values. Consequently, the majority of central banks can be classified as relatively independent, underscoring the importance of examining independence as a potential channel through which solvency might foster resilience to financial stress.

Furthermore, the results of a correlation analysis reveal that all central bank independence measures are uncorrelated with the solvency measure, thereby ruling out concerns regarding multicollinearity. The results are presented in Table 18. As expected, the central bank independence measures show higher correlations among themselves.

We incorporate measures of central bank independence into our baseline regressions, using Formula (5). Table 15 presents the findings from panel regressions of monthly stock market excess returns on central bank solvency (CBS), global financial stress (ΔVIX_t), central bank independence (CBI), and their interactions. Contrary to our initial expectations, central bank solvency appears as a negatively significant factor in three out of the four regressions. Consistent with the previous results, elevated global financial stress remains negatively associated with stock market returns in all specifications. Importantly, the interaction between central bank solvency and global financial stress is consistently positive and significant, reinforcing our hypothesis that

stronger central bank balance sheets can mitigate the detrimental impact of global financial stress on stock markets.

Next, we incorporate different indices of central bank independence to test our proposed channel. Across all models, the direct effect of independence is statistically insignificant, aligning with our initial hypothesis that independence per se may not influence baseline returns in normal times. Our hypothesis is that the triple interaction of central bank solvency, independence, and global financial stress is significantly negative. The results provide mixed evidence. Column (1) includes the results using the Romelli Index. The triple interaction suggests that higher independence attenuates the mitigating effect of solvency on financial stress, aligning with our expectation. By contrast, when using the Cukierman Index in Column (2), the triple interaction is not significant; however, the interaction between financial stress and independence alone is negatively significant. This outcome is less straightforward to interpret. It may stem from the Cukierman Index's narrower scope, which does not explicitly consider financial independence. Finally, in the specification using the de jure Financial Independence Index in Column (3), independence and financial stress interact positively. Notably, both the solvency-financial stress interaction and the independence-financial stress interaction remain significant, suggesting that solvency and independence each exert an independent stabilizing influence during periods of stress.

Since only certain value ranges can be responsible for a significant effect when using continuous variables, we show the marginal effects in Figure 8. The left plot shows the marginal effects of VIX changes on stock market returns in color, which is determined here by the level of central bank solvency and central bank independence using the Romelli Index. Solvency appears to be especially significant in reducing financial stress in situations where central bank independence is limited. Given a low solvency, a higher level of independence reduces stress only slightly. The graph on the right also shows a reduction in financial stress, especially when the Cukierman Index is low.

Given the mixed evidence regarding the interaction between central bank independence and solvency in mitigating financial stress, we undertake two additional robustness checks to ascertain whether our findings are sensitive to the choice of solvency and financial stress measures.

First, we use the alternative solvency CBS_2, which incorporates NetII. As shown in Table 16, we continue to find that the triple interaction between central bank solvency, independence, and financial stress shows a statistically significant effect. Notably, when employing this solvency measure, the magnitude and significance of the triple interactions are generally consistent with our main findings.

Second, we replace the ΔVIX with the excess bond premium ΔEBP as an alternative measure

of global financial stress. As reported in Table 17, the patterns observed with the VIX largely hold when the EBP is used. The interaction between solvency and financial stress remains significant and positive, underscoring the resilience afforded by more solvent central banks. In particular, the negative and significant triple interaction coefficients observed in multiple specifications indicate that higher central bank independence may indeed dampen the ability of solvency to mitigate financial stress.

Taken together, our results indicate that central bank independence is a robust channel. Solvency appears to be particularly relevant for less independent central banks. Central banks with lower levels of independence may focus resources on immediate crisis mitigation or politically visible "bailout"-style measures. Under conditions of sufficient solvency, these central bank interventions appear to dampen stress more directly, leading to a stronger observed correlation between solvency and financial stress reduction.

Central Bank Transparency. Especially during periods of financial stress, central bank transparency can be crucial in shaping the impact of solvency, as it largely determines the set of available information regarding the economic situation, central bank policy actions, and balance sheet constraints.

A strand of the literature highlights the positive effects of central bank transparency on outcome variables and expectations (e.g., Geraats, 2005; Eichengreen & Dincer, 2007; Neuenkirch, 2012; Čihák et al., 2012; Blinder et al., 2022). Higher transparency, especially during periods of financial stress, could also have ambiguous effects. For example, Born et al. (2010) show that central bank reports have a longer-term positive effect on stock markets, while speeches and interviews tend to increase market volatility. Because speeches and interviews tend to be used in times of financial stress, higher central bank transparency could have a negative effect. Horváth & Vaško (2016) indicate that central bank transparency reduces financial stress. Yet, this effect weakens as transparency rises, implying that too much transparency—especially in times of crisis—can be detrimental. Excessive disclosure may heighten investor uncertainty and intensify the crisis.

When transparency is low, investors face higher uncertainty about potential policy actions and are thus unable to form clear expectations about how the central bank might intervene. This ambiguity could exacerbate financial stress, as investors withdraw capital in anticipation of insufficient support. However, a high-solvency central bank with robust balance sheet "firepower" is more likely to credibly backstop the financial system. For our channel, we expect that when central bank transparency is low, strong solvency can better ease financial stress. In contrast, central banks with high transparency are unable to mitigate financial stress.

Here, we follow the approach of Dincer et al. (2022), where central bank transparency is focused

on monetary policy. They develop an index based on five distinct dimensions, such as political transparency, economic transparency, and procedural transparency. The resulting index reflects how openly a central bank can communicate its information and objectives concerning monetary policy.

Figure 9 illustrates the average level of the central bank transparency index developed by Dincer et al. (2022), based on data from 43 countries. The figure clearly demonstrates a steady increase in transparency over the sample period. The right-hand panel, which displays the distribution of transparency across central banks, further indicates that most central banks are relatively transparent. Only a few exhibit very low or very high transparency levels. Additionally, the correlation analysis in Table 19 reveals a slightly negative correlation between transparency and central bank solvency.[9]

The results appear in Table 20. In Column (1), the interaction term between central bank solvency and ΔVIX remains significantly positive, indicating that a more solvent central bank can indeed moderate the impact of financial stress. By contrast, central bank transparency itself is associated with a significantly negative coefficient, suggesting that higher transparency corresponds to lower stock market returns outside of financial stress. Consistent with Born et al. (2010), the interaction of transparency with ΔVIX shows that greater transparency amplifies the effect of volatility. Finally, the triple interaction term is significantly negative, supporting our hypothesis that higher transparency dampens the moderating role of central bank solvency under stress.

Figure 10 illustrates the marginal effects of ΔVIX on stock market returns, conditional on central bank transparency and solvency. The results indicate that, particularly under low transparency, increasing solvency can mitigate the impact of financial stress. Higher solvency may therefore enhance the central bank's credibility in fulfilling its lender-of-last-resort function during periods of financial distress. Conversely, the findings suggest that under conditions of higher transparency, solvency plays a less significant role, which is consistent with the results from the literature.

Size financial system. The insolvency of the central bank itself would represent a significant shock to the domestic financial system. As a result, the central bank is likely to prioritize maintaining solvency by reducing the intensity of its last-resort policies. To capture the size of the financial system, we use the ratio of stock market size to a country's GDP. The data are sourced from the World Bank Group. Due to significant skewness in the data, we apply a logarithmic transformation. For instance, in January 2001, Bulgaria had a ratio of 0.58%, while Hong Kong reported a ratio of 1778% in January 2020.

[9]However, the Variance Inflation Factor (VIF) does not indicate multicollinearity.

Part of the literature explores the transmission of shocks in financial systems and the relevant contributing factors (e.g., Brunnermeier & Pedersen, 2009; Acemoglu et al., 2015). Findings indicate that larger financial systems exhibit greater resilience to financial stress compared to smaller systems, particularly concerning market liquidity. For example, Cetorelli & Goldberg (2012) provide evidence that banks without international operations are more exposed to monetary policy effects than banks with global reach. Moreover, Naqvi & Pungaliya (2023) show that smaller banks respond more strongly to liquidity shocks and face a higher likelihood of bailouts. These insights suggest that central bank solvency is more critical for smaller financial systems, as they are disproportionately affected by liquidity shocks and are more dependent on lender-of-last-resort measures.

The results presented in Table 21 explore how central bank solvency, financial stress, and the size of the financial system interact to influence stock market returns. The positive and significant interaction between central bank solvency and ΔVIX reaffirms our main hypothesis that higher solvency can reduce the impact of financial stress. The triple interaction term involving financial system size is negative and marginally significant, suggesting that the contribution of central bank solvency to moderating stress becomes less pronounced as the financial system grows.

Figure 11 illustrates the marginal effects of ΔVIX on stock market returns across different financial system sizes and levels of central bank solvency. Smaller financial systems appear to benefit more from higher central bank solvency, as these tend to be less liquid and therefore more reliant on the central bank's function as a lender of last resort. Interestingly, in cases of very high solvency, smaller systems can absorb shocks more effectively than larger ones, possibly due to the relative ease of stabilizing a smaller market.

Recapitalization. We hypothesize that the financial autonomy can fundamentally alter how a central bank's solvency influences market perceptions. If the government is legally responsible for maintaining the integrity of central bank capital, the impact of solvency should diminish. In this case, a deterioration in balance sheet quality would likely prompt the government to undertake a recapitalization. As a result, the central bank could continue to perform its lender-of-last-resort function effectively, even when its balance sheet quality is low during periods of financial stress.

The central bank survey by Romelli (2022, 2024) include the question on the extent to which the government has a legal obligation to provide the central bank with capital again. There are the categories: Government should maintain central capital integrity; Government is legally allowed to capitalize the central bank; The law does not allow the government to capitalize the central bank; The central bank conducts quasi-fiscal operations. This level variable is used in our triple interaction model.

Table 22 indicates that neither the interaction between central bank solvency and ΔVIX, nor the triple interaction with recapitalization, is statistically significant—thus failing to support our hypothesis in this specification.

However, because certain data overlaps may affect the estimates, we present the marginal effects in Figure 12. The figure shows that when no recapitalization is possible, the effect of ΔVIX on stock market returns is strongest for low-solvency central banks. The stronger mitigation of financial stress effects by low-solvency central banks may stem from the fact that these countries are particularly likely to engage in such agreements. Conversely, if the government ensures central bank solvency through recapitalization, financial stress diminishes. Under very high solvency, it appears to matter little whether the government intervenes, since financial stress is already moderately reduced.

Given that these findings are only marginally insignificant, we test alternative solvency measures. Indeed, when using log(Z-Score) to gauge solvency, our hypothesis is significantly supported, both for the interaction with financial stress and for the triple interaction involving recapitalization.

Career concerns. The central bank's insolvency could be linked to fluctuations in its management, making it rational for the central bank's government to act in ways that prevent insolvency due to career concerns. The literature indicates that career concerns are correlated with an incentive to avoid losses (e.g., Jensen, 1986; Stein, 1989; Graham et al., 2005; Bennett et al., 2017; Goncharov et al., 2023). Consequently, a central bank governor facing career concerns should be inclined to maintain higher solvency. We argue that career concerns dampen the moderating role of solvency in shaping the impact of ΔVIX on stock market returns. Even though reappointable governors generally report more frequent profits and thus higher solvency, they should remain cautious in engaging in lender-of-last-resort interventions to preserve their financial gains.

Goncharov et al. (2023) show that governors with the possibility of re-election are motivated by career considerations. However, it can also be argued that a high central bank turnover rate triggers career concerns, given that governors recognize the likelihood of frequent changes. Therefore, finding a variable that fully captures this effect remains challenging.

Following Goncharov et al. (2023), we introduce a variable that captures the possibility of the central bank governor's reappointment. Using data from Dreher et al. (2010), we assess whether the governor's tenure exceeds the duration of a single legislative term. If the governor has been reappointed and serves beyond one term, the variable takes a value of 1; otherwise, it is assigned 0.

Our results are presented in Table 23. Our main hypothesis is reaffirmed, suggesting that rising solvency enhances the ability to dampen financial stress. Concerning the triple interaction,

the results indicate that heightened career concerns diminish this effect, which aligns with our hypothesis[10]. For a more precise interpretation, Figure 13 illustrates the marginal effects, revealing a discernible difference in stress reduction between the two groups. In countries where governors can be re-elected, stress has a greater impact, as interventions are likely avoided due to career concerns. When career concerns are less relevant, stress reduction tends to be more pronounced on average.

6 Conclusion

Recent literature increasingly acknowledges that central banks are exposed to rising balance sheet risks, especially in the aftermath of large-scale asset purchases and recent interest rate hikes (e.g., Cecchetti & Hilscher, 2024; Kiley & Mishkin, 2024). However, the connection between these risks and the lender of last resort function remains underexplored. Our study addresses this gap by examining how a deterioration in central bank solvency can weaken the capacity to implement aggressive policy measures during periods of global financial stress, thereby heightening vulnerability in domestic stock markets.

Building on the hypothesis that higher central bank solvency reduces the adverse impact of financial stress, we propose a novel solvency measure and apply it within an asset-pricing framework inspired by Fama and MacBeth (1973). Our findings demonstrate that, during normal market conditions, countries with lower central bank solvency earn higher excess returns, reflecting a risk premium. However, in times of heightened financial stress, portfolios with stronger central bank solvency outperform. Panel regressions incorporating various transmission channels further reveal that the beneficial effects of solvency are especially pronounced in developing economies, low-independence central banks, smaller financial systems, and in contexts of limited transparency. Recapitalization agreements tend to offer additional shielding against financial stress, whereas governors without strong career concerns appear more willing to deploy lender of last resort interventions.

By highlighting the multifaceted role of central bank balance sheet quality, this paper makes three principal contributions. First, we extend the literature on unconventional monetary policies by explicitly linking central bank solvency to financial stress transmission. Second, we introduce a solvency index that captures capital adequacy, profitability and risk dimensions, offering a more comprehensive gauge of balance sheet strength. Finally, our evidence on diverse channels—such as transparency, independence, and financial system size—underscores the need for nuanced policy

[10] Although these findings align with theoretical expectations, we must acknowledge a limitation in statistical power. The sample comprises 31 countries, of which 29 have reelectable governors and only 2 do not. This imbalance limits the robustness of cross-country comparisons and suggests that the estimated effects should be interpreted with caution.

design. In doing so, we provide new insights into how robust central bank solvency can mitigate global risk spillovers and bolster domestic stock market resilience.

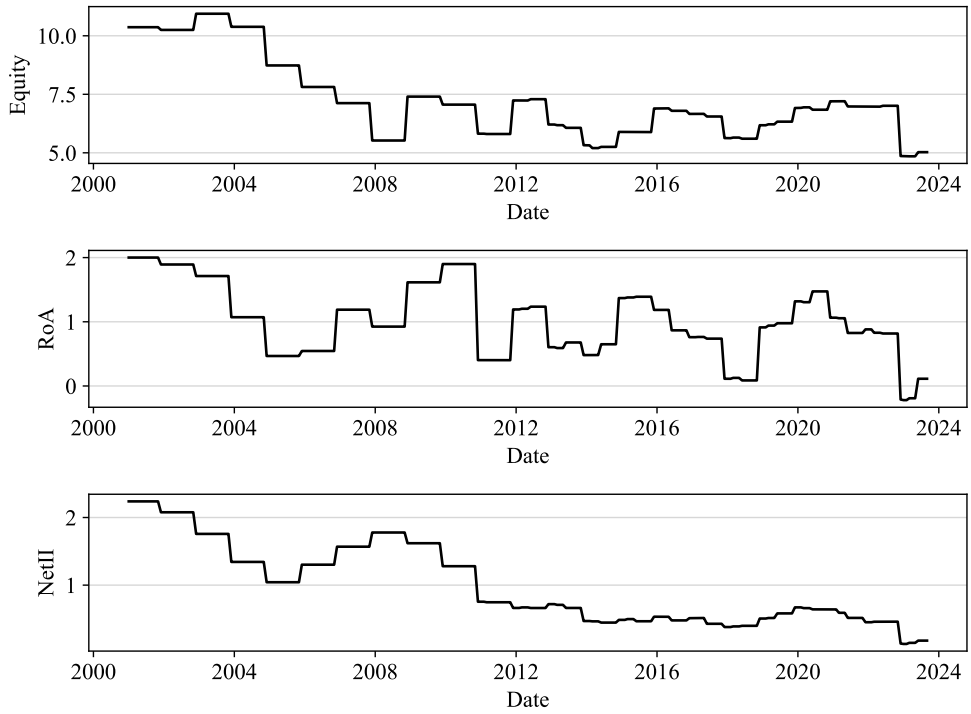


Figure 1: Country average balance sheet items. This figure shows the country average of the balance sheet items equity ratio, return on assets (RoA) and net interest income to total assets (NetII). The data are from BankFocus, covering the period from Jan. 2001 to Sep. 2023.

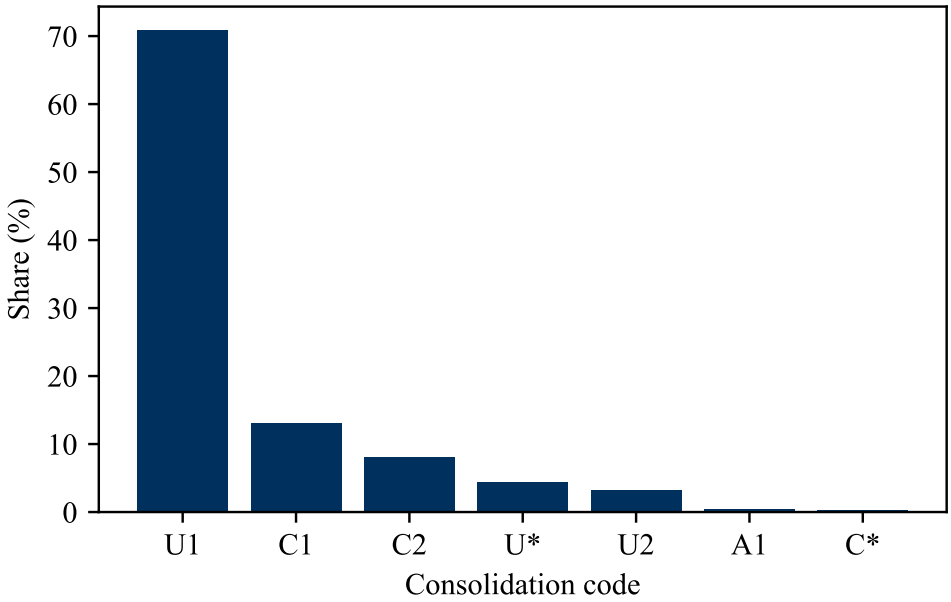


Figure 2: BankFocus consolidation codes. This figure shows the distribution of consolidation codes, offering information about the type of standard applied in the central bank accounting. This outcome is explained by our methodology regarding the consolidation codes, as outlined in Appendix A.1. The data are from BankFocus, covering the period from Jan. 2001 to Sep. 2023.

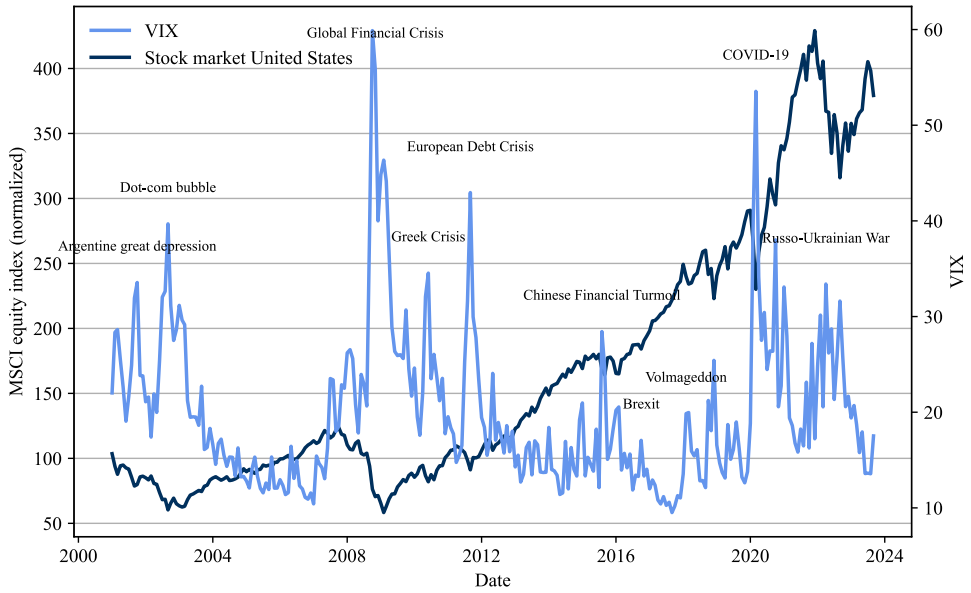


Figure 3: VIX and MSCI US equity index. This figure shows the developement of VIX and the normalized MSCI US equity index. Periods of financial stress are highlighted with a text marker. The data are from Thomson Reuters via Datastream, covering the period from Jan. 2001 to Sep. 2023.

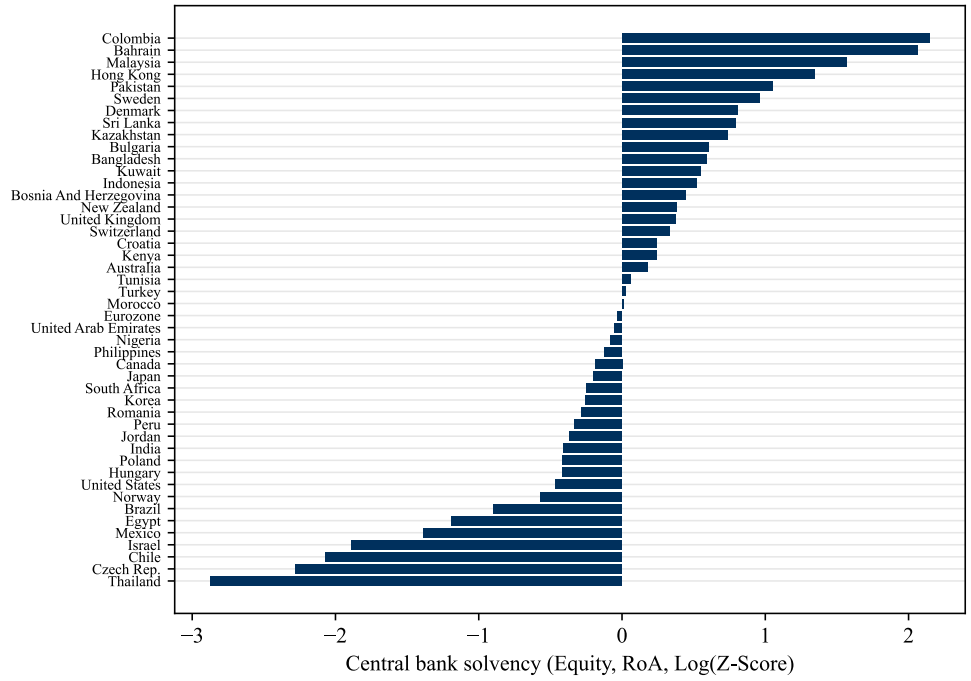


Figure 4: Average central bank solvency index CBS_1 per country. This figures shows average central bank solvency by country. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 46 countries. The countries are sorted in descending order. The data are from BankFocus, covering the period from Jan. 2001 to Sep. 2023.

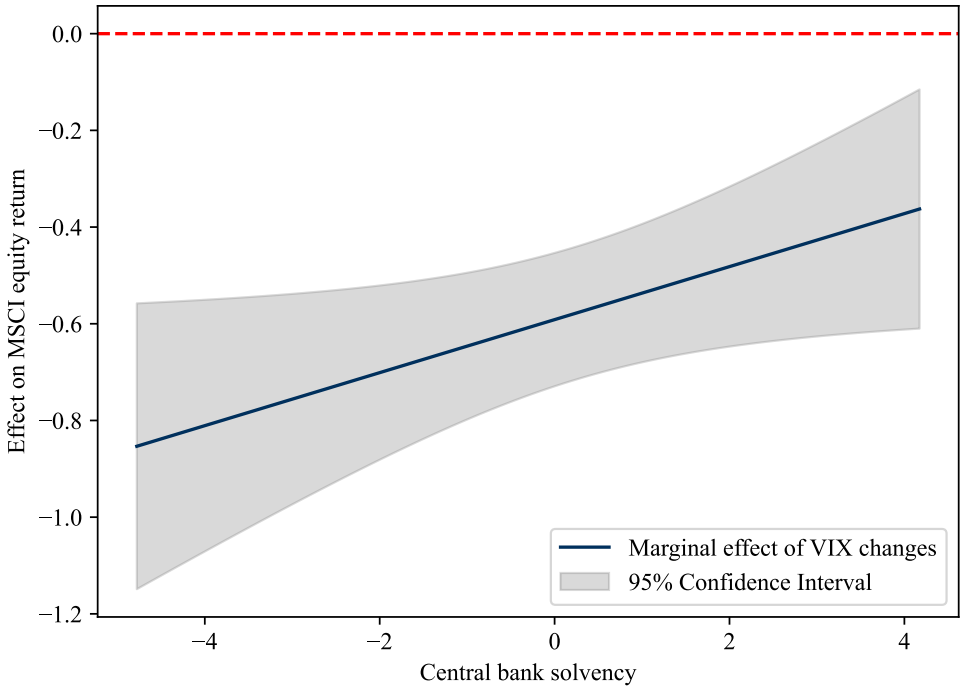


Figure 5: Marginal effects of changes in the VIX index. This figure illustrates the average marginal effects of a one-point change in the ΔVIX for different levels of central bank solvency, shown within a 95% confidence interval. These effects are derived from the baseline model (4) with controls: $rx_{i,t} = \alpha_i + \delta_\tau + \beta_1 CBS_{i,t} + \beta_2 \Delta VIX_t + \beta_3(\Delta VIX_t \times CBS_{i,t}) + \gamma' X_t + \epsilon_{i,t}$. The excess returns of a country's stock market are denoted with rx, CBS denotes the central bank solvency of the country, and ΔVIX signifies the monthly changes of in the VIX. The regression includes country and year fixed effects. The stock market returns are based on MSCI indices obtained from Thomson Reuters via Datastream and are reported in US dollars. The VIX data are also sourced from Thomson Reuters. Central bank solvency is estimated using principal component analysis, incorporating equity, return on assets (RoA), and log(Z-Score). This data is provided by BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023.

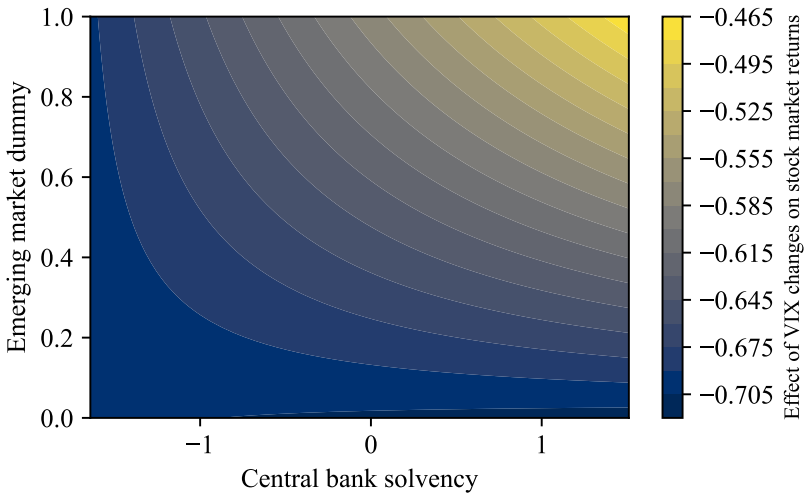


Figure 6: Marginal effects of global financial stress given developing country dummy. The figure displays the marginal effects of global financial stress, given central bank solvency and an emerging markets dummy. We distinguish between developed countries and emerging markets based on the classification from the IMF World Economic Outlook Database. Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

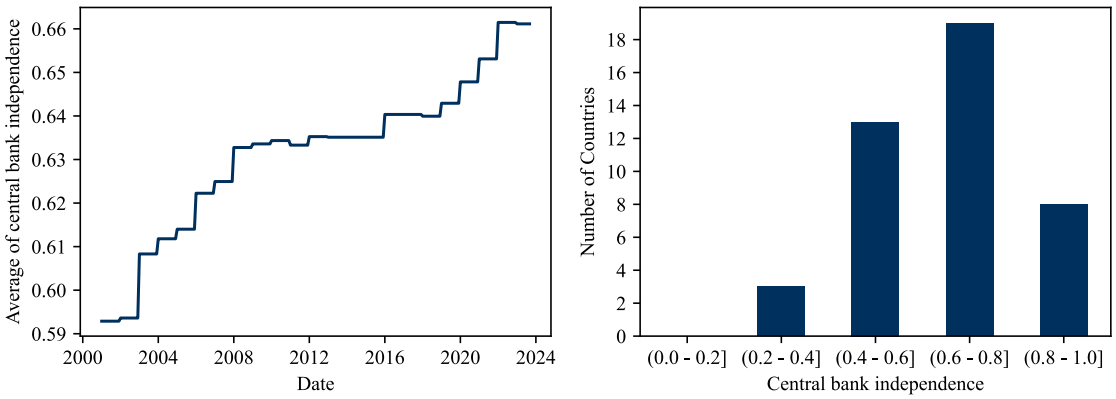


Figure 7: Central bank independence measure. The left figure displays the average trend of the Romelli (2022, 2024) Index as a measure of central bank independence across 43 countries over time, and the right figure illustrates the distribution of the country averages across five ascending, equally sized groups from 0 to 1. The data are sourced from Romelli (2022, 2024), covering the period from Jan. 2001 to Sep. 2023.

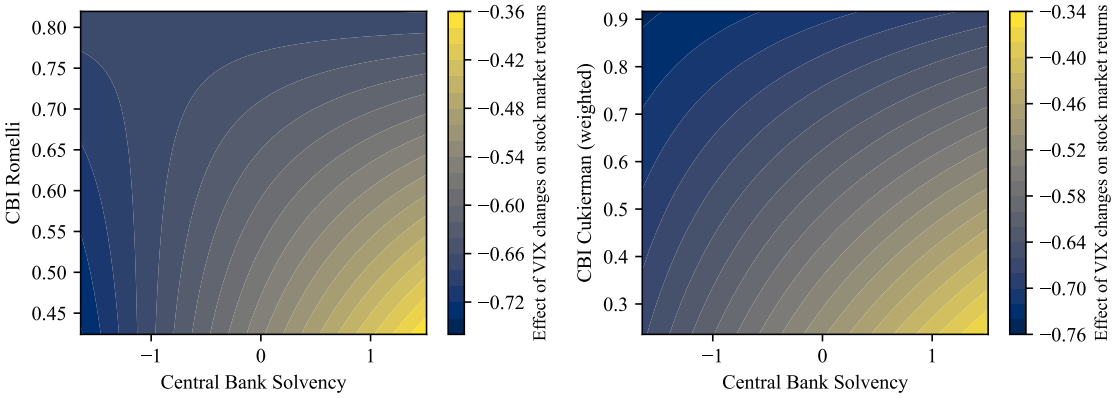


Figure 8: Marginal effects of global financial stress given central bank independence. The figure displays the marginal effects of global financial stress, given central bank solvency and various measures of central bank independence. We use the data from Romelli (2022, 2024) for central bank independence. Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

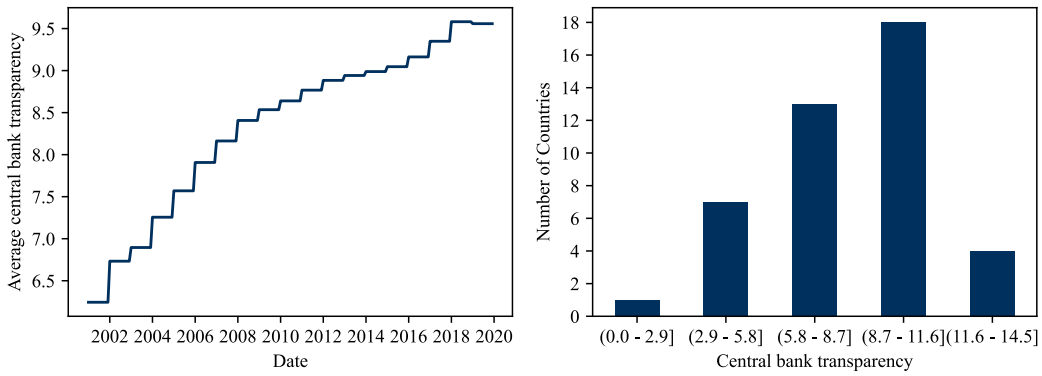


Figure 9: Central bank transparency measure The left chart displays the average trend of the Dincer et al. (2022) Index as a measure of central bank transparency across 43 countries over time, and the right figure illustrates the distribution of the country averages across five ascending. The data source is Dincer et al. (2022), covering January 2001 to December 2019.

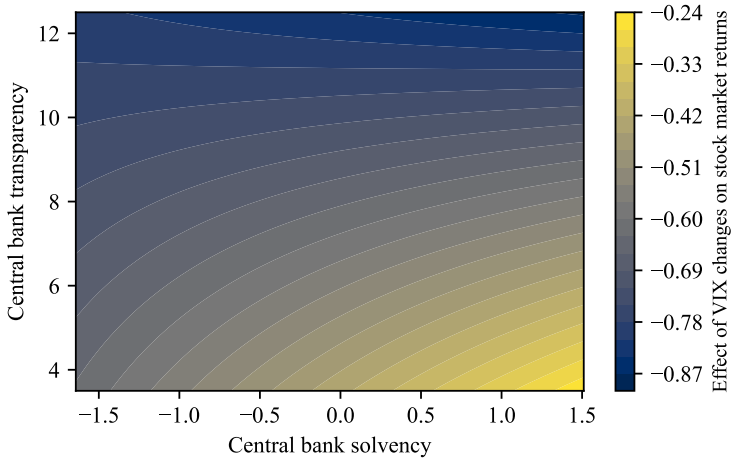


Figure 10: Marginal effects of global financial stress given central bank transparency. The figure displays the marginal effects of global financial stress, given central bank solvency and various measures of central bank transparency. We use the data on the central bank transparency index from Dincer et al. (2022). Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

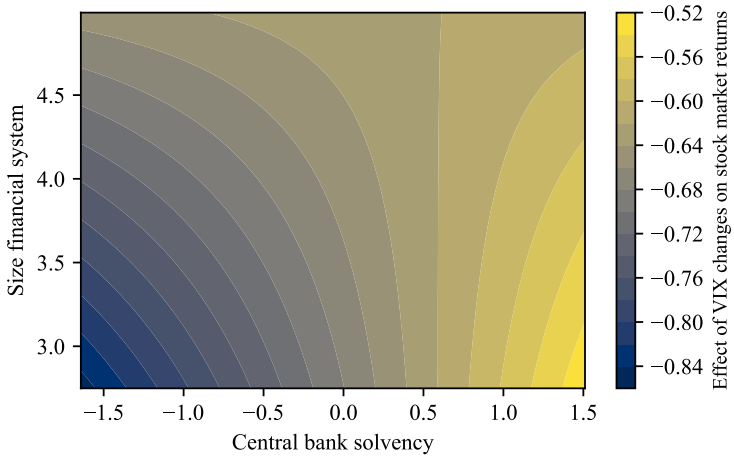


Figure 11: Marginal effects of global financial stress given size of the financial system The figure shows the marginal effects of global financial stress given central bank solvency and the size of the financial system, measured by the stock market size in relation to the GDP. The data of the financial system size are from the World Bank Group. Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

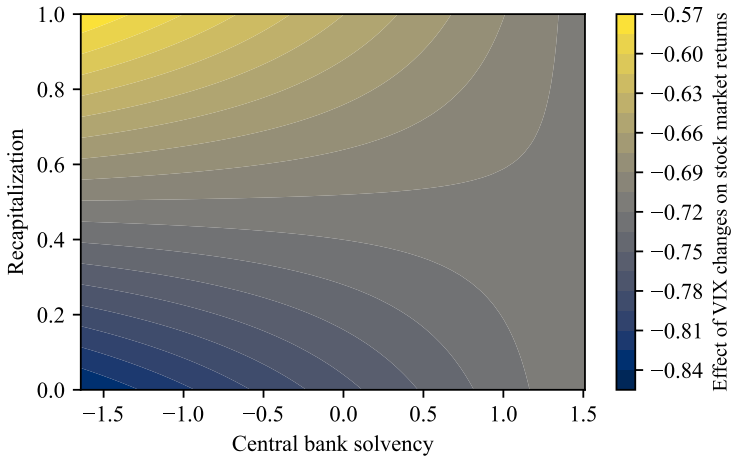


Figure 12: Marginal effects of global financial stress given the recapitalization capacity. The figure displays the marginal effects of global financial stress given central bank solvency and the recapitalization capacity. The data of the recapitalization capacity are from Romelli (2022, 2024), using survey question three in the category financial independence. Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

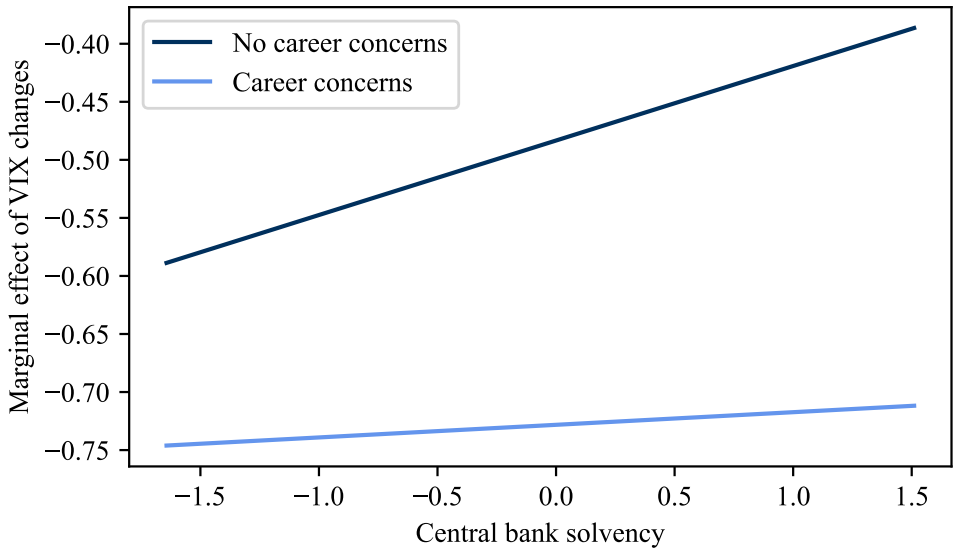


Figure 13: Marginal effects of global financial stress given career concerns. The figure displays the marginal effects of global financial stress given central bank solvency and the career concerns. Using data from Dreher et al. (2010), the variable career concerns is defined based on governor turnover. It takes the value of 1 if a country's central bank governor remains in office beyond the legally stipulated term. Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

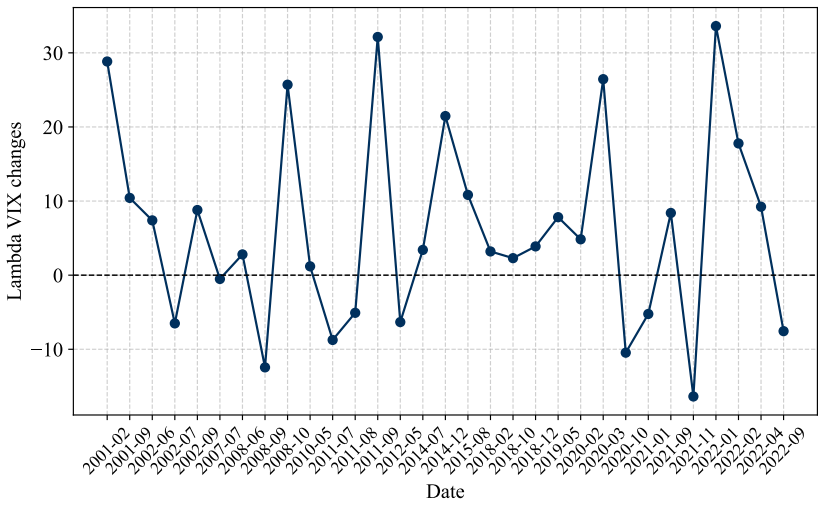


Figure 14: Cross-section regression - Lambda coefficients for VIX changes. The figure displays the lambda coefficients for VIX changes (ΔVIX), derived from the analysis in Table 9. The country portfolios are sorted by the solvency of their central banks. Central bank solvency is assessed using principal component analysis, incorporating equity, return on assets (RoA), and the log(Z-Score). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from January 2001 to September 2023.

Table 1: Summary statistics of central bank balance sheet items, central bank solvency and financial stress. This table presents the summary statistics of central bank balance sheet items, variables for global financial stress and central bank solvency. The *balance sheet items* comprise the equity ratio, return on assets (RoA) and net interest income to total assets (NetII). The data is available on an annual basis and is sourced from BankFocus. *Central bank solvency* is estimated via a principal component analysis using the balance sheet items and using the log(Z-Score). The resulting series are created on a monthly basis. CBS_1 is the first principal component of Equity, RoA, and log(Z-Score), and CBS_2, considers additionally NetII. The variables for *financial stress* are the innovations of the S&P500 Volatility Index (VIX), using data from Thomson Reuters via Datastream. EBP is the excess bond premium created by Gilchrist & Zakrajšek (2012). BS is the effective yield of the BofA US high yield index, using data from Federal Reserve Economic Data (FRED).

	Balance sheet items			Financial stress			Central bank solvency		
	Equity	RoA	NetII	VIX	EBP	BS	CBS_1	CBS_2	log(Z-Score)
Mean	7.03	0.93	0.87	-0.03	-0.01	-0.02	-0.00	-0.00	2.13
Standard deviation	10.45	2.61	1.57	5.13	0.28	0.78	1.34	1.46	1.42
Minimum	-29.30	-9.19	-4.50	-19.39	-1.10	-3.58	-4.78	-5.13	-4.48
10th percentile	-0.56	-1.48	-0.67	-5.67	-0.28	-0.72	-1.64	-1.74	0.52
25th percentile	1.49	0.01	0.06	-2.64	-0.14	-0.32	-0.58	-0.62	1.43
50th percentile	4.50	0.63	0.72	-0.24	-0.00	-0.07	-0.00	-0.01	2.28
75th percentile	11.68	1.89	1.56	2.15	0.12	0.25	0.74	0.75	3.00
90th percentile	18.65	3.70	2.72	5.56	0.25	0.64	1.51	1.68	3.80
Maximum	52.50	11.34	6.92	21.27	1.70	5.21	4.17	5.11	5.21
Skewness	0.88	0.09	0.32	0.43	0.93	1.63	-0.40	-0.13	-0.91
Excess kurtosis	2.93	3.48	1.91	3.46	7.92	11.98	1.52	1.61	1.78
N	1042	1031	960	273	273	273	11823	10989	11823

Table 2: Correlation of central bank solvency components. This table presents the correlation between the candidates for the principal component analysis of central bank solvency. The data are sourced from BankFocus, covering the period from Jan. 2001 to Sep. 2023.

	Equity	RoA	NetII	log(Z-Score)
Equity	1.00			
RoA	0.36	1.00		
NetII	0.35	0.50	1.00	
log(Z-Score)	0.55	0.26	0.26	1.00

Table 3: Principal components. This table shows the Eigenvalues of the principal component analyses for CBS_1, considering equity, RoA and log(Z-Score), and CBS_2, including equity, RoA, NetII and log(Z-Score).

CBS_1	Eigenvalue	Proportion	Cumulative
λ_1	1.78	59.47	59.47
λ_2	0.77	25.81	85.28
λ_3	0.44	14.72	100.00
CBS_2			
λ_1	2.14	53.62	53.62
λ_2	0.91	22.65	76.27
λ_3	0.50	12.50	88.77
λ_4	0.45	11.23	100.00

Table 4: Factor Loadings. This table shows the factor loadings for first three Eigenvalues of CBS_1, considering equity, RoA and log(Z-Score), and CBS_2, including equity, RoA, NetII and log(Z-Score).

CBS_1	λ_1	λ_2	λ_3	
Equity	0.73	0.69	-0.06	
RoA	0.81	-0.25	0.53	
log(Z-Score)	0.80	-0.37	-0.48	
CBS_2	λ_1	λ_2	λ_3	λ_4
Equity	0.79	0.35	-0.03	0.51
RoA	0.72	-0.47	-0.49	-0.10
NetII/TA	0.72	-0.47	0.50	-0.05
log(Z-Score)	0.69	0.58	0.02	-0.43

Table 5: Correlation matrix of central bank solvency measures. This table presents results of a correlation analysis between our central bank solvency measures, including our first principal components (CBS) and the log(Z-Score). CBS_1 is the first principal component of Equity, RoA, and log(Z-Score), and CBS_2, considers additionally NetII. The data used for the PCA is available on an annual basis and are sourced from BankFocus, covering the period from Jan. 2001 to Sep. 2023.

	CBS_1	CBS_2	log(Z-Score)
CBS_1	1.000		
CBS_2	0.949	1.000	
log(Z-Score)	0.804	0.694	1.000

Table 6: Composition of solvency portfolios. This table shows the composition of the four portfolios, structured by central bank solvency, and identifies the six countries most commonly assigned to each portfolio. Central bank solvency is estimated via a principal component analysis using the components equity, RoA, and log(Z-Score) for 46 countries. The share is the percentage of the sample time. The data are from BankFocus, covering the period from Jan. 2001 to Sep. 2023.

P_1	Freq. (%)	P_2	Freq. (%)
Bahrain	94.5	Kuwait	67.3
Colombia	86.8	New Zealand	64.1
Malaysia	82.4	United Kingdom	62.6
Hong Kong	77.9	Morocco	52.7
Pakistan	65.6	Bangladesh	48.8
P_3	Freq. (%)	P_4	Freq. (%)
United Arab Emirates	67.3	Israel	94.3
Japan	63.0	Czech Rep.	90.8
Norway	61.5	Thailand	90.4
South Africa	53.1	Chile	86.3
Hungary	52.7	Egypt	76.0

Table 7: Descriptive statistics of solvency portfolios. This table presents descriptive statistics for country portfolios sorted by the solvency of their central banks. Central bank solvency is estimated using principal component analysis, incorporating equity, return on assets (RoA), and the logarithm of the Z-score for 46 countries. The first portfolio (P_1) consists of the 25% of countries with the highest solvency, while the last portfolio (P_4) contains the 25% with the lowest central bank solvency. Portfolios are rebalanced monthly. The difference between portfolio P_4 and P_1 is displayed in the last column as $\Delta_{P_4-P_1}$. The table also reports autocorrelation (AC). The t-statistic follows Newey & West (1987), with optimal lag estimation based on Andrews (1991). The data are sourced from BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023.

	P_1	P_2	P_3	P_4	$\Delta_{P_4-P_1}$
Mean	0.28	0.51	0.44	0.54	0.27
t-stat	1.63	3.31	2.68	3.65	3.65
Med	0.62	0.78	0.72	0.85	0.03
SD	7.79	7.26	7.83	7.59	2.82
Skew	-1.22	-0.55	-0.73	-0.80	0.07
Exc. Kurt	8.33	5.84	9.02	3.87	1.19
AC	0.12	0.09	0.09	0.04	-0.05
CBS_1	1.46	0.33	-0.26	-1.61	
CBS_2	1.50	0.32	-0.25	-1.65	
CBS_3	3.20	2.78	2.06	0.48	

Table 8: Time series regression. This table presents the results of the time series regression of monthly portfolio excess returns rx_k on the risk factors MKT and ΔVIX, following Formula (1) $rx_{kt} = \alpha_k + \beta_{j,k}^{\Delta VIX} \Delta VIX_t + \beta_{j,k}^{MKT} MKT_t^{orth} + \epsilon_{it}$, where $\beta_{j,k}$ are the factor loadings and α_k the constant. The test assets consist of four stock market portfolios, sorted in descending order based on central bank solvency. The procedure for the standard errors follows Newey & West (1987) (NW) with estimation of optimal lags according to Andrews (1991). The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 46 countries. The data are from BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023. The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level respectively and are based on NW.

	α	MKT	ΔVIX	R^2
P_1	0.36	1.07***	-0.57***	0.71
	(0.39)	(0.04)	(0.06)	
P_2	0.47	0.99***	-0.63***	0.70
	(0.26)	(0.05)	(0.09)	
P_3	0.57	1.03***	-0.63***	0.68
	(0.47)	(0.06)	(0.07)	
P_4	0.55	1.16***	-0.74***	0.79
	(0.37)	(0.09)	(0.09)	

Table 9: Cross-section regression. This table presents the results of cross-sectional regressions, following Formula (2) $rx_k = \lambda_j^{\Delta VIX} \hat{\beta_{j,k}}^{\Delta VIX} + \lambda_j^{MKT} \hat{\beta_{j,k}}^{MKT} + \epsilon_k$, where rx_k is the excess return of portfolio k, λ estimates the factor prices for MKT and ΔVIX, and the estimators $\hat{\beta}_k$ result from the time-series regression in Table 8. In Panel A, all time periods of the sample are included in the cross-sectional regression. Panels B and C split the sample into periods of low and high financial stress. Financial stress is defined as periods in which VIX changes exceed one standard deviation above their mean. The main procedure for standard errors follows Newey & West (1987) (NW), with optimal lag estimation according to Andrews (1991). Additionally, Shanken (1992) (Sh) standard errors are shown and a method with block bootrapped standard errors is used (e.g., Horowitz, 2019) (Boot). The test assets comprise four stock market portfolios, sorted in descending order by central bank solvency. Stock market returns are based on MSCI indices from Thomson Reuters via Datastream and are reported in US dollars. VIX data are also sourced from Thomson Reuters. Central bank solvency is estimated using principal component analysis, incorporating equity, RoA, and log(Z-Score) for 46 countries. The data are sourced from BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023. Market excess returns orthogonalized to VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on NW.

A: Sample period					
	MKT	VIX	HJ	p(HJ)	R^2
λ	-0.38	-1.21*	0.04	0.98	0.80
(Sh)	(0.51)	(0.81)			
(NW)	(0.51)	(0.70)			
B: Normal times					
	MKT	VIX	HJ	p(HJ)	R^2
λ	-0.05	-2.15***	0.04	0.99	0.79
(Sh)	(0.57)	(0.88)			
(NW)	(0.55)	(0.77)			
C: Financial stress					
	MKT	VIX	HJ	p(HJ)	R^2
λ	-2.99**	6.17***	0.33	0.62	0.88
(Sh)	(2.79)	(4.46)			
(NW)	(1.40)	(1.64)			
(Boot)	(1.45)	(1.75)			

Table 10: Baseline results. This table presents baseline results of the panel regressions of monthly stock market excess returns rx_t on changes in the VIX index ΔVIX_t, central bank solvency, and an interaction between both variables. The first column only shows the result with the VIX differences. The second column adds central bank solvency and the interaction term. The controls in the third column are orthogonalized market excess returns, small minus big factor, high minus low factor, liquidity, country inflation rate and GDP growth. Country fixed effects and year fixed effects are included in every column. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity ratio, RoA and log(Z-Score) for 45 countries. The data are from BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
ΔVIX	-0.598(0.070)***	-0.591(0.070)***	-0.616(0.048)***
Central Bank Solvency		-0.130(0.072)*	-0.103(0.082)
Central Bank Solvency $\times\Delta$VIX		0.055(0.027)**	0.051(0.025)**
Controls	N	N	Y
Obs.	11907	11243	10924
R^2 (within)	0.227	0.228	0.367

Table 11: Baseline results with alternative CBS measures. This table presents baseline results of the panel regressions of monthly stock market excess returns rx_t on changes in the VIX index ΔVIX_t, central bank solvency with alternative measures, and an interaction between both variables. In the first column, the alternative measure for central bank solvency is estimated by a principal component of equity ratio, RoA, log(Z-Score) and net interest income to total assets (NetII). In the second column, only log(Z-Score) is used as a measure. The controls are orthogonalized market excess returns, small minus big factor, high minus low factor, liquidity, country inflation rate and GDP growth. Country fixed effects and year fixed effects are included in both column. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. The data are from BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)
Δ VIX	-0.608(0.050)***	
Central Bank Solvency	-0.055(0.088)	
Central Bank Solvency $\times\Delta$ VIX	0.051(0.027)*	
Δ VIX		-0.723(0.062)***
Central Bank Solvency		-0.071(0.075)
Central Bank Solvency $\times\Delta$ VIX		0.050(0.016)***
Controls	Y	Y
Countries	44	45
Obs.	10090	10924
R^2 (within)	0.228	0.367

Table 12: Baseline results with alternative financial stress measures. This table presents baseline results of the panel regressions of monthly stock market excess returns rx_t on changes in financial stress with alternative measures, central bank solvency, and an interaction between both variables for 45 countries. In the first column, the alternative measure for financial stress is the change in the excess bond premium ΔEBP. In the second column, the alternative measure is the change on the bond spread ΔBS. The controls are orthogonalized market excess returns, small minus big factor, high minus low factor, liquidity, country inflation rate and GDP growth. Country fixed effects and year fixed effects are included in both column. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The EBP data created by Gilchrist & Zakrajšek (2012) and the BS data are from Federal Reserve Economic Data (FRED). The data are from BankFocus via Wharton Research Data Services. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)
Δ EBP	-6.898(1.397)***	
Central Bank Solvency	-0.108(0.076)	
Central Bank Solvency ×Δ EBP	0.770(0.372)**	
Δ BS		-4.021(0.531)***
Central Bank Solvency		-0.118(0.081)
Central Bank Solvency ×Δ BS		0.326(0.143)**
Controls	Y	Y
Obs.	10924	10924
R^2 (within)	0.228	0.367

Table 13: Baseline results with variable dummies. This table presents baseline results of the panel regressions of monthly stock market excess returns rx_t on changes in financial stress, central bank solvency CBS_t, and an interaction between both variables. The dummy for financial stress (VIX, EBP, BS) equals 1 if the mean is exceeded by more than one standard deviation. The central bank solvency dummy is set to 1 for countries above the median, and 0 otherwise. The controls are orthogonalized market excess returns, small minus big factor, high minus low factor, liquidity, country inflation rate and GDP growth. Country fixed effects and year fixed effects are included in both column. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. Central bank solvency is estimated via a principal component analysis using the components equity ratio, RoA and log(Z-Score) for 45 countries. The VIX data are also from Thomson Reuters. The EBP data created by Gilchrist & Zakrajšek (2012) and the BS data are from Federal Reserve Economic Data (FRED). The data are from BankFocus via Wharton Research Data Services. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
Δ VIX	-7.690(1.078)***		
Central Bank Solvency	-0.326(0.153)**		
Central Bank Solvency ×Δ VIX	0.980(0.662)		
Δ EBP		-5.012(1.397)***	
Central Bank Solvency		-0.334(0.157)**	
Central Bank Solvency ×Δ EBP		1.613(0.720)**	
Δ BS			-6.990(1.459)***
Central Bank Solvency			-0.329(0.151)**
Central Bank Solvency ×Δ BS			1.513(0.729)**
Controls	Y	Y	Y
Obs.	10924	10924	10924
R^2 (within)	0.277	0.219	0.235

Table 14: Panel regressions with developing country dummy. This table presents baseline results of the panel regressions of monthly stock market excess returns rx_t on changes in the VIX index ΔVIX_t, central bank solvency CBS_t, an emerging markets dummy, and interactions between the variables. The controls are orthogonalized market excess returns, small minus big factor, high minus low factor, liquidity, country inflation rate and GDP growth. Country fixed effects and year fixed effects are included in every column. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity ratio, RoA and log(Z-Score) for 45 countries. The data are from BankFocus via Wharton Research Data Services. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)
ΔVIX	-0.707(0.041)***
Central Bank Solvency	-0.185(0.075)**
Central Bank Solvency $\times\Delta$VIX	-0.003(0.023)
Central Bank Solvency $\times$ Country dummy	0.124(0.113)
ΔVIX $\times$ Country dummy	0.131(0.071)*
Central Bank Solvency $\times\Delta$VIX $\times$ Country dummy	0.074(0.039)*
Controls	Y
Obs.	10924
R^2 (within)	0.369

Table 15: Panel regressions with central bank independence and VIX. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the VIX index ΔVIX_t, central bank independence CBI and interactions between those variables. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 43 countries. The data are from BankFocus via Wharton Research Data Services. Data for central bank independence is provided by Romelli (2022, 2024). The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
Central bank solvency	-0.521(0.261)**	-0.267(0.157)*	-0.632(0.296)**
Δ VIX	-0.402(0.179)**	-0.432(0.097)***	-0.882(0.119)***
Central bank solvency $\times$ Δ VIX	0.252(0.118)**	0.124(0.061)**	0.210(0.113)*
$\text{CBI}_{\text{Romelli}}$	-1.018(1.826)		
Central bank solvency $\times$ $\text{CBI}_{\text{Romelli}}$	0.609(0.411)		
Δ VIX $\times$ $\text{CBI}_{\text{Romelli}}$	-0.334(0.280)		
Central bank solvency $\times$ Δ VIX $\times$ $\text{CBI}_{\text{Romelli}}$	-0.311(0.170)*		
$\text{CBI}_{\text{Cukierman}}$		-0.387(1.582)	
Central bank solvency $\times$ $\text{CBI}_{\text{Cukierman}}$		0.220(0.234)	
Δ VIX $\times$ $\text{CBI}_{\text{Cukierman}}$		-0.300(0.152)**	
Central bank solvency $\times$ Δ VIX $\times$ $\text{CBI}_{\text{Cukierman}}$		-0.110(0.085)	
$\text{CBI}_{\text{Financial}}$			-0.388(1.430)
Central bank solvency $\times$ $\text{CBI}_{\text{Financial}}$			0.801(0.534)
Δ VIX $\times$ $\text{CBI}_{\text{Financial}}$			0.418(0.172)**
Central bank solvency $\times$ Δ VIX $\times$ $\text{CBI}_{\text{Financial}}$			-0.242(0.163)
Controls	Y	Y	Y
Obs.	10457	10457	10457
R^2 (within)	0.364	0.364	0.365

Table 16: Panel regressions with central bank independence and VIX - Alternative CBS measure. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the VIX index ΔVIX_t, central bank independence CBI and interactions between those variables. The alternative measure for central bank solvency is estimated via a principal component analysis using the components equity, RoA, log(Z-Score) and net interest income to total assets for 43 countries. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. The data are from BankFocus via Wharton Research Data Services. Data for central bank independence is provided by Romelli (2022, 2024). The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
Central bank solvency	-0.174(0.310)	-0.056(0.175)	-0.366(0.334)
Δ VIX	-0.377(0.160)**	-0.439(0.098)***	-0.841(0.126)***
Central bank solvency × Δ VIX	0.261(0.082)***	0.129(0.051)**	0.182(0.096)*
$\text{CBI}_{\text{Romelli}}$	-0.410(1.682)		
Central bank solvency × $\text{CBI}_{\text{Romelli}}$	0.142(0.470)		
Δ VIX × $\text{CBI}_{\text{Romelli}}$	-0.360(0.253)		
Central bank solvency × Δ VIX × $\text{CBI}_{\text{Romelli}}$	-0.335(0.124)***		
$\text{CBI}_{\text{Cukierman}}$		-0.045(1.494)	
Central bank solvency × $\text{CBI}_{\text{Cukierman}}$		-0.034(0.247)	
Δ VIX × $\text{CBI}_{\text{Cukierman}}$		-0.276(0.153)*	
Central bank solvency × Δ VIX × $\text{CBI}_{\text{Cukierman}}$		-0.128(0.074)*	
$\text{CBI}_{\text{Financial}}$			-0.566(1.443)
Central bank solvency × $\text{CBI}_{\text{Financial}}$			0.430(0.557)
Δ VIX × $\text{CBI}_{\text{Financial}}$			0.362(0.179)**
Central bank solvency × Δ VIX × $\text{CBI}_{\text{Financial}}$			-0.202(0.146)
Controls	Y	Y	Y
Obs.	9623	9623	9623
R^2 (within)	0.355	0.354	0.355

Table 17: Panel regressions with central bank independence and EBP. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the EBP index ΔEBP_t, central bank independence CBI and interactions between those variables. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. The data are from BankFocus via Wharton Research Data Services. Data for central bank independence is provided by Romelli (2022, 2024). The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
Central bank solvency	-0.513(0.228)**	-0.276(0.154)*	-0.596(0.257)**
Δ EBP	-4.422(2.325)*	-4.989(1.196)***	-7.664(1.827)***
Central bank solvency $\times$ Δ EBP	3.759(0.870)***	1.851(0.494)***	2.979(1.248)**
$\text{CBI}_{\text{Romelli}}$	-1.005(1.770)		
Central bank solvency $\times$ $\text{CBI}_{\text{Romelli}}$	0.598(0.373)		
Δ EBP $\times$ $\text{CBI}_{\text{Romelli}}$	-3.998(3.977)		
Central bank solvency $\times$ Δ EBP $\times$ $\text{CBI}_{\text{Romelli}}$	-4.498(1.372)***		
$\text{CBI}_{\text{Cukierman}}$		-0.382(1.643)	
Central bank solvency $\times$ $\text{CBI}_{\text{Cukierman}}$		0.235(0.236)	
Δ EBP $\times$ $\text{CBI}_{\text{Cukierman}}$		-3.293(1.902)*	
Central bank solvency $\times$ Δ EBP $\times$ $\text{CBI}_{\text{Cukierman}}$		-1.559(0.729)**	
$\text{CBI}_{\text{Financial}}$			-0.357(1.296)
Central bank solvency $\times$ $\text{CBI}_{\text{Financial}}$			0.743(0.488)
Δ EBP $\times$ $\text{CBI}_{\text{Financial}}$			1.329(2.577)
Central bank solvency $\times$ Δ EBP $\times$ $\text{CBI}_{\text{Financial}}$			-3.311(1.948)*
Controls	Y	Y	Y
Obs.	10457	10457	10457
R^2 (within)	0.244	0.244	0.244

Table 18: Correlation matrix of central bank solvency and central bank independence. This table presents results of a correlation analysis between our main measure of central bank solvency (CBS) and the measures for central bank independence, consisting of the Romelli (2022, 2024) Index, Cukierman et al. (1992) Index, financial independence de jure Index. The data are from Romelli (2022, 2024).

	$CBI_{Romelli}$	$CBI_{Cukierman}$	$CBI_{Financial}$	CBS_1	CBS_2	log(Z-Score)
$CBI_{Romelli}$	1.00					
$CBI_{Cukierman}$	0.87	1.00				
$CBI_{Financial}$	0.48	0.27	1.00			
CBS_1	0.01	-0.05	0.12	1.00		
CBS_2	-0.02	-0.10	0.10	0.95	1.00	
log(Z-Score)	-0.00	-0.08	0.15	0.80	0.69	1.00

Table 19: Correlation matrix of central bank solvency and central bank transparency. This table presents results of a correlation analysis between our main measure of central bank solvency (CBS) and the measures for central bank transparency (CBT). The data is from Dincer et al. (2022).

	CBT	CBS_1	CBS_2	log(Z-Score)
CBT	1.00			
CBS_1	-0.27	1.00		
CBS_2	-0.32	0.95	1.00	
log(Z-Score)	-0.16	0.80	0.69	1.00

Table 20: Panel regressions with central bank transparency and VIX. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the VIX index ΔVIX_t, central bank transparency CBT and interactions between those variables. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 42 countries. The data are from BankFocus via Wharton Research Data Services. Data for central bank transparency is provided by Dincer et al. (2022). The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)
Central bank solvency	-0.172(0.343)
Δ VIX	-0.268(0.156)*
Central bank solvency × Δ VIX	0.175(0.103)*
CBT	-0.174(0.084)**
Central bank solvency × CBT	0.012(0.033)
Δ VIX × CBT	-0.046(0.014)***
Central bank solvency × Δ VIX × CBT	-0.016(0.008)*
Controls	Y
Obs.	8406
R^2 (within)	0.373

Table 21: Panel regressions with size financial system. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the VIX index ΔVIX_t, Size financial system and interactions between those variables. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 44 countries. The data are from BankFocus via Wharton Research Data Services. Data for size of the financial system, measured by the stock market size in relation to GDP, is provided by the World Bank Group. The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)
ΔVIX	-0.744(0.217)***
Central Bank Solvency	0.345(0.209)*
Central Bank Solvency ×ΔVIX	0.212(0.110)*
Size financial system	1.842(0.238)***
Central Bank Solvency × Size financial system	-0.073(0.046)
ΔVIX × Size financial system	0.023(0.047)
Central Bank Solvency ×ΔVIX × Size financial system	-0.040(0.023)*
Controls	Y
Obs.	7920
R^2 (within)	0.403

Table 22: Panel regressions with recapitalization. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the VIX index ΔVIX_t, recapitalization and interactions between those variables. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 30 countries. The data are from BankFocus via Wharton Research Data Services. Data for recapitalization, measured by four different categories, is provided by Romelli (2022, 2024). The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)
ΔVIX	-0.770(0.045)***
Central Bank Solvency	-0.150(0.060)**
Central Bank Solvency ×ΔVIX	0.043(0.027)
Recapitalization	-1.896(1.371)
Central Bank Solvency × Recapitalization	0.215(0.204)
ΔVIX × Recapitalization	0.125(0.085)
Central Bank Solvency ×ΔVIX × Recapitalization	-0.088(0.054)
Controls	Y
Obs.	7390
R^2 (within)	0.467

Table 23: Panel regressions with career concerns. This table presents results for panel regressions of monthly stock market excess returns rx_t on central bank solvency CBS, changes in the VIX index ΔVIX_t, career concerns and interactions between those variables. Controls are the market excess returns and the factors small minus big, high minus low and liquidity provided by Ken French's data library. Country fixed effects and year fixed effects are included. The stock market returns are based on MSCI indices, from Thomson Reuters via Datastream, and are reported in US Dollar. The VIX data are also from Thomson Reuters. Central bank solvency is estimated via a principal component analysis using the components equity, RoA and log(Z-Score) for 31 countries. The data are from BankFocus via Wharton Research Data Services. The data on career concerns, measured by the possibilities for re-election of the central bank governor, are provided by Romelli (2022, 2024). The market excess returns orthogonalized to the VIX differences are used as a control variable. Standard errors are clustered by country and month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)
ΔVIX	-0.483(0.040)***
Central Bank Solvency	0.058(0.068)
Central Bank Solvency ×ΔVIX	0.064(0.003)***
Central Bank Solvency × Career concerns	-0.209(0.106)**
ΔVIX × Career concerns	-0.245(0.050)***
Central Bank Solvency ×ΔVIX × Career concerns	-0.053(0.017)***
Controls	Y
Obs.	7694
R^2 (within)	0.464

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Appendix

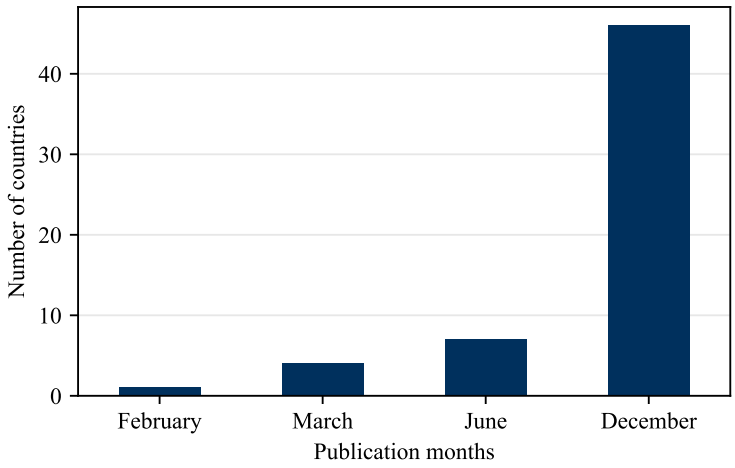


Figure A.1: Publication month of countries This figures shows the number of countries publicating the balance sheet in February, March, June or December.

A.1 Priority Codes and Supranational Central Banks

This appendix clarifies how we address the comparability of balance sheet items across central banks over time. Although central banks are not formally obliged to follow any single accounting standard, many comply (at least partially) with IFRS (Bholat & Darbyshire, 2016). However, deviations from IFRS may occur (Goncharov et al., 2023), which can lead to inconsistencies in the reported data.

To mitigate these inconsistencies, BankFocus provides a set of consolidation codes that indicate whether the data are consolidated, unconsolidated, or follow additional companion statements. Following Duprey & Lé (2016), we give higher priority to consolidated (C) codes than unconsolidated (U) codes, and we explicitly avoid or remove additional companion statements if possible. We do so because these statements might use different units (e.g., inflation-adjusted vs. nominal values), different accounting standards (e.g., local GAAP vs. IFRS), or stem from different sources (e.g., FDIC vs. SEC). Such diversity would otherwise bias the results of our empirical analyses.

In practice, C1 and C2 (or U1 and U2, respectively) have higher priority than their counterparts C* (U*). Additionally, there is the code A1 (Category in the former date set under Bankscope), which only applies to supranational central banks such as the Federal Reserve or European Central Bank. We treat A1 as functionally equivalent to C1.

Below is an abbreviated explanation of how these priority rules are applied in the code:

1. **Pre-Filtering:** Observations with missing consolidation codes are dropped.

2. **Merging the Bankscope data set with BankFocus data**: Before the introduction of the BankFocus database, the Bankscope database was used, which had some differences in the assignment of consolidation codes. The classification "A1" existed only in Bankscope and is no longer present in BankFocus. For instance, the Federal Reserve case shows particularly many overlaps. In this context, we first delete entries with the consolidation code U1 (Board of Governors), followed by cases with A1 from 2013 onward and cases with C1 prior to 2013.

3. **Selecting the Highest-Priority Code**: We define a priority order: $C1 > C2 > C^* > U1 > U2 > U^*$. When multiple codes appear in the same country-year (e.g., C1 and U1), we keep the entry with the highest priority (in this example, C1). This priority is balanced against the need for consistency. In cases where the code changes for only one year, the lower-priority code is retained to avoid abrupt shifts.

4. **Country-specific cleaning:** In rare cases, multiple high-priority codes persist for the same country-year. These observations are treated carefully, typically by removing additional statements or incomplete entries. Specific manual filters handle anomalies for countries like Hong Kong, Belize, and Moldova.

Table A.1: Country sample. This table lists the countries in the sample for which MSCI stock market returns and balance sheet data are comprehensively available. We distinguish between developed countries and emerging markets based on the classification from the IMF World Economic Outlook Database. The MSCI equity index returns are sourced from Thomson Reuters via Datastream. The balance sheet data are obtained from BankFocus via Wharton Research Data Services, covering the period from Jan. 2001 to Sep. 2023.

Country	Start Date	End Date	Category
Australia	2001-01	2023-09	Developed market
Bahrain	2005-06	2023-09	Emerging market
Bangladesh	2009-12	2023-09	Emerging market
Bosnia And Herzegovina	2010-06	2023-09	Emerging market
Brazil	2001-01	2023-09	Emerging market
Bulgaria	2005-06	2023-09	Emerging market
Canada	2001-01	2023-09	Developed market
Chile	2001-01	2023-09	Emerging market
Colombia	2001-01	2023-09	Emerging market
Croatia	2002-06	2022-12	Emerging market
Czech Rep.	2001-01	2023-09	Developed market
Denmark	2001-01	2023-09	Developed market
Egypt	2001-01	2023-09	Emerging market
Eurozone	2001-01	2023-09	Developed market
Hong Kong	2001-01	2023-09	Developed market
Hungary	2001-01	2023-09	Emerging market
India	2001-01	2023-09	Emerging market
Indonesia	2001-01	2023-09	Emerging market
Israel	2001-01	2023-09	Developed market
Japan	2001-01	2023-09	Developed market
Jordan	2001-01	2023-09	Emerging market
Kazakhstan	2005-12	2023-09	Emerging market
Kenya	2002-06	2023-09	Emerging market
Korea	2001-01	2023-09	Developed market
Kuwait	2005-06	2023-09	Emerging market
Malaysia	2001-01	2023-09	Emerging market
Mexico	2001-01	2023-09	Emerging market
Morocco	2001-01	2023-09	Emerging market
New Zealand	2001-01	2023-09	Developed market
Nigeria	2002-06	2023-09	Emerging market
Norway	2001-01	2023-09	Developed market
Pakistan	2001-01	2023-09	Emerging market
Peru	2001-01	2023-09	Emerging market
Philippines	2001-01	2023-09	Emerging market
Poland	2001-01	2023-09	Emerging market
Romania	2005-12	2023-09	Emerging market
South Africa	2001-01	2023-09	Emerging market
Sri Lanka	2001-01	2023-09	Emerging market
Sweden	2001-01	2023-09	Developed market
Switzerland	2001-01	2023-09	Developed market
Thailand	2001-01	2023-09	Emerging market
Tunisia	2004-06	2023-09	Emerging market
Turkey	2001-01	2023-09	Emerging market
United Arab Emirates	2005-06	2023-09	Emerging market
United Kingdom	2001-01	2023-09	Developed market
United States	2001-01	2023-09	Developed market

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