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Dissertation

FINANCIAL CRISES AND ECONOMIC GROWTH: A PANEL DATA APPROACH FOR OECD COUNTRIES

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Finally, I want to mention an interesting and insightful quote, from Winston Churchill, which may serve as inspiration for anyone: "Success is not final, failure is not fatal: it is the courage to continue that counts".

Abstract

This dissertation examines the relationship between financial crises and economic growth, using a panel data approach for OECD countries, from 1967 to 2023. This data was split between macroeconomic variables, varying from 1980 to 2023, and financial stress variables, varying from 1967 to 2018.

Through applying a variety of econometric models, namely random and fixed effects, as well as instrumental variable regressions, the study focus on the relationships between financial crises, financial stress and economic growth.

For the computed regressions were employed both financial stress and macroeconomic variables and its impact on economic growth was assessed.

The results presented in this paper allow a better understanding of financial crises by policymakers, since it covers a considerable number of countries with different stages of economic growth and a considerable time period. We also identify periods of heightened financial stress with past financial crises, which may attenuate future ones.

JEL Classification : E44 ; F41 ; F43 ; F44 ; G01.

Keywords: Financial Stress; Financial Crises; Economic Growth; OECD Countries.

1. Introduction

The relationship between financial crises, financial stress and economic growth is a major concern of economic research. It is therefore important for policymakers to understand (1) how financial stress affects real economic growth, (2) how economic growth correlates with financial crises, and (3) how financial stress differs among countries and different types of crises. These will be the points tackled in the current study.

How does financial stress affect real economic growth?

Financial stress, portrayed by augmented uncertainty, diminished asset values and increased risk aversion, has considerable impact on real economic growth. Episodes of high financial stress, usually resulting in financial crises, have a strong negative impact on real GDP growth. According to empirical evidence, financial stress, namely when originated from banking sector, is related with stringent economic throughs, caused by a lack of credit availability and a fall in investor confidence. For example, the negative coefficients of financial stress indicators on real GDP growth in various regression models, further in this paper, enhance the harmful effects of financial stress on economic behavior.

How does economic growth correlate with financial crises?

The correlation between economic growth and financial crises is complex. Financial crises are generally provoked by episodes of high financial stress, often leading to expressive contractions in business cycles. This relationship is established by the positive strong correlation between leverage and the volatility arising from disruptions in financial markets.

According to historical data, financial crises are generally foreshadowed by periods of strong and consolidated economic growth followed by acute downturns when financial stress peaks. Furthermore, the outbreak of crises intensifies economic contractions, as seen in the 2008 Global Financial Crisis and during the Covid-19 pandemic, for example.

How does financial stress vary among countries and different types of crises?

Financial stress varies among countries and types of crises, mostly because economic frameworks, financial systems, political realities and policy responses differ from region to region, from emerging to advanced economies, globally.
The development and utilization of Financial Stress Indices (FSIs) have been contributory in the measure and comparation of financial stress across different economic realities.
For instance, the Cleveland Financial Stress Index (CFSI) and the St. Louis Financial Stress Index (STLFSI) allow to extract key takeaways regarding temporal and cross-sectional changes in financial stress.
According to the existing literature, while financial stress globally impacts economic growth, its magnitude and outcomes vary based on the inherent causes of the crisis – whether they derive from banking, securities or exchange rate oscillations.
The main results of the study are as follows: Financial Stress Index and Lagged Financial Stress Index (FSI) regularly presents considerably negative coefficients, emphasizing the adverse effects of financial instability on economic growth. The study also finds that better-capitalized banks contribute positively to economic growth, while, on the other hand, increased leverage in the banking sector leads to lower real GDP growth.

Regarding macroeconomic variables´ effects on real GDP growth, the results were mixed, with high levels of public debt and unemployment deteriorating economic growth and government expenditure, consumption and investment enhancing real GDP growth.

This paper is organized as follows: section 2 is the literature review. Section 3 provides the empirical analysis. Section 4 is the conclusion.

2. Literature Review

Back in 1987, Eichengreen & Portes, defined a financial crisis as "a disturbance to financial markets, associated typically with falling asset prices and insolvency among debtors and intermediaries, which spreads through the financial system, disrupting the market´s capacity to allocate capital."

Although economists' understanding of financial crises has deepened in recent years, periods of huge financial sector growth and development (often accompanied by steeply rising private indebtedness) will probably always generate waves of financial crises. (Reinhart & Rogoff, 2013)

Financial crises share at least four main features: rapid increases in asset prices, credit booms, a dramatic expansion in marginal loans; and fails in regulation and supervision, that cannot keep it up with the developments. (Claessens et al., 2013) They are also associated with unconscious, excessive risk taking by household and firms, bringing unsustainable debt levels, both to individuals, which keep abusing credit and leveraging, and in the aftermath for governments, which end up needing help from the exterior to finance their budget deficits.

Financial crises hit small and large countries as well as poor and rich ones. They can have domestic or external origins, and stem from private or public sectors. They often require immediate and comprehensive policy responses, call for major changes in financial sector and fiscal policies, and can necessitate global coordination of policies.

(Claessens & Kose, 2013)

Financial crises have been around since the development of money and financial markets. (Vermeulen et al., 2015)

According to Ogun (2021), financial crises are essentially classified into four groups: currency crises, sudden stop crises, debt crises and banking crises.

Currency crises occur when there is a devaluation on the currency due to a speculative attack.

A sudden stop crisis happens when there is a large decrease in international capital flows

Debt crises happen when governments cannot repay their debts (bonds, for example), being in default.

Banking crises occur generally because of bank runs. Uncertainty and fear by agents lead them to withdraw their deposits, creating problems for banks in terms of convertibility and liquidity. They start lending less, agents perceive this uncertainty, and it is fast for panic to be installed. (Ogun, 2021)

Financial crises are associated with severe and protracted downturns in economic activity. (Sufi & Taylor, 2022)

Financial stress is connected to financial crises and can be thought of as an interruption to the normal functioning of financial markets. Every episode seems to involve at least one of the phenomena, and often all of them: increased uncertainty about fundamental value of assets, about the behavior of other investors, increased asymmetry of information, decreased willingness to hold risky assets (flight to quality), decreased willingness to hold illiquid assets (flight to liquidity). (Hakkio and Keeton, 2009)

Many authors have developed papers examining financial stress indexes and financial crises.

Hakkio & Keeton (2009) developed a new index of financial stress – the Kansas City Financial Stress Index (KCFSI), based on 11 financial market variables. This index performed well in identifying widely recognized episodes of financial stress over the last 20 years (from 1989). Has also been shown to be a good predictor in anticipating changes in economic activity.

Cardarelli et al. (2011) analysed episodes of stress in banking, securitization, and Forex markets, in 17 advanced economies over 30 years. The findings evidenced that financial stress is often, but not always a precursor to an economic slowdown or recession. Factors like a rapid expansion of credit, sudden housing price increases, and large borrowings by the corporate and household sectors, have proven to increase the probability that stress in the financial system will lead to more severe economic downturns. Banking-related financial stress was shown to be associated with the most severe downturns, due to the procyclicality of leverage, which always carries some risk with it, leading to increases in volatility and shocks in the financial system.

Oet et al., (2015) developed a financial stress index, for the United States, the Cleveland Financial Stress Index (CFSI), based on publicly available data from credit, funding, real estate, securitization, foreign exchange, and equity markets. In a systematic approach, this index has shown that is useful for decomposing stress, monitoring its development and historical analysis.

Vermeulen et al., (2015), created a Financial Stress Index (FSI) for 28 OECD countries, using four criteria for indicators to be used in constructing the FSI (the index should cover the entire financial system, indicators used should be available at a sufficiently high frequency for many countries for a long period, they should be comparable, and related to financial crisis in line with theoretical expectations). They crossed the FSI with a novel crisis dataset by Babecký et al. (2014) using simple correlations and logistic regressions. This study found that stress indices and sub-indices are related to crisis occurrence, however, the relationship between stress indices and crisis onset is weak. There was no robust temporal pattern between financial system stress and crisis onset, suggesting that stress indices are not reliable in evaluating financial stability threats. This paper also highlighted that the FSI had some limitations, as it could not include indicators related to financial crises for all countries.

Monin (2019) introduced financial stress index developed by the Office of Financial Research (OFR FSI). This index basically captures a daily market-based snapshot of global financial market stress, providing insight into stress drivers. It helps the OFR in monitoring, comparing, and understanding financial stress events. This index presents improvements over other FSIs, namely the decomposition into stress categories and dynamic construction. According to empirical results, it successfully identifies financial stress events and predicts economic activity changes but is not a sufficient statistic for understanding financial markets or stress events.

Afonso et al. (2017) analysed the interactions between fiscal policy, output growth and financial stress, using a VAR model on a panel of four countries: USA, UK, Germany, and Italy.

The results evidenced that the identified periods of financial stress are also characterized by lower output growth and in several cases coincide with recessions. The findings showed nonlinear effects of fiscal shocks, due to initial conditions, financial stress, government indebtedness and monetary policy behavior. These effects were proven to vary across countries and through time. This financial stress index captured three forms of financial stress: banking, securities, and exchange rate related stress, affecting the transmission mechanism of fiscal developments.

3. Empirical analysis

3.1. Stylized facts

Financial stress post-2018:

Since the FSI values, extracted from the IMF, range from 1967 to 2018, it´s also important to analyse how financial stress has behaved since then.

[Graph I]

The image above (Graph I), taken from "St. Louis Fed Financial Stress Index", (2023) allows to understand the impact of the Covid crisis (starting on March 2020), with the St. Louis Financial Stress Index reaching a value of approximately 5.33 on March 20th.

This value was only surpassed by the 2008 values, with the St. Louis Financial Stress Index reaching 9.32 approximately, on October 10th. These huge financial stress levels were a direct consequence of the Great Recession crisis, stemmed mostly after the collapse of the Lehman Brothers investment bank. The Sub-prime Mortgage crisis, allied with risky and complex financial derivatives, lack of regulation, which allowed an increase in the exchange of these speculative securities by investors, combined with a high level of globalization, increased a lot the volatility and uncertainty in financial markets. The restrictions by reluctant banks such as credit freezes were "the last straw", banks panicked as well as investors, resulting in one of the worse financial stress episodes ever registered.

In the 2020 Covid-19 crisis, the financial stress was more related to lockdowns´ measures, by governments, which created uncertainty: for workers (employees), not knowing if they would have cuts in wages or posteriorly be fired; for firms, not knowing how would react the productivity of their employees, how much they would be able to sell, to quantify their revenues and profits in a time of high insecurity in trade, while maintaining fixed costs; for investors, not being able to assess clearly and accurately to the financial statements of the companies where they had invested their money, to quantify their dividends and returns, which generated uncertainty and high volatility in financial markets. Also, the increase in expenditure by the governments enhanced government debts, which led some investors to fear a potential default and led to sales of government bonds and other securities.

[Graph II]

The CBOE Volatility Index, represented in Graph II, is a good indicator of financial volatility and market sentiment.

“The VIX Index is a calculation designed to produce a measure of constant, 30day expected volatility of the U.S. stock market, derived from real-time, mid-quote prices of S&P 500® Index (SPX℠) call and put options. On a global basis, it is one of the most recognized measures of volatility - widely reported by financial media and closely followed by a variety of market participants as a daily market indicator.” (VIX Index, n.d.)

According to the graph, from 1990 to 2007 there were some fluctuations, with some peaks and troughs.

In the early 1990s occurred a recession in the United States, which lasted minus than one year.

The causes were mainly on the supply side and generated a downfall in employment, which took some months to restore to its initial level. However, these negative impacts on volatility in the economy weren´t much severe.

Around 1997 and 1998 it’s perceptible that volatility increased considerably, more than in the case described before. This happened due to the Asian Financial Crisis (1997) and the Russian Financial Crisis (1998). The Asian Financial Crisis was provoked by a devaluation of the Thai baht, in Thailand, which then spread to other Asian economies. The Russian Financial Crisis was caused by a devaluation of the Ruble and a default on Russian government´s debt.

In the beginning of the millennium, a fast growth in information, technology and Internet led to the so-called “Dot-com bubble”. Investors were very enthusiastic with tech startups´ potential, although many weren´t profitable. This generated a bubble due to the market sentiment that these stocks´ values would rise. The bubble soon burst, leading these stock values to fall abruptly and many startups collapsed. This downturn caused an economic recession, affecting the Nasdaq index. “Then the bubble imploded. As the value of tech stocks plummeted, cash-strapped internet startups became worthless in months and collapsed. The market for new IPOs froze. On October 4, 2002, the Nasdaq index fell to 1,139.90 units, a fall of 77% from its peak.

The bursting of the bubble preluded the economic recession of 2001. The Nasdaq would only reach a new all-time high fifteen years later, on April 23, 2015.” (*Goldman Sachs |*

Commemorates 150 Year History - the Late 1990s Dot-Com Bubble Implodes in 2000, n.d.)

In 2007 and 2008, volatility in financial markets reached the highest level ever with the Global Financial Crisis, as described before.

In 2009-2012 there is again some evidence of volatility and uncertainty due mainly to the Eurozone debt crisis.

Until 2020, financial stress was at low levels. With the Covid-19 global pandemic, started in March 2020, volatility in the stock market and in the whole economy rose to levels never seen for a pandemic crisis, only below the effects of the Great Recession.

Nowadays, financial stress is more contained but there are still supply chain and inflation concerns, as well as the Russia-Ukraine conflict, a war that persists for more than two years already, generating millions of deaths and destruction in Ukraine, pushing volatility in the markets up.

3.2. Data

I have collected data from various sources: IMF – World Economic Outlook, OECD Statistics and World Data Bank - World Development Indicators.

For the macroeconomic variables were used: Real GDP growth - annual percentage change (IMF), General government final consumption expenditure - annual % growth (World Data Bank), General government gross debt (Percentage of GDP) (IMF), Unemployment rate annual change – constructed manually in Excel using a variation formula for annual Unemployment rate – percentage of labor force (OECD Statistics), Inflation rate at average consumer prices - annual percent change (IMF), Gross capital formation - annual % growth (World Data Bank), Final consumption expenditure - annual % growth (World Data Bank).

For the financial stress variables were used: FSI (extracted from IMF Working Papers.

Ahir, H. (2023). Financial Stress and Economic Activity: Evidence from a New Worldwide Index), Nonperforming loans to total gross loans, Regulatory capital to risk weighted assets, Tier 1 capital to risk-weighted assets (FSIs and Underlying Series – IMF Financial Soundness Indicators), S&P Global Equity Indices - annual % change (World

Data Bank), Short-term interest rate (%) (OECD Statistics, Economic Outlook) and Leverage of the banking sector (OECD Statistics, Financial Indicators – Stocks).

3.3. Model Specification

<u>For macroeconomic analysis:</u>

1. **Fixed effects model**

$$Y_{i,t} = \alpha_i + \delta_t + \gamma \boldsymbol{X'}_{i,t-1} + \quad {}_{i,t} \quad (1)$$

Where Y is GDP real growth (annual percent change), $\boldsymbol{X_{i,t}}$ is a vector of relevant explanatory variables (General government final consumption expenditure - annual % growth, General government gross debt (Percent of GDP), Unemployment rate annual change, Inflation rate at average consumer prices - annual percent change, Gross capital formation - annual percent growth, Final consumption expenditure - annual percent growth); $\boldsymbol{\alpha_i}$ are country-fixed effects to capture unobserved heterogeneity across countries, and time-unvarying factors; $\boldsymbol{\delta_t}$ are time effects to control for global shocks; $\boldsymbol{\varepsilon_{it}}$ is an i.i.d. error term satisfying the usual assumptions of zero mean and constant variance. Countries and years are identified by subscripts i and t, respectively.

2. **Random effects model**

$$Y_{i,t} = \alpha_i + \delta_t + \gamma \boldsymbol{X'}_{i,t-1} + \mu_{i,t} \quad (2)$$

Where Y is GDP real growth (annual percent change), $\boldsymbol{X_{i,t}}$ is a vector of relevant explanatory variables (General government final consumption expenditure - annual % growth, General government gross debt (Percent of GDP), Unemployment rate annual change, Inflation rate, average consumer prices - annual percent change, Gross capital formation - annual percent growth, Final consumption expenditure - annual percent growth; $\boldsymbol{\alpha_i}$ are random variables that are uncorrelated with the independent variables; $\boldsymbol{\delta_t}$ are time effects to control for global shocks; $\boldsymbol{\mu_{i,t}}$is the error term, capturing the combined effect of the unobserved heterogeneity and the random error term. Countries and years are identified by subscripts i and t, respectively.

<u>For financial stress analysis:</u>

3. **Fixed effects model**

$$Y_{i,t} = \alpha_i + \delta_t + \gamma \boldsymbol{X}'_{i,t-1} + {}_{i,t} \quad (3)$$

Where Y is GDP real growth (annual percent change), $\boldsymbol{X_{i,t}}$ is a vector of relevant explanatory variables (FSI, Lagged FSI, Nonperforming loans as a percentage of total gross loans, Regulatory capital to risk weighted assets, Tier 1 capital to risk weighted assets, S&P500 Equity annual returns (as annual % change), Short term interest rate (%) and Leverage of the banking sector), $\boldsymbol{\alpha_i}$ are country-fixed effects to capture unobserved heterogeneity across countries, and time-unvarying factors; $\boldsymbol{\delta_t}$ are time effects to control for global shocks; $\boldsymbol{\varepsilon_{it}}$ is an i.i.d. error term satisfying the usual assumptions of zero mean and constant variance. Countries and years are identified by subscripts i and t, respectively.

4. **Random effects model**

$$Y_{i,t} = \alpha_i + \delta_t + \gamma \boldsymbol{X}'_{i,t-1} + \mu_{i,t} \quad (4)$$

Where Y is GDP real growth (annual percent change), $\boldsymbol{X_{i,t}}$ is a vector of relevant explanatory variables (FSI, Lagged FSI, Nonperforming loans as a percentage of total gross loans, Regulatory capital to risk weighted assets, Tier 1 capital to risk weighted assets, S&P500 Equity annual returns (as annual % change), Short term interest rate (%) and Leverage of the banking sector); $\boldsymbol{\alpha_i}$ are random variables that are uncorrelated with the independent variables; $\boldsymbol{\delta_t}$ are time effects to control for global shocks; $\boldsymbol{\mu_{i,t}}$is the error term, capturing the combined effect of the unobserved heterogeneity and the random error term. Countries and years are identified by subscripts i and t, respectively.

3.4. Results

For clarity and conciseness, both macroeconomic and financial stress variables were abbreviated, in some cases. The abbreviations used are defined in Tables AI (macroeconomic) and AII (financial stress).

Analysis of results of Macroeconomic variables – GDP as dependent variable

I have computed linear regressions with my macroeconomic variables, as panel data, having as dependent variable GDP_Growth, for all OECD countries; and as independent variables were used the ones in Table I. The analysis of the results from this table is presented from page 20 to page 24.

[Table I]

<u>Before conversion to panel data:</u>

I wanted to assess if multicollinearity would be a significant issue among the variables, so I did a simple regression. The results are presented below in Table II.

[Table II]

[Table III]

According to Table III´s results, the model has an overall mean of 7.40 which is considered moderate. However, Imports and Exports (% of GDP) have high VIFs (variance inflation factors), which suggests strong multicollinearity between them, meaning that these variables have high correlation with each other, which could cause problems with stability and interpretability of coefficient estimates. So, to eliminate this possibility, I have removed these two variables from the regression. Table IV presents the results after the exclusion of these variables.

[Table IV]

[Table V]

The new VIF values for the variables are low (Table V), meaning that they are not highly correlated between each other in the model.

I also assessed heteroskedasticity, which is not desirable in any model, as it means that the variance of the error terms in a regression model is not constant.

Computed a Breusch-Pagan/Cook-Weisberg test in Stata. As the p-value associated with the test statistic is 0.5928, higher than the usual significance level (for example, 0.05), the null hypothesis cannot be rejected, meaning that there is not enough evidence to conclude the presence of heteroskedasticity in the regression model. There is no evidence that the assumption of constant variance of the error terms in the model (homoskedasticity) is violated.

After converting to panel data:

First, computed a regression, with a fixed effects estimator (1); then with a random effects estimator (2), and finally with fixed effects robust standard errors (3).

These models were employed to analyse the link between the various independent variables and the dependent variable (GDP_Growth).

Computing regressions for different models (fixed effects, random effects, and robust fixed effects) is valuable and important, to assess the robustness of the results to different assumptions and methodologies.

In fixed effects models, within-group variation is considered, while in random effects models both within-group and between-group variation is considered. Fixed effects capture specific characteristics that remain constant across observations, while random effects are used to account for variability and differences between different entities or subjects within a larger group. (Mustafa, 2024)

Fixed effects Panel Data regression in Stata:

[Table VI]

Using this model, individual-specific effects are constant over time but may change across countries.

Random effects Panel Data regression in Stata:

[Table VII]

In this model, individual-specific effects are random variables that are not correlated with the independent variables.

The coefficients and significance levels remain very similar to Table VI.

Robust fixed effects Panel Data regression in Stata:

[Table VIII]

Using this model, robust standard errors are used to estimate fixed effects.

Adding the "robust" option ensures that Stata calculates heteroskedasticity-robust standard errors for the fixed effects model, correcting the model for heteroskedasticity and serial correlation in the residuals.

Interpretation of the coefficients:

These represent the change in the dependent variable (GDP_Growth) associated with a one-unit change in the independent variable, with all the other variables constant.

Although the results differ a little bit from model to model, in all three the same coefficients have the same signals.

Analysing for fixed effects model (Table VI), for example: Government expenditure, Inflation, Capital stock formation (Investment) and Final consumption expenditure have positive coefficients, meaning that a one-unit increase in these independent variables, holding all the others constant, will cause that coefficient value increase in GDP_Growth.

For Gov_Debt and Unemployment, the relation is negative, meaning that a one-unit increase in these independent variables, holding the others constant, will cause GDP_Growth to shrink by that coefficient value.

The signals of these coefficients are congruent with the GDP/aggregate demand formula as it is the sum of Private consumption plus Investment plus Government Expenditure plus Net trade (in open economies).

Analysis of coefficients´ significance:

- **Gov_Exp (annual % change):** the coefficient changes across the different model specifications. For fixed effects (Table VI), is equal to 0.0113, for random effects (Table VII) is equal to 0.0353 and for robust fixed effects (Table VIII) is equal to 0.0113. In all models, the coefficient is not statistically significant ($p < 0.1$ or lower). This means that there is not sufficient evidence to conclude that the annual change in government expenditure significantly impacts GDP_Growth.
- **Gov_Debt (% of GDP):** For fixed effects, the coefficient is equal to -0.00730 ($p < 0.01$), for random effects is equal to -0.00614 ($p < 0.01$) and for robust fixed effects is equal to -0.00730 ($p < 0.1$). These results suggest a robust relationship between this independent variable and GDP_Growth.
- **Unemp_Change:** These coefficients remain the same for both fixed and robust fixed effects, equal to -0.0294 ($p < 0.01$). For random effects are slightly different (-0.0284), also significant at the 1% level. This evidences a robust and significant negative relationship between this variable and GDP_Growth.
- **Infl_Rate:** For fixed effects, the coefficient is equal to 0.0363 ($p < 0.01$). For random effects, the coefficient is equal to 0.0314 ($p < 0.01$), and for robust fixed effects is equal to 0.0363 ($p < 0.05$). The coefficient for inflation is statistically significant at the 1% level in the fixed and random effects, but only at the 5% level in the robust fixed effects model.
- **Cap_Form:** The coefficient remains very similar in all models.

  For fixed effects is equal to 0.102 ($p < 0.01$), for random effects is equal to 0.104 ($p < 0.01$) and for robust fixed effects is equal to 0.102 ($p < 0.01$).

  This coefficient remains statistically significant at the 1% level for all models, suggesting a strong positive relationship with GDP_Growth.
- **Final consumption expenditure (annual % change):** The coefficient remains practically constant across all the model specifications (0.501 for fixed effects and 0.502 for random effects), with $p < 0.01$ for all the three models.

The model has a constant of 1.330 (fixed effects) and of 1.228 (random effects), statistically significant at the 1% level, meaning that even when all independent variables are zero there is still a significant and positive effect on GDP_Growth.

Overall, these variables contribute to a good explanation of the variation of GDP_Growth, the model has an R-squared of 0.693.

There are 1145 observations through 34 countries.

Analysis of results of Financial Stress Indicators – GDP as dependent variable

After analysing the results of the macroeconomic variables in GDP_Growth, I proceeded to understand how financial stress indicators would influence this same variable.

As independent variables I used "FSI"- a financial stress indicator already created by the IMF, Nonperforming loans as a percentage of total gross loans, Regulatory capital to risk weighted assets, Tier 1 capital to risk weighted assets. These variables were extracted from IMF´s Financial Soundness Indicators (FSIs). I have also used S&P500 Equity annual returns (as annual % change) – extracted from the World Data Bank – World Development Indicators, Short term interest rate (%) and Leverage of the banking sector – extracted from the OECD Statistics.

A more detailed explanation of each variable can be found on the Annex data table.

I computed linear regressions using the financial stress indicator already mentioned, developed by the IMF. This FSI had a quarterly frequency from 1967 to 2018, so, to avoid problems with my other variables, which have annual frequency, I have disposed the FSI variable also with yearly data.

I have computed regressions for two scenarios: in the first one, keeping the last quarter of every year (q4) as the yearly value; in the second one I did an average of the four quarters, considering that value as the annual value.

First scenario:

Below, I present the results of two OLS regressions I have computed:

[Table IX]

The difference between the two regressions´ results, presented in Table IX, is that in the first one (Model 1) I used simply the FSI variable, which varies from 1967 to 2018. Since the dependent variable varies from 1980 to 2018, I have generated a lagged FSI variable

(Model 2) to account for possible time lags in the effects on GDP_Growth. With this, a better explanation of the model by the independent variables was obtained, since the R-squared increased from 0.188 to 0.264.

Also, I generated the residuals, calculated the percentiles of these and stored the 1st and 99th percentiles in local macros.

I defined the winsorization boundaries and replaced the outliers with these.

Then, I wanted to analyze how these variables would interact in panel data. I separated "Country_Year" into "Country_ID" and "Year" variables and got a strongly balanced panel from 1967 to 2018.

[Table X]

Analysis of coefficients´ significance (Table X):

- **Lagged_FSI:** For robust fixed effects, the coefficient is equal to -4.45, being significant at 1% level (***). For random effects, the coefficient is equal to -4.47, significant at 1% level.

  This independent variable has a considerable negative coefficient and is highly significant in both models. This means that an increase in the Financial Stress Index (FSI), as a measure of financial instability in the previous period, is associated with a big decrease in GDP_Growth.

- **NPL_Ratio:** For fixed effects, the coefficient is equal to 0.076, significant only at the 10% level. For random effects, the coefficient is 0.02, not significant.

  This means that, in the fixed effects model, a higher ratio of nonperforming loans is positively correlated with GDP_Growth, although weakly significant. This result seems to be counterintuitive and could be due to specific country or time period effects, which aren´t found in the random effects model, in which the coefficient is smaller and not significant.

- **Reg_Cap_RWA:** For fixed effects, the coefficient is equal to 0.31, not significant. For random effects, the coefficient is equal to 0.20, significant at 10% level (*).

  This evidences that higher regulatory capital seems to influence positively GDP_Growth in the random effects model, suggesting that better-capitalized banks may lead to economic growth. This isn´t seen in the fixed effects model, where the effect is not statistically significant.

- **Tier1_RWA:** In the fixed effects model, the coefficient is negative (-0.33), not significant. For random effects model, the coefficient is -0.15, also not significant. This variable doesn´t seem therefore to have a strong impact on GDP_Growth annual change.
- **SP500_Returns:** For both fixed and random effects models, the coefficients are slightly negative (-0.007 and -0.003, respectively) and aren´t significant in any of these models. This suggests that the U.S. equity and stocks market performance may not provoke real GDP growth annual changes for the OECD countries.
- **ST_IR:** the coefficient is positive for both fixed and random effects model. However, its value is higher in the random effects model (0.14) than in the fixed effects model (0.04). Also, it is not significant in the fixed effects model, but it is in the random effects model (at the 5% level). The conclusion is that higher interest rates, in the short term, are associated with higher GDP_Growth. This is valid for the fixed effects model only and can reveal an overheating economy.
- **Banking_Lev:** The coefficient is negative for both fixed (0.07) and random (-0.03) effects models. It is significant only in the random effects model, at 5% level.

  This suggests that, in the random effects model, the higher leveraged is the banking sector, the worse will be for real economic growth.
- **Constant:** For fixed effects model, the coefficient is equal to 2.84, approximately, significant at 5% level. For random effects model, the coefficient is equal to 1.7, approximately, significant at the 1% level. This constant reflects the average GDP_Growth when all other independent variables are held constant.
- Both models have 338 observations and include 27 countries (Country_ID), composing the panel data of the dataset.
- Regarding the explanation of the model, in the fixed effects model, the R-squared is equal to 0.267, indicating that approximately 27% of the annual variability in GDP_Growth is explained by the model.

  For the random effects model, the R-squared is not visible in the results.

- Overall, the results above are consistent with the major goal of this paper: to understand how financial stress affects real economic growth. According to them, the variable "lagged FSI" has a significant negative impact on GDP_Growth, and this is one of the things that I want to prove with this paper: that high financial stress episodes can´t be undissociated to financial crises and that the highest values of financial stress in the recent years were compatible with financial crises and losses on economic growth.

Second scenario:

First, I computed two linear OLS regressions, just like in the first scenario, having as dependent variable real GDP annual growth and the same independent variables used before, but now the FSI values are the average of each year´s quarters.

[Table XI]

Analysis of coefficients´ significance (Table XI):

When compared to the first scenario (Table IX), we can see that, in the second, the coefficient for the **FSI** variable (-6.19) is more negative than in the first (-2.91) and also highly significant, at the 1% level.

We can therefore conclude that computing the yearly FSI as an average of the four quarters, per each country, maximizes the negative impact of financial stress in real GDP annual growth.

Regarding the **lagged FSI**, it is statistically significant at the 1% level for both scenarios, but in the first its negative impact is stronger (-4.32) than in the second (-3.36), its absolute value is higher in the first scenario.

Regarding **NPL_Ratio**, this variable is negative in both models for the two scenarios but is only significant in the Model 1 of the first scenario.

Reg_Cap_RWA has positive coefficients in both models and scenarios but it´s not significant.

Tier1_RWA has positive coefficients for the first model and negative for the second model, where FSI lagged is used. However, it is not statistically significant in any model.

Regarding **SP500_Returns**, this variable is negative in all models but only significant in Model 1 of the first scenario, at the 5% level.

For **ST_IR (%)**, this variable has positive coefficients and is highly significant in all models and for both scenarios.

Finally, **Banking_Lev** has negative coefficients in both scenarios, is statistically significant at 5% level in Model 1 (1st scenario) and at 1% level in Model 2 (2nd scenario).

From the R-squared values, we can conclude that regarding Model 1 in the second scenario (0.271) explains more variance than Model 1 in the first scenario (0.188), whereas for Model 2, in which is used lagged FSI, the first scenario is the one that best explains the variance (0.264), compared to 0.175 in the second scenario.

Then, similarly to what was done for the first scenario (Table X), I wanted to analyse how these variables would interact in panel data (Table XII). I separated "Country_Year" into "Country_ID" and "Year" variables and got a strongly balanced panel from 1967 to 2018.

[Table XII]

The results presented in Table XII enhance the negative and highly significant impact of FSI in GDP growth, in both models.

SP500_Returns have negative coefficients and significant in both models, being this significance level higher in the fixed effects model.

Reg_Cap_RWA and **Tier1_RWA** aren´t significant in any model, indicating no strong impact on real GDP annual growth.

NPL_Ratio have a positive relation with the dependent variable, show no significance for random effects, however, has significance at the 10% level for robust fixed effects.

ST_IR has positive coefficients in both models but is only statistically significant for random effects (at the 1% level).

Regarding **Banking_Lev**, it has a negative relation with GDP_Growth, more pronounced for random effects (statistically significant at the 5% level), but not significant in the fixed effects model.

The constant term is positive and statistically significant in both models. This represents the expected growth rate of real GDP when all independent variables are zero, meaning the average growth rate not explained by the independent variables in the model.

The fact that these coefficients are statistically significant indicates that may exist unobserved factors influencing economic growth.

ARCH model analysis

An Autoregressive Conditional Heteroskedasticity (ARCH) model is a time series model that describes the variance of a time series as a function of its own past values. Basically, it estimates the time-varying volatility, namely in situations where heteroskedasticity may be present. (Bera & Higgins, 1993).

I created the panel data, having as panel variable Country_ID and as time variable Year, from 1967 to 2018.

[Table XIII]

Analysing the results, in Table XIII, the ARCH model indicates a mean volatility level of 2.68%, approximately, for GDP_Growth rate. The estimated variance of the error term (8.42) indicates a significant variability around the mean growth rate.

[Table XIV]

Table XIV shows the ARCH model for the FSI variable, with a mean volatility level of 0.042, approximately. The estimated variance of the error term (0.027) exhibits a low/stable level of volatility around the mean financial stress level.

[Table XV]

The ARCH model for NPL_Ratio, in Table XV, shows a mean volatility level around 3.53%. The estimated variance of the error term (35.30) suggests high variability over time.

[Table XVI]

Table XVI presents the mean volatility level for Reg_Cap_RWA (13,69%), with the ARCH model. The estimated variance of the error term is 37.93, a considerably high level of volatility regarding this ratio.

[Table XVII]

Table XVII evidences the mean volatility level for the Tier1_RWA ratio (11.61%). The estimated variance of the error term is 32.49, which suggests the existence of fluctuations around this variable over time.

[Table XVIII]

Table XVIII presents the mean volatility level for the SP500_Returns (4.89%). The estimated variance of the error term is 491.9, which indicates huge volatility regarding capital market returns.

[Table XIX]

Table XIX exhibits the mean volatility level for the ST_IR (6.70%). The estimated variance of the error term is 43.72, which indicates some fluctuations in volatility regarding this variable over time.

[Table XX]

Table XX shows the mean volatility level for the Banking_Lev (8.95%). The estimated variance of the error term (139.1) indicates an expressive, high variability in this variable over time.

[Table XXI]

Table XXI displays the mean volatility level for the Lagged FSI variable (0.042). The estimated variance of the error term (0.0272) suggests a stable volatility trend in financial stress levels over time.

Overall, the results indicate statistically significant variability regarding the mean levels of all variables, with different intensities from variable to variable over time.

Endogeneity analysis

Endogeneity may be a problem to econometric models, since the explanatory variable is correlated with the error term, which may lead to incongruent and biased estimation of parameters. One way to mitigate this issue is by computing Instrumental Variables (IV) regressions. In these regressions, instruments are correlated with the endogenous variables but uncorrelated with the error term.

First, I´ll apply this analysis to my macroeconomic variables (1) and then to my financial stress variables (2)

1) <u>Macroeconomic variables:</u>

[Table XXII]

a) Gov_Exp as endogenous variable:

Table XXII presents the results of an Instrumental variables 2SLS regression, having as dependent variable GDP_Growth, as endogenous variable Government Expenditure annual change and as exogenous Cap_Form, Cons_Exp, Gov_Debt, Unemp_Change. The coefficient (1.749) suggests that a one percent increase in Government Expenditure annual change is associated with a 1.75% increase in GDP_Growth. This coefficient is strong and highly significant, at the 1% level.

The constant value (-1.24) represents the expected growth rate of real GDP when all independent variables are zero, representing the average growth rate not explained by the independent variables in the model. It is negative and statistically significant at the 1% level, in this case.

The model has 1.145 observations.

The first-stage regression has an adjusted R-squared of 0.2533, meaning that around 25% of the variation in the endogenous variable (Gov_Exp) is explained by the instruments and the other exogenous variables.

The F-statistic (78.6149) tests the null hypothesis inferring that the instruments are weak. Usually, if this value is higher than 10, it suggests that the instruments are not weak. In this case, instruments are strong.

The p-value (Prob>F=0.0000) seems to indicate that the instruments are statistically significant in explaining the endogenous variable at the 1% level.

Overall, these instruments have a considerable explanatory power on Gov_Exp.

The overidentifying restrictions test assesses the validity of the instruments by evaluating if they are not correlated with the error term in the second stage regression.

Both the Sagan and Basmann tests indicate that the instruments aren´t valid as they are correlated with the error term (p-value is equal to 0.0000 in both cases), rejecting the null hypothesis that the instruments are not correlated with the error term, and therefore, valid.

b) Gov_Debt as endogenous variable:

[Table XXIII]

Table XXIII presents the results of an Instrumental variables 2SLS regression, having as dependent variable GDP_Growth, as endogenous variable Gov_Debt (% of GDP) and as exogenous Gov_Exp, Infl_Rate, Cap_Form, Cons_Exp, Unemp_Change.

The coefficient (-0.0910) suggests that a one percent increase in Gov_Debt (% of GDP) is associated with a 0.09% decrease in GDP_Growth. This coefficient has a slightly negative value but is strong and highly significant, at the 1% level.

The constant value (8.116) represents the expected growth rate of real GDP when all independent variables are zero, meaning the average growth rate not explained by the independent variables in the model. It is positive and statistically significant at the 1% level, in this case.

The model has 1.145 observations.

The first-stage regression has an adjusted R-squared of 0.1788, meaning that around 18% of the variation in the endogenous variable (Gov_Debt as percentage of GDP) is explained by the instruments and the other exogenous variables.

The F-statistic (50.813) tests the null hypothesis inferring that the instruments are weak. Since this value is higher than 10, it suggests that the instruments are strong.

The p-value (Prob>F=0.0000) seems to indicate that the instruments are statistically significant in explaining the endogenous variable at the 1% level.

Overall, these instruments have a considerable explanatory power on Gov_Debt (% of GDP).

Both the Sagan and Basmann tests indicate that the instruments aren´t valid as they are correlated with the error term (p-value is equal to 0.0000 in both cases), rejecting the null hypothesis that the instruments are not correlated with the error term, and therefore, valid.

c) Unemp_Change as endogenous variable :

[Table XXIV]

Table XXIV presents the results of an Instrumental variables 2SLS regression, having as dependent variable GDP_Growth, as endogenous variable Unemp_Change and as exogenous Gov_Exp, Infl_Rate, Cap_Form, Cons_Exp, Gov_Debt.

The coefficient (-0.192) suggests that a one percent increase in Unemp_Change is associated with a 0.19% decrease in GDP_Growth. This coefficient has a slightly negative value but is strong and highly significant, at the 1% level.

The constant value (2.795) represents the expected growth rate of real GDP when all independent variables are zero, meaning the average growth rate not explained by the independent variables in the model. It is positive and statistically significant at the 1% level, in this case.

The model has 1.145 observations.

The first-stage regression has an adjusted R-squared of 0.3649, meaning that around 36% of the variation in the endogenous variable (Unemp_Change) is explained by the instruments and the other exogenous variables.

The F-statistic (132.473) tests the null hypothesis inferring that the instruments are weak. This value is expressively high, meaning that instruments are very strong.

The p-value (Prob>F=0.0000) seems to indicate that the instruments are statistically significant in explaining the endogenous variable at the 1% level.

Overall, these instruments have high explanatory power on Unemp_Change.

Both the Sagan and Basmann tests indicate that the instruments aren´t valid as they are correlated with the error term (p-value is equal to 0.0000 in both cases), rejecting the null hypothesis that the instruments are not correlated with the error term, and therefore, valid.

d) Infl_Rate as endogenous variable:

[Table XXV]

Table XXV presents the results of an Instrumental variables 2SLS regression, having as dependent variable GDP_Growth, as endogenous variable Inflation rate at average consumer prices (% annual growth) and as exogenous Gov_Exp, Cap_Form, Cons_Exp, Gov_Debt, Unemp_Change.

The coefficient (0.251) suggests that a one percent increase in Inflation rate (at average consumer prices) is associated with a 0.25% increase in GDP_Growth. This coefficient is strong and highly significant, at the 1% level.

The constant value (1.654) represents the expected growth rate of real GDP when all independent variables are zero, meaning the average growth rate not explained by the independent variables in the model. It is positive and statistically significant at the 1% level, in this case.

The model has 1.145 observations.

The first-stage regression has an adjusted R-squared of 0.0498, meaning that around 5% of the variation in the endogenous variable (Infl_Rate) is explained by the instruments and the other exogenous variables.

The F-statistic (12.9867) tests the null hypothesis inferring that the instruments are weak. Usually, if this value is higher than 10, it suggests that the instruments are not weak. In this case, instruments are moderately strong.

The p-value (Prob>F=0.0000) seems to indicate that the instruments are statistically significant in explaining the endogenous variable at the 1% level.

Overall, these instruments have moderate explanatory power Infl_Rate.

Both the Sagan and Basmann tests indicate that the instruments aren´t valid as they are correlated with the error term (p-value is equal to 0.0000 in both cases), rejecting the null hypothesis that the instruments are not correlated with the error term, and therefore, valid.

e) Cap_Form as endogenous variable:

[Table XXVI]

Table XXVI presents the results of an Instrumental variables 2SLS regression, having as dependent variable GDP_Growth, as endogenous variable Cap_Form and as exogenous Gov_Exp, Infl_Rate, Cons_Exp, Gov_Debt, Unemp_Change.

The coefficient (0.396) suggests that a one percent increase in Cap_Form is associated with a 0.4% increase in GDP_Growth. This coefficient is strong and highly significant, at the 1% level.

The constant value (1.266) represents the expected growth rate of real GDP when all independent variables are zero, representing the average growth rate not explained by the independent variables in the model. It is positive and statistically significant at the 1% level, in this case.

The model has 1.145 observations and an R-squared of 0.092, meaning that Capital stock formation variability explains around 9.2% of the variability in GDP_Growth.

The first-stage regression has an adjusted R-squared of 0.3520, meaning that around 35% of the variation in the endogenous variable (Capital stock formation – annual % change) is explained by the instruments and the other exogenous variables.

The F-statistic (125.271) tests the null hypothesis inferring that the instruments are weak. In this case, the instruments are very strong.

The p-value (Prob>F=0.0000) seems to indicate that the instruments are statistically significant in explaining the endogenous variable at the 1% level.

Overall, these instruments have high explanatory power on Cap_Form.

Both the Sagan and Basmann tests indicate that the instruments aren´t valid as they are correlated with the error term (p-value is equal to 0.0000 in both cases), rejecting the null hypothesis that the instruments are not correlated with the error term, and therefore, valid.

f) Cons_Exp as endogenous variable :

[Table XXVII]

Table XXVII presents the results of an Instrumental variables 2SLS regression, having as dependent variable GDP_Growth, as endogenous variable Cons_Exp (annual change) and as exogenous Gov_Exp, Cap_Form, Infl_Rate, Gov_Debt and Unemp_Change.

The coefficient (1.182) suggests that a one percent increase in Cons_Exp is associated with a 1.182% increase in GDP_Growth. This coefficient is strong and highly significant, at the 1% level.

The constant value (-0.320) represents the expected growth rate of real GDP when all independent variables are zero, representing the average growth rate not explained by the independent variables in the model. It is negative and statistically significant at the 1% level, in this case.

The model has 1.145 observations and an R-squared of 0.477, meaning that Cons_Exp variability explains around 48% of the variability in GDP_Growth, a very high contribution.

The first-stage regression has an adjusted R-squared of 0.5066, meaning that around 51% of the variation in the endogenous variable (Cons_Exp) is explained by the instruments and the other exogenous variables.

The F-statistic (235.939) tests the null hypothesis inferring that the instruments are weak. In this case, the instruments are very strong.

The p-value (Prob>F=0.0000) seems to indicate that the instruments are statistically significant in explaining the endogenous variable at the 1% level.

Overall, these instruments have high explanatory power on Cons_Exp.

Both the Sagan and Basmann tests indicate that the instruments aren´t valid as they are correlated with the error term (p-value is equal to 0.0000 in both cases), rejecting the null hypothesis that the instruments are not correlated with the error term, and therefore, valid.

2) **<u>Financial stress variables:</u>**

The results of the IV regressions for the financial stress variables, having as dependent variable GDP_Growth are presented in the tables below:

[Table XXVIII]

[Table XXIX]

[Table XXX]

For specification (1), FSI is an endogenous variable, and all the others are exogenous variables, instruments used to address the endogeneity of the FSI variable.

FSI has a negative and pronounced coefficient of -8.504, significant at 1% level, as well as SP500_Returns. NPL_Ratio and Reg_Cap_RWA also have negative coefficients, but not statistically significant.

Tier1_RWA, ST_IR and Banking_Lev show positive coefficients, but only significant at the 1% level for ST_IR.

The constant term exhibits a positive value of 1.530, significant at the 1% level.

For specification (2), NPL_Ratio is the endogenous variable.

In this model, the endogenous variable has a negative and statistically significant value (0.991), at the 1% level. FSI, Reg_Cap_RWA, SP500_Returns, and Banking_Lev also have negative coefficients, but only Reg_Cap_RWA is significant, at the 10% level.

Tier1_RWA and ST_IR have positive coefficients. The first one is significant at the 5% level.

The constant term is positive (2.459) and statistically significant at the 5% level.

For specification (3), Reg_Cap_RWA is analysed as the endogenous variable. FSI, NPL_Ratio, Reg_Cap_RWA and SP500_Returns exhibit negative coefficients. Only FSI is significant, at the 1% level.

Tier1_RWA, ST_IR and Banking_Lev show positive coefficients, but only ST_IR is significant, at the 1% level.

The constant term is 8.413, a positive and high value, meaning that with all the other exogenous variables at zero, not affecting GDP_Growth, the model estimates that GDP_Growth will be approximately 8.413%.

For specification (4), Tier1_RWA is analysed as the endogenous variable.

This variable exhibits a positive coefficient as well as ST_IR and Banking_Lev. FSI, NPL_Ratio, Reg_Cap_RWA and SP500_Returns exhibit negative coefficients.

None of the coefficients is statistically significant. The constant term is positive (1.461).

For specification (5), SP500_Returns is the endogenous variable. This variable has a negative coefficient, as well as FSI, NPL_Ratio, Reg_Cap_RWA and Banking_Lev.

Tier1_RWA and ST_IR have positive coefficients.

FSI and SP500_Returns have statistically significant coefficients, at the 1% level. ST_IR is significant at the 10% level and Banking_Lev is significant at the 5% level. The constant term (3.215) is statistically significant at the 1% level.

For specification (6), ST_IR is the endogenous variable.

Tier1_RWA, NPL_Ratio, SP500_Returns, ST_IR and Banking_Lev exhibit positive coefficients. FSI and Reg_Cap_RWA show negative coefficients.
Tier1_RWA and FSI are significant at the 1% level, SP500_Returns is significant at the 5% level.
The negative constant term (-8.151) is significant at the 5% level.

For specification (7), Banking_Lev is the endogenous variable. Banking_Lev, NPL_Ratio, Tier1_RWA, SP500_Returns and ST_IR have negative coefficients.
Leverage of the banking sector is significant at the 1% level and SP500_Returns is significant at the 5% level.
FSI and Reg_Cap_RWA have positive coefficients.
The positive constant term (9.424) is statistically significant at the 1% level.

For specification (8), Lagged FSI is the endogenous variable. Banking_Lev, NPL_Ratio, Tier1_RWA and SP500_Returns and lagged FSI have negative coefficients, being this last one the only statistically significant, at the 1% level. Reg_Cap_RWA has a positive coefficient, significant at the 5% level.

The positive constant term (1.935) is statistically significant at the 1% level.

This model has a R-squared of 0.242 meaning that the variability in the independent variables explain around 24% of the variability in the dependent variable.
I then proceeded to compute the IV regressions, in Stata, for each specification, accounting for robust standard errors:

[Table XXXI]

Table XXXI presents the results of an IV regression, having as dependent variable GDP_Growth and FSI as independent and endogenous variable. The exogenous variables are NPL_Ratio, Reg_Cap_RWA, Tier1_RWA, SP500_Returns, ST_IR and Banking_Lev.

The negative coefficient of FSI (-3.818) is significant at the 5% level, meaning that a one-unit increase in FSI is associated with a decrease of 3.818% in GDP real annual growth.
The positive constant term (2.466) is highly significant at the 1% level. This represents the annual change in GDP_Growth when the FSI is zero.
The R-squared suggests that Financial Stress Index (FSI) can only explain around 7.8% of the variance in GDP_Growth.

According to the first-stage regression. the R-squared is equal to 0.2526, meaning that around 25% of the variance in the endogenous variable (FSI) can be explained by the instruments (the exogenous variables). Regarding the F-statistic (6.04029), it is lower than 10, with alongside with the fact that p-value is equal to 0.0000, indicate that the instruments aren´t strongly correlated with the endogenous regressor, not being therefore important instruments.
The test of overidentifying restrictions presents results which indicate that the instruments are much likely to be invalid, since the low p-value (0.0000). This p-value suggests that the null hypothesis that the instruments are valid (not correlated with the error term) is rejected.

[Table XXXII]

According to Table XXXII, NPL_Ratio has a negative coefficient (-0.140), significant at the 10% level.

The positive constant term (2.482) is highly significant, at the 1% level.

According to the first-stage regression, the R-squared is equal to 0.1592, meaning that around 16% of the variance in the endogenous variable (NPL_Ratio) can be explained by the instruments (the exogenous variables). Regarding the F-statistic (8.5958), it is lower than 10, with alongside with the fact that p-value is equal to 0.0000, indicate that the instruments aren´t strongly correlated with the endogenous regressor, not being therefore important instruments.
The test of overidentifying restrictions presents results which indicate that the instruments are much likely to be invalid, since the low p-value (0.0000). This p-value suggests that

the null hypothesis that the instruments are valid (not correlated with the error term) is rejected.

[Table XXXIII]

Table XXXIII presents the results of an IV regression, having as dependent variable GDP_Growth and as independent Reg_Cap_RWA, as endogenous variable.

The exogenous variables are FSI, NPL_Ratio, Tier1_RWA, SP500_Returns, ST_IR and Banking_Lev.

The positive coefficient of Reg_Cap_RWA (0.0760) is significant at the 5% level, meaning that a one-unit increase in FSI is associated with a decrease of 0.076% in GDP real annual growth.

The positive constant term (0.956) is significant at the 10% level. This represents the annual change in GDP_Growth when the Reg_Cap_RWA is zero.

The R-squared suggests that Reg_Cap_RWA can only explain around 2.4% of the variance in GDP_Growth.

According to the first-stage regression, the R-squared is equal to 0.9390, meaning that around 94% of the variance in the endogenous variable (Reg_Cap_RWA) can be explained by the instruments (the exogenous variables).

Regarding the F-statistic it has a very high value (776.647).

Therefore, these instruments are very relevant and much correlated with Reg_Cap_RWA (the endogenous variable), given the high R-squared and F-statistic values.

The test of overidentifying restriction presents results which indicate that the instruments are much likely to be invalid, since the low p-value (0.0000). This p-value suggests that the null hypothesis that the instruments are valid (not correlated with the error term) is rejected.

[Table XXXIV]

Table XXXIV presents the results of an IV regression, having as dependent variable GDP_Growth and as independent Tier1_RWA, as endogenous variable.

The exogenous variables are FSI, NPL_Ratio, Reg_Cap_RWA, SP500_Returns, ST_IR and Banking_Lev.

The positive coefficient of Tier1_RWA (0.0715) is significant at the 10% level, meaning that a one-unit increase in this variable is associated with an increase of 0.0715% in GDP real annual growth.

The positive constant term (1.164) is significant at the 5% level. This represents the annual change in GDP_Growth when the Tier1_RWA is zero.

The R-squared suggests that Tier1_RWA can only explain around 1.6% of the variance in GDP_Growth.

According to the first-stage regression, the R-squared is equal to 0.9422, meaning that around 94% of the variance in the endogenous variable (Tier1_RWA) can be explained by the instruments (the exogenous variables).

Regarding the F-statistic it has an outrageously high value (1985.69).

Therefore, these instruments are very relevant and much correlated with Tier1_RWA (the endogenous variable), given the high R-squared and F-statistic values.

The test of overidentifying restrictions presents results which indicate that the instruments are much likely to be invalid, since the low p-value (0.0000). This p-value suggests that the null hypothesis that the instruments are valid (not correlated with the error term) is rejected.

[Table XXXV]

Table XXXV presents the results of an IV regression, having as dependent variable GDP_Growth and as independent SP500_Returns, as endogenous variable.

The exogenous variables are FSI, NPL_Ratio, Reg_Cap_RWA, Tier1_RWA ST_IR and Banking_Lev.

The positive coefficient of SP500_Returns (0.0723) is significant at the 1% level, meaning that a one-unit increase in this variable is associated with an increase of 0.0723% in GDP real annual growth.

The positive constant term (1.677) is significant at the 1% level. This represents the annual change in GDP_Growth when the SP500_Returns is zero.

According to the first-stage regression, the R-squared is equal to 0.0983, meaning that around 10% of the variance in the endogenous variable (SP500_Returns) can be explained by the instruments (the exogenous variables). Regarding the F-statistic it has a low value (3.92883). The Prob > F equal to 0.0008 (p <0.01) suggests that the instruments, jointly, have significance but they aren´t strong predictors. Therefore, these instruments aren´t very relevant and much correlated with SP500_Returns (the endogenous variable), given the low R-squared and F-statistic values.

The test of overidentifying restrictions presents results which indicate that the instruments are much likely to be invalid, since the low p-value (0.0001). This p-value suggests that the null hypothesis that the instruments are valid (not correlated with the error term) is rejected.

[Table XXXVI]

Table XXXVI presents the results of an IV regression, having as dependent variable GDP_Growth and as independent ST_IR (%), as endogenous variable.

The exogenous variables are FSI, NPL_Ratio, Reg_Cap_RWA, Tier1_RWA, of SP500_Returns and Banking_Lev.

The positive coefficient of ST_IR (%) (0.0187) is not significant. This coefficient means that a one-unit increase in this variable is associated with an increase of 0.0187% in GDP real annual growth.

The positive constant term (1.935) is significant at the 1% level. This represents the annual change in GDP_Growth when the ST_IR (%) is zero.

According to the first-stage regression, the R-squared is equal to 0.1738, meaning that around 17% of the variance in the endogenous variable (ST_IR (%)) can be explained by the instruments (the exogenous variables). Regarding the F-statistic it has a high value (20.7721).

Therefore, these instruments are relevant and considerably correlated with ST_IR (the endogenous variable), given the moderate R-squared and high F-statistic values.

The test of overidentifying restrictions presents results which indicate that the instruments are much likely to be invalid, since the low p-value (0.0000). This p-value suggests that the null hypothesis that the instruments are valid (not correlated with the error term) is rejected.

[Table XXXVII]

Table XXXVII presents the results of an IV regression, having as dependent variable GDP_Growth and as independent Banking_Lev, as endogenous variable.

The exogenous variables are FSI, NPL_Ratio, Reg_Cap_RWA, Tier1_RWA, of SP500_Returns and ST_IR.

The negative coefficient of Banking_Lev (-0.187) is significant at the 1% level. This coefficient means that a one-unit increase in this variable is associated with a decrease of 0.187% in GDP real annual growth.

The positive constant term (4.970) is significant at the 1% level. This represents the annual change in GDP_Growth when the Banking_Lev is zero.

According to the first-stage regression, the R-squared is equal to 0.1922, meaning that around 19% of the variance in the endogenous variable (Banking_Lev) can be explained by the instruments (the exogenous variables). Regarding the F-statistic it has a low value (3.59828).

The test of overidentifying restrictions presents a p-value equal to 0.0184 (p>0.01, <0.05). This p-value suggests potential problems with the validity of instruments, that they may not be fully exogenous, which could lead to biased regression estimates.

[Table XXXVIII]

Table XXXVIII presents the results of an IV regression, having as dependent variable GDP_Growth and as independent lagged FSI, as endogenous variable.

The exogenous variables are FSI, NPL_Ratio, Reg_Cap_RWA, Tier1_RWA, SP500_Returns, ST_IR, Banking_Lev.

The negative coefficient of lagged FSI (-7.993) is very significant, at the 1% level, more significant than FSI as endogenous variable (Table XXXI). This coefficient means that a one-unit increase in this variable is associated with a decrease of 7.993% in GDP real annual growth.

The positive constant term (2.991) is also significant at the 1% level. This represents the annual change in GDP_Growth when lagged FSI is zero.

According to the first-stage regression, the R-squared is equal to 0.1654, meaning that around 17% of the variance in the endogenous variable (lagged FSI) can be explained by the instruments (the exogenous variables). Regarding the F-statistic it has a low value (4.72082).

The F-statistic is highly significant ($p<0.01$), which indicates that, jointly, the instruments are significant in predicting Banking_Lev.

The test of overidentifying restrictions originates a p-value equal to 0.0036, which indicates that the null hypothesis that rejects these instruments is rejected at the 1% level.

Overall, there are specifications in which instruments (exogenous variables) explain better the variance in the endogenous variable than others. In specifications 3 (Reg_Cap_RWA) and 4 (Tier1_RWA), the R-squared is very high. In others, the explanation of the model is not as good.

For the majority of the specifications, we reject the null hypothesis, not assuring that the instruments are not correlated with the error term, not being able to tell if they are valid.

4. Conclusion

This dissertation aimed to understand: (1) how financial stress impacted real economic growth, (2) how financial crises correlated with economic growth; (3) how financial stress varied among countries and various types of crises.

These research questions were assessed by using a panel data approach, using several econometric models to understand the relationships between macroeconomic variables, financial stress indicators and GDP_Growth.

The employed dataset included macroeconomic variables, ranging from 1967 to 2018, and financial stress variables from 1980 to 2023.

Regarding the first question, the findings regularly showed that financial stress has a considerable harmful effect on real economic growth. In the various regression models, the Financial Stress Index (FSI) and its lagged values consistently showed significantly negative coefficients. High levels of financial stress have proven to be related to high levels of uncertainty and reduction in real GDP growth.

Regarding the second question, the evidence suggests that financial crises are typically preceded by periods of high financial stress, which leads to significant negative effects in economic activity.

Looking upon historical data, it is perceptible that generally crises occur after long periods of economic growth. These continuous moments of economic prosperity generate sudden increases in assets´ value, namely through speculation, which then collapse abruptly when financial stress levels reach its peak (Minsky moment), leading to a reduction in economic growth. This happened, for example, in the 2008 Global Financial Crisis.

Also, the positive correlation between market volatility and leverage emphasizes how leveraged growth can lead to worse, more severe economic downturns during crises.

Regarding the third question, financial stress varies regarding its type, due to financial systems, economic and political frameworks, governments´ interventions, etc.

Financial stress indices such as the St. Louis Financial Stress Index (STLFSI) and the Cleveland Financial Stress Index (CFSI) evidence these differences, showing how banking, exchange rate, securities, economic, pandemic crises affect countries differently. Also, in Table XXXIX, in the Annex, these differences are analysed, through the FSI values, which are often higher in banking/credit crisis and affect usually first the advanced economies, and then have some spillover effects on more emerging economies.

The results of this paper contribute with key takeaways regarding the relationship between financial crises and economic growth, in OECD countries.

According to the analysis, increased levels of financial stress, evaluated by the different financial stress indicators (FSIs), including the IMF FSI (Financial Stress Index) lead to a reduction in real GDP growth. In various regression models, this negative correlation is robust, for both random and fixed effects, and in instrumental variable regressions.

The findings show that the lagged FSI frequently exhibits a considerable negative coefficient, which supports the idea that economic growth is highly affected by intense levels of financial stress from the previous period. This provides an important conclusion for policymakers, meaning that the harmful effects of financial stress and uncertainty prolong for more than the actual period, so it is necessary to be proactive in taking measures to anticipate these consequences and guarantee financial stability, which allows economic growth.

The other variables of financial stress analysed (Nonperforming loans, Regulatory capital to risk weighted assets, Tier1 capital to risk weighted assets, S&P500 equity annual returns, ST_IR and Leverage of the banking sector) provided varied results.

Higher levels of nonperforming loans have proven to be associated with higher real GDP growth, although not significantly, in the fixed effects model. This seems unreasonable but may be possibly due to country-specific reasons not attained.

The fact that higher regulatory capital to risk-weighted assets contribute to higher economic growth, in the random effects model, indicates that economic stability can occur through having a robust banking system, with well-capitalized banks.

Higher short-term interest rates were proven to increase real GDP growth in the random effects model. On the other side, leverage of the banking sector is consistently correlated with lower real GDP growth, which emphasizes that borrowing in excessive may contribute to financial fragility and economic recession.

The analysed macroeconomic variables also provide supplementary insights. Overall, government expenditure, inflation, capital formation (investment) and consumption present a positive relationship with real GDP growth, while public debt and unemployment have a negative relationship with economic growth.

To conclude, in summary, the findings indicate that financial crises have deep and long-lasting negative impact on real economic growth, namely through increased financial stress levels. Governments and financial institutions must follow robust regulatory frameworks and attentive financial management to sustain economic growth.

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Appendix

- **Tables**

For clarity and conciseness, both macroeconomic and financial stress variables were abbreviated. The abbreviations used are defined in Tables AI (macroeconomic) and AII (financial stress).

Table AI – Data description (Macroeconomic variables)

Variable	Abbreviation	Frequency	First observation	Last observation	Data source
Real GDP growth (annual % change)	GDP_Growth	Annual	1980	2023	IMF
Government Expenditure (annual % change)	Gov_Exp	Annual	1980	2023	IMF
Government Public Debt (% of GDP)	Gov_Debt	Annual	1980	2023	IMF

Unemployment rate (annual % change)	Unemp_Change	Annual	1980	2023	OECD Statistics
Inflation rate, average consumer prices (annual % change)	Infl_Rate	Annual	1980	2023	IMF
Gross capital formation (annual % change)	Cap_Form	Annual	1980	2023	World Data Bank
Final consumption expenditure (annual % change)	Cons_Exp	Annual	1980	2023	World Data Bank

Description of the macroeconomic variables:

Real GDP growth (annual % change) - Gross domestic product is the most commonly used single measure of a country's overall economic activity. It represents the total value at constant prices of final goods and services produced within a country during a specified time-period, such as one year. *Source: World Economic Outlook (April 2024)* Real GDP growth corresponds to nominal GDP growth divided by the deflator.

Basically, this indicator measures the annual change in economic growth adjusted for inflation.

General government final consumption expenditure (annual % growth) - Annual percentage growth of general government final consumption expenditure based on constant local currency. Aggregates are based on constant 2015 prices, expressed in U.S. dollars. General government final consumption expenditure (general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security but excludes government military expenditures that are part of government capital formation.

Source: World Bank national accounts data, and OECD National Accounts data files.

General government gross debt (Percent of GDP) - Gross debt consists of all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future. This includes debt liabilities in the form of SDRs, currency and deposits, debt securities, loans, insurance, pensions and standardized guarantee schemes, and other accounts payable. Thus, all liabilities in the GFSM 2001 system are debt, except for equity and investment fund shares and financial derivatives and employee stock options. Debt can be valued at current market, nominal, or face values (GFSM 2001, paragraph 7.110).)

Source: World Economic Outlook (April 2024).

Unemployment rate (annual % change) – The indicator "Unemployment rate – percentage of total labour force" is measured in numbers of unemployed people as a percentage of the labour force, and it is seasonally adjusted. The labour force is defined as the total number of unemployed people plus those in employment. Data are based on labor force surveys (LFS). For European Union countries where monthly LFS information is not available, monthly unemployment figures are estimated by Eurostat.

Source: Unemployment rate. (n.d.). OECD.

Based on this indicator, I computed a simple annual variation and updated the formula for all countries and all years, which resulted in this new indicator.

Inflation rate, average consumer prices (annual % change) - The average consumer price index (CPI) is a measure of a country's average level of prices based on the cost of a typical basket of consumer goods and services in a given period. The rate of inflation is the percent change in the average CPI.

Source: World Economic Outlook (April 2024)

Gross capital formation (annual % growth) - Annual growth rate of gross capital formation based on constant local currency. Aggregates are based on constant 2015 prices, expressed in U.S. dollars. Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in

production or sales, and "work in progress." According to the 2008 SNA, net acquisitions of valuables are also considered capital formation.
Source: World Bank national accounts data, and OECD National Accounts data files.

Final consumption expenditure (annual % growth) - Average annual growth of final consumption expenditure based on constant local currency. Aggregates are based on constant 2015 prices, expressed in U.S. dollars. Final consumption expenditure (formerly total consumption) is the sum of household final consumption expenditure (formerly private consumption) and general government final consumption expenditure (formerly general government consumption). This estimate includes any statistical discrepancy in the use of resources relative to the supply of resources.
Source: World Bank national accounts data, and OECD National Accounts data files.

Table AII – Data description (Financial stress variables)

Variable	Frequency	Abbreviation	First observation	Last observation	Data source
FSI	Annual	FSI	1967	2018	IMF
Nonperforming loans to total gross loans	Annual	NPL_Ratio	1967	2018	IMF
Regulatory capital to riskweighted assets	Annual	Reg_Cap_RWA	1967	2018	IMF
Tier 1 capital to riskweighted assets	Annual	Tier1_RWA	1967	2018	IMF
S&P Global Equity Indices (% annual change)	Annual	SP500_Returns	1967	2018	World Data Bank
Short-term interest rate (%)	Annual	ST_IR	1967	2018	OECD Statistics

Leverage of the banking sector	Annual	Banking_Lev	1967	2018	OECD Statistics

Description of the financial stress variables:

FSI: The Financial Stress Index (FSI) data was taken from (Ahir, et al., 2023). Its construction involves a four-step process: i) identification of keywords related to financial stress in EUI reports; ii) Revision of paragraphs containing these keywords to confirm actual financial stress, distinguishing between domestic and external sources; iii) There´s a validation of these signals by IMF county economists; iv) The verified signals are scaled by the total number of words in each report to permit comparability across countries. This whole process, with human control to eliminate false positives ensures the accuracy and consistency of the index.

Source : Ahir, H. et al., 2023. Financial Stress and Economic Activity: Evidence from a New Worldwide Index. *IMF Working Papers.*

Nonperforming loans to total gross loans: This FSI is calculated by using the value of NPLs (Nonperforming loans) as the numerator and the total value of the loan portfolio (including NPLs, and before the deduction of specific loan-loss provisions) as the denominator. This FSI is often used as a proxy for asset quality and is intended to identify problems with asset quality in the loan portfolio.

Source: *IMF Financial Soundness Indicators (FSIs)—Concepts and Definitions*

Regulatory capital to risk-weighted assets: This FSI is calculated using total regulatory capital as the numerator and risk-weighted assets as the denominator. Data is compiled in accordance with the guidelines of either Basel I or Basel II. It measures the capital adequacy of deposit takers. Capital adequacy and availability ultimately determine the degree of robustness of financial institutions to withstand shocks to their balance sheets.

Source: *IMF Financial Soundness Indicators (FSIs)—Concepts and Definitions*

Tier 1 capital to risk-weighted assets: The data for this FSI are also compiled in accordance with the guidelines of either Basel I or Basel II. It measures the capital adequacy of deposit takers based on the core capital concept of the Basle Committee on Banking Supervision (BCBS).

Source: *IMF Financial Soundness Indicators (FSIs)—Concepts and Definitions*

S&P Global Equity Indices (% annual change): S&P Global Equity Indices measure the U.S. dollar price change in the stock markets covered by the S&P/IFCI and S&P/Frontier BMI country indices. The S&P Global Equity Index Series covers approximately 11,000 securities from over 80 countries. It includes the S&P Global Broad Market Index (BMI), S&P Global 1200, S&P/IFCI, and S&P Frontier BMI. All indices are float-adjusted, market capitalization-weighted indices and include security classifications for country, size, style and industry. Source: World Bank Group Data – License Creative Commons Attribution 4.0 (CC-BY 4.0).

Short-term interest rate (%): Short-term interest rates are the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market. Short-term interest rates are generally averages of daily rates, measured as a percentage. Short-term interest rates are based on three-month money market rates where available. Typical standardised names are "money market rate" and "treasury bill rate".

Source: Short-term interest rates. (n.d.). OECD.

Leverage of the banking sector: This indicator presents the ratio between selected financial assets of the banking sector and their total equity; it is also known as the equity multiplier ratio (or financial leverage). The banking sector covers the central bank, and monetary financial institutions, as well as other financial intermediaries (except insurance corporations and pension funds). The financial assets cover currency and deposits; debt securities; and loans. Total equity relates to the market value of equity, excluding investment fund shares.

Source: Banking sector leverage (n.d.). OECD.

Table I – Results of macroeconomic variables' regressions

	(1) fixed effects	(2) random effects	(3) robust fixed effects
VARIABLES	**GDP_Growth**	**GDP_Growth**	**GDP_Growth**
Gov_Exp	0.0113	0.0353	0.0113
	(0.0255)	(0.0249)	(0.0818)
Gov_Debt	-0.00730***	-0.00614***	-0.00730*
	(0.00240)	(0.00176)	(0.00387)
Unemp_Change	-0.0294***	-0.0284***	-0.0294***
	(0.00317)	(0.00315)	(0.0105)
Infl_Rate	0.0363***	0.0314***	0.0363**
	(0.0115)	(0.0109)	(0.0133)
Cap_Form	0.102***	0.104***	0.102***
	(0.00608)	(0.00610)	(0.0238)
Cons_Exp	0.501***	0.502***	0.501***

	(0.0263)	(0.0260)	(0.136)
Constant	1.330***	1.228***	1.330***
	(0.201)	(0.170)	(0.361)
Observations	1,145	1,145	1,145
R-squared	0.693		0.693
Number of Country_ID	34	34	34

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table II – OLS regression with macroeconomic variables

	(1)
VARIABLES	**GDP_Growth**
Gov_Exp	0.0488**
	(0.0244)
Gov_Debt	-0.00396***
	(0.00148)
Unemp_Change	-0.0263***
	(0.00315)
Infl_Rate	0.0395***
	(0.0108)

Cap_Form	0.108***
	(0.00619)
ImportsofGDP	-0.0374***
	(0.0105)
ExportsofGDP	0.0381***
	(0.00901)
Cons_Exp	0.519***
	(0.0259)
Constant	0.864***
	(0.187)
Observations	1,145
R-squared	0.710

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table III – VIF analysis for macroeconomic variables

Variable	**VIF**	**1/VIF**
ExportsofGDP	25.21	0.039664
ImportsofGDP	25.00	0.039993
Cons_Exp	2.06	0.484579
Unemp_Change	1.59	0.627378
Cap_Form	1.58	0.633597
Gov_Exp	1.35	0.739036
Gov_Debt	1.30	0.769600
Infl_Rate	1.12	0.889589
Mean VIF	**7.40**	

Table IV – Results of macroeconomic variables´ regression, corrected for multicollinearity

	(1)
VARIABLES	**GDP_Growth**
Gov_Exp	0.0554**
	(0.0246)
Gov_Debt	-0.00554***
	(0.00145)
Unemp_Change	-0.0275***
	(0.00317)
Infl_Rate	0.0267**
	(0.0105)
Cap_Form	0.106***
	(0.00619)
Cons_Exp	0.503***
	(0.0260)
Constant	1.141***
	(0.145)
Observations	1,145
R-squared	0.703

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table V – Variance Inflation Factors after remotion of problematic variables

Variable	**VIF**	**1/VIF**
Cons_Exp	2.04	0.491225
Unemp_Change	1.58	0.632298

Cap_Form	1.55	0.645195
Gov_Exp	1.35	0.743436
Gov_Debt	1.22	0.817622
Infl_Rate	1.06	0.946065
Mean VIF	**1.47**	

Table VI – Results of fixed effects panel data with macroeconomic variables

	(1)
VARIABLES	**GDP_Growth**
Gov_Exp	0.0113
	(0.0255)
Gov_Debt	-0.00730***
	(0.00240)
Unemp_Change	-0.0294***
	(0.00317)
Infl_Rate	0.0363***
	(0.0115)
Cap_Form	0.102***
	(0.00608)
Cons_Exp	0.501***
	(0.0263)
Constant	1.330***
	(0.201)
Observations	1,145
Number of Country_ID	34
R-squared	0.693

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table VII – Results of random effects panel data with macroeconomic variables

	(1)
VARIABLES	**GDP_Growth**
Gov_Exp	0.0353
	(0.0249)
Gov_Debt	-0.00614***
	(0.00176)
Unemp_Change	-0.0284***
	(0.00315)
Infl_Rate	0.0314***
	(0.0109)
Cap_Form	0.104***
	(0.00610)
Cons_Exp	0.502***
	(0.0260)
Constant	1.228***
	(0.170)
Observations	1,145
Number of Country_ID	34

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table VIII - Results of fixed effects panel data with macroeconomic variables

	(1)
VARIABLES	**GDP_Growth**
Gov_Exp	0.0113
	(0.0818)
Gov_Debt	-0.00730*
	(0.00387)
Unemp_Change	-0.0294***
	(0.0105)
Infl_Rate	0.0363**
	(0.0133)
Cap_Form	0.102***
	(0.0238)
Cons_Exp	0.501***
	(0.136)
Constant	1.330***
	(0.361)
Observations	1,145
Number of Country_ID	34
R-squared	0.693

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table IX – Results of financial stress variables' regressions – 1st scenario

	(1) Model 1	(2) Model 2
VARIABLES	**GDP_Growth**	**GDP_Growth**

FSI	-2.910***	
	(0.630)	
NPL_Ratio	-0.0427*	-0.0209
	(0.0258)	(0.0248)
Reg_Cap_RWA	0.0802	0.140
	(0.0995)	(0.0941)
Tier1_RWA	0.00380	-0.0502
	(0.112)	(0.106)
SP500_Returns	-0.0123**	-0.000223
	(0.00593)	(0.00555)
ST_IR	0.249***	0.188***
	(0.0602)	(0.0565)
Banking_Lev	-0.0271**	-0.0173
	(0.0130)	(0.0122)

lagged_FSI		-4.320***
		(0.568)
Constant	1.294**	1.136**
	(0.503)	(0.478)
Observations	338	338
R-squared	0.188	0.264

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table X – Results of financial stress variables' regressions (in panel data)

	(1) robust fixed effects	**(2) random effects**
VARIABLES	**GDP_Growth**	**GDP_Growth**
lagged_FSI	-4.448***	-4.470***
	(0.883)	(0.544)
NPL_Ratio	0.0754*	0.0202
	(0.0373)	(0.0287)
Reg_Cap_RWA	0.312	0.200*
	(0.220)	(0.109)
Tier1_RWA	-0.326	-0.146
	(0.220)	(0.124)

SP500_Returns	-0.00736	-0.00297
	(0.00520)	(0.00526)
ST_IR	0.0382	0.136**
	(0.151)	(0.0673)
Banking_Lev	-0.0687	-0.0346**
	(0.0543)	(0.0153)
Constant	2.836**	1.697***
	(1.213)	(0.593)
Observations	338	338
R-squared	0.267	
Number of Country_ID	27	27

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XI – Results of financial stress variables' regressions – 2nd scenario

	(1) Model 1	**(2) Model 2**
VARIABLES	**GDP_Growth**	**GDP_Growth**
FSI	-6.189***	
	(0.787)	
NPL_Ratio	-0.0222	-0.0320
	(0.0246)	(0.0265)
Reg_Cap_RWA	0.0639	0.126
	(0.0940)	(0.0996)
Tier1_RWA	0.0223	-0.0289
	(0.106)	(0.112)
SP500_Returns	-0.00629	-0.00285
	(0.00547)	(0.00587)

ST_IR	0.225***	0.175***
	(0.0562)	(0.0601)
Banking_Lev	-0.0169	-0.0354***
	(0.0122)	(0.0127)
lagged_FSI		-3.361***
		(0.841)
Constant	1.375***	1.264**
	(0.476)	(0.507)
Observations	338	338
R-squared	0.271	0.175

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XII - Results of financial stress variables' regressions (in panel data)

	(1) random effects model	**(2) robust fixed effects model**
VARIABLES	**GDP_Growth**	**GDP_Growth**
FSI	-6.689***	-6.754***
	(0.765)	(1.052)
NPL_Ratio	0.0209	0.0744*
	(0.0285)	(0.0396)
Reg_Cap_RWA	0.0921	0.164
	(0.108)	(0.160)
Tier1_RWA	-0.0408	-0.171
	(0.123)	(0.150)
SP500_Returns	-0.00912*	-0.0130**
	(0.00513)	(0.00564)
ST_IR	0.192***	0.129

	(0.0674)	(0.161)
Banking_Lev	-0.0320**	-0.0633
	(0.0153)	(0.0522)
Constant	1.940***	2.932**
	(0.589)	(1.213)
Observations	338	338
R-squared		0.284
Number of Country_id	27	27

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XIII – Results of ARCH model for GDP_Growth

	(1)	(2)
VARIABLES	GDP_Growth	SIGMA2
Constant	2.675***	8.418***
	(0.0848)	(0.182)
Observations	1,170	1,170

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XIV – Results of ARCH model for FSI

	(1)	(2)
VARIABLES	FSI	SIGMA2

Constant	0.0416***	0.0272***
	(0.00711)	(0.000251)
Observations	1,560	1,560

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XV - Results of ARCH model for NPL_Ratio

	(1)	**(2)**
VARIABLES	**NPL_Ratio**	**SIGMA2**
Constant	3.525***	35.30***
	(0.589)	(1.547)
Observations	365	365

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XVI - Results of ARCH model for Reg_Cap_RWA

	(1)	**(2)**
VARIABLES	**Reg_Cap_RWA**	**SIGMA2**
Constant	13.69***	37.93***
	(0.375)	(2.698)
Observations	365	365

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table XVII - Results of ARCH model for Tier1_RWA

	(1)	**(2)**
VARIABLES	**Tier1_RWA**	**SIGMA2**
Constant	11.61***	32.49***
	(0.307)	(2.176)
Observations	365	365

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table XVIII – Results of ARCH model for SP500_Returns

	(1)	**(2)**
VARIABLES	**SP500_Returns**	**SIGMA2**

Constant	4.891***	491.9***
	(0.693)	(12.58)
Observations	1,170	1,170

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XIX - Results of ARCH model for ST_IR

	(1)	**(2)**
VARIABLES	**ST_IR**	**SIGMA2**
Constant	6.703***	43.72***
	(0.291)	(1.343)
Observations	1,004	1,004

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XX - Results of ARCH model for Banking_Lev

	(1)	**(2)**
VARIABLES	**Banking_Lev**	**SIGMA2**
Constant	8.947***	139.1***
	(0.516)	(3.698)
Observations	1,036	1,036

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXI - Results of ARCH model for Lagged FSI

	(1)	(2)
VARIABLES	**lagged_FSI**	**SIGMA2**
Constant	0.0417***	0.0272***
	(0.00711)	(0.000251)
Observations	1,559	1,559

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXII – Gov_Exp as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Gov_Exp	1.749***
	(0.102)
Constant	-1.240***
	(0.257)
Observations	1,145

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXIII – Gov_Debt as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Gov_Debt	-0.0910***
	(0.00728)
Constant	8.116***
	(0.460)
Observations	1,145

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXIV – Unemp_Change as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Unemp_Change	-0.192***
	(0.00807)
Constant	2.795***
	(0.101)
Observations	1,145

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXV – Infl_Rate as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Infl_Rate	0.251***
	(0.0851)
Constant	1.654***
	(0.328)
Observations	1,145

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXVI – Cap_Form as an endogenous variable

	(1)
VARIABLES	GDP_Growth
Cap_Form	0.396***
	(0.0146)
Constant	1.266***
	(0.103)
Observations	1,145
R-squared	0.092

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXVII – Cons_Exp as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Cons_Exp	1.182***
	(0.0338)
Constant	-0.320***
	(0.108)
Observations	1,145
R-squared	0.477

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXVIII - IV regression´s results for financial stress variables

	(1) FSI as endogenous	**(2) NPL_Ratio as endogenous**	**(3) Reg_Cap_RWA as endogenous**
VARIABLES	**GDP_Growth**	**GDP_Growth**	**GDP_Growth**
FSI	-8.504***	-0.0456	-7.674*

	(1.292)	(1.807)	(3.956)
NPL_Ratio	-0.0144	-0.991***	-0.382
	(0.0289)	(0.380)	(0.246)
Reg_Cap_RWA	-0.0199	-0.644*	-6.546
	(0.111)	(0.363)	(4.425)
Tier1_RWA	0.0822	1.070**	7.171
	(0.124)	(0.490)	(4.788)
SP500_Returns	-0.0243***	-0.0195	-0.0340
	(0.00692)	(0.0135)	(0.0265)
ST_IR	0.340***	0.0181	0.871*
	(0.0685)	(0.163)	(0.472)
Banking_Lev	0.0149	-0.0247	0.0250
	(0.0165)	(0.0290)	(0.0599)

Constant	1.530***	2.459**	8.413*
	(0.555)	(1.214)	(5.100)
Observations	338	338	338

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table XXIX - IV regression´s results for financial stress variables (continuation)

	(4) Tier1_RWA as endogenous	**(5) SP500_Returns as endogenous**	**(6) ST_IR as endogenous**
VARIABLES	**GDP_Growth**	**GDP_Growth**	**GDP_Growth**
Tier1_RWA	9.040	0.0748	2.572***
	(7.246)	(0.158)	(0.965)

FSI	-6.952	-5.540***	-7.033***
	(4.307)	(1.101)	(2.240)
NPL_Ratio	-0.584	-0.0581	0.0612
	(0.449)	(0.0364)	(0.0735)
Reg_Cap_RWA	-7.687	-0.0201	-0.516
	(6.230)	(0.142)	(0.337)
SP500_Returns	-0.0290	-0.121***	0.927**
	(0.0299)	(0.0283)	(0.459)
ST_IR	1.293	0.148*	0.00863
	(0.878)	(0.0882)	(0.0162)

Banking_Lev	0.0657	-0.0461**	0.0768
	(0.0946)	(0.0189)	(0.0523)
Constant	1.461	3.215***	-8.151**
	(2.275)	(0.853)	(4.056)
Observations	338	338	338

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXX - IV regression´s results for financial stress variables (continuation)

	(7) Banking_Lev as endogenous variable	**(8) Lagged_FSI as endogenous variable**
VARIABLES	**GDP_Growth**	**GDP_Growth**

Banking_Lev	-0.466***	-0.0224
	(0.164)	(0.0139)
FSI	4.842	
	(3.153)	
NPL_Ratio	-0.0383	-0.0264
	(0.0538)	(0.0261)
Reg_Cap_RWA	0.282	0.187**
	(0.221)	(0.0929)
Tier1_RWA	-0.329	-0.126
	(0.263)	(0.103)
SP500_Returns	-0.0283**	-0.00251
	(0.0137)	(0.00567)
ST_IR	-0.171	
	(0.200)	
lagged_FSI		-4.477***
		(1.092)

Constant	9.424***	1.935***
	(3.183)	(0.415)
Observations	338	341
R-squared		0.242

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXI – FSI as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
FSI	-3.818**
	(1.626)
Constant	2.466***
	(0.253)
Observations	338
R-squared	0.078

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXII – NPL_Ratio as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
NPL_Ratio	-0.140*
	(0.0842)
Constant	2.482***
	(0.282)
Observations	338

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXIII – Reg_Cap_RWA as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Reg_Cap_RWA	0.0760**
	(0.0388)
Constant	0.956*
	(0.517)
Observations	338
R-squared	0.024

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXIV – Tier1_RWA as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Tier1_RWA	0.0715*
	(0.0420)
Constant	1.164**
	(0.474)
Observations	338
R-squared	0.016

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXV - SP500_Returns as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
SP500_Returns	0.0723***
	(0.0229)
Constant	1.677***
	(0.236)
Observations	338

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXVI - ST_IR as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
ST_IR	0.0187
	(0.176)
Constant	1.935***
	(0.490)
Observations	338
R-squared	0.006

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXVII – Banking_Lev as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
Banking_Lev	-0.187***
	(0.0582)
Constant	4.970***
	(0.918)

Observations	338

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXVIII – Lagged FSI as an endogenous variable

	(1)
VARIABLES	**GDP_Growth**
lagged_FSI	-7.993***
	(2.225)
Constant	2.991***
	(0.258)
Observations	338
R-squared	0.123

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table XXXIX – FSI values per Country and Financial Crises

Country	**Year**	**FSI**
Australia	2008	0.283
Australia	2009	0.110
Australia	1992	0.051

Austria	2008	0.400
Austria	2009	0.355
Austria	2010	0.313
Belgium	2009	0.624
Belgium	2008	0.525
Belgium	2010	0.338
Canada	2008	0.222
Canada	1985	0.097
Canada	2009	0.077
Chile	2009	0.172
Chile	1982	0.159
Chile	2003	0.075
Colombia	1984	0.207
Colombia	1983	0.193
Colombia	1999	0.143
Costa Rica	1981	1.295
Costa Rica	1967	0.525
Costa Rica	1982	0.284
Denmark	2009	0.377
Denmark	2008	0.367
Denmark	1987	0.283
Finland	1992	0.338
Finland	2008	0.271
Finland	1993	0.236
France	2009	0.522
France	2012	0.318
France	2008	0.239
Germany	2009	0.698
Germany	2008	0.581

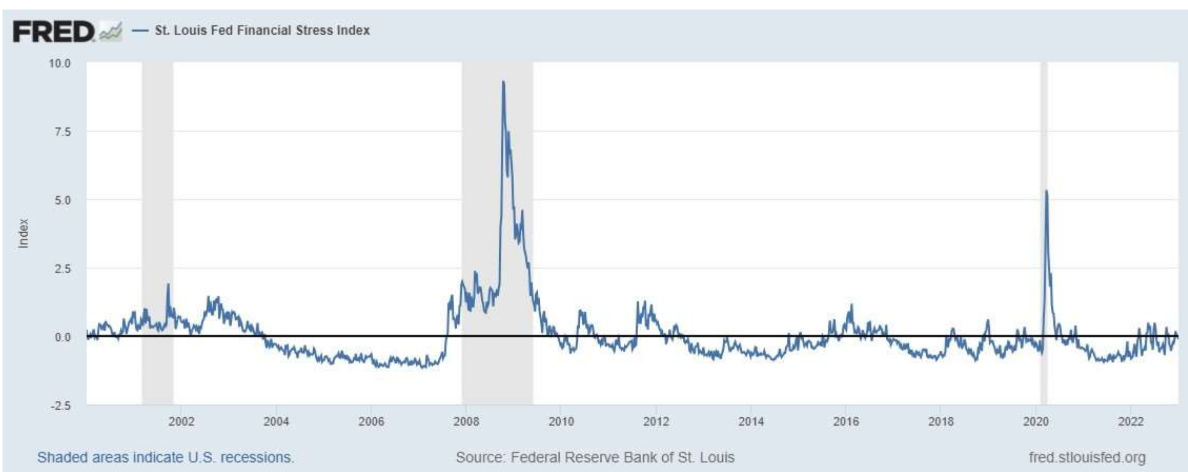
Germany	2010	0.157
Greece	2011	0.312
Greece	2012	0.304
Greece	2010	0.278
Hungary	2012	0.454
Hungary	2009	0.418
Hungary	2010	0.383
Iceland	2010	0.467
Iceland	2008	0.427
Iceland	2009	0.422
Ireland	2012	0.641
Ireland	2011	0.625
Ireland	2013	0.613
Israel	1967	0.075
Israel	1983	0.041
Israel	1968	0.035
Italy	2009	0.510
Italy	2012	0.347
Italy	2008	0.294
Japan	1998	0.400
Japan	1995	0.320
Japan	1996	0.251
Korea	1998	0.482
Korea	1999	0.450
Korea	2009	0.191
Mexico	2009	0.306

Mexico	1996	0.289
Mexico	1982	0.277
Netherlands	2009	0.790
Netherlands	2008	0.272
Netherlands	2010	0.232
New Zealand	2008	0.218
New Zealand	2009	0.204
New Zealand	1990	0.077
Norway	1992	0.316
Norway	2009	0.276
Norway	2008	0.210
Portugal	2009	0.350
Portugal	2012	0.244
Portugal	2014	0.228
Spain	2012	0.937
Spain	2013	0.782
Spain	2011	0.414
Sweden	2008	0.458
Sweden	1992	0.289
Sweden	2009	0.204
Switzerland	2007	0.322
Switzerland	2008	0.312
Switzerland	2009	0.187
Turkey	2001	0.607
Turkey	2009	0.208
Turkey	2002	0.193

United Kingdom	2009	1.078
United	2008	1.065
Kingdom		
United Kingdom	2010	0.681
United States	2008	1.106
United States	2009	0.794
United States	2007	0.364

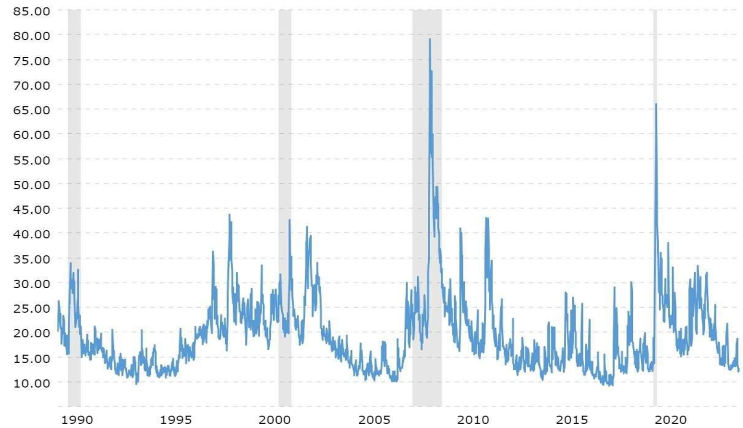
- **Graphs**

Graph I – St. Louis Financial Stress Index



Source : https://fred.stlouisfed.org/series/STLFSI4

Graph II – VIX (Volatility Index)



Source: https://www.macrotrends.net/2603/vix-volatility-index-historical-chart.

Annex

Top 3 highest FSI values per Country and Financial Crises

[Table XXXIX]

According to the results, presented in Table XXXIX, the higher FSI values for OECD countries were mostly obtained in 2007-2010, especially for the more advanced economies. This follows along with the **Global Financial Crisis (2007-2009)**. The Global Financial Crisis was provoked by the collapse of the Lehmann Brothers in September 2008. This event led to a global wave of fear and uncertainty in the financial markets and the banking system. Banks virtually stopped lending to each other, and the risk premium rose. With less borrowing, both for firms and households, trade credit went down, demand fell, particularly for investment goods and durable goods like cars, houses, etc. (McKibbin & Stoeckel, 2010)

The fiscal responses to the 2008 Financial Crisis involved considerable government expenditures, both under Bush and Obama mandates. The Troubled Asset Relief Program (TARP) allocated $700 billion for purchasing nonperforming financial assets. The

American Recovery and Reinvestment Act (ARRA), taken by President Obama, appropriated an additional $787 billion.
These measures included tax cuts, benefits, and public investments. However, their impact on GDP growth and employment was limited, being needed monetary policies also. (Tcherneva, 2011)

However, if we look at Table XXXIX, the highest FSI values for the Asian countries (Japan and Korea) were registered from 1995 to 1999. This period intersects with the **1997 Asian Financial Crisis**. these Asian countries "suffered from their own success". According to the IMF, Finance and Development (1998) Asian countries are generally known for their prudent fiscal policies and high rates of savings, leading to economic growth, but they ended up not being able to keep pace with an increased demand on policies and institutions, motivated by huge capital inflows.

Thailand announced the float of the Baht and had to request financial assistance from the International Monetary Fund. The financial crisis significantly impacted and damaged the Thai economy and spread throughout the ASEAN region and other countries in Asia until it escalated into a financial crisis. (Lessons Learnt from the Asian Financial Crisis, n.d.)

Currency and equity markets in emerging Asia recorded huge falls-on the order of 30 to 50 percent-in the second half of 1997 (as measured from the end of June, just before the floating of the Thai baht). (Goldstein, 1998)

The IMF intervened to quickly restore confidence in the three hardest hit Asian economies – Indonesia, Korea and Thailand, through a combination of tough economic conditionalities and substantial financial support. In 1997, the IMF provided $35 billion in loans for these countries, and in addition, mobilized commitments worth $77 billion from the Asian Development Bank, the World Bank and bilateral sources. Regarding macroeconomic policy, the IMF implemented higher interest rates to maintain the exchange rates stable, to reverse the capital outflows, stabilizing the currency. A modestly tighter fiscal policy was adopted to support current account adjustment and provide the funds that would be necessary to bail out sick banking systems. The IMF also implemented a substantial structural reform, namely of the region´s banking systems. (Padoan, 2009)

Also, for Southern Europe countries like Portugal, Spain, Italy, France, Greece, there is at least one year from 2009-2012 in all these countries top 3 of FSI values. This reflects the effects of the Eurozone debt crisis.

The **Eurozone debt crisis (2009)** affected some Southern European countries, which had unsustainable budget deficits and government debt. Was the first experience with an economic crisis in a currency union in the modern history of the world. Concerns about an incoming debt crisis began to surface around November 2009, after Greece announced previously undisclosed large budget deficits. In the following three years, deficit and debt issues extended to Ireland, Portugal, Italy, Spain, and Cyprus. The IMF and the European Commission provided bailouts for Greece, Ireland and Portugal. The crisis-hit countries began pursuing a variety of financial and economic changes, including large austerity measures. (Samarakoon, 2017)