

**Cracow University of Economics**

Field of science: Social Sciences

Discipline of science: Economics and Finance

By

Abhishek Anand

**PROCYCLICAL EFFECT OF CREDIT RISK OF BANKS – ECONOMETRIC ANALYSIS FOR  
EU FINANCIAL SYSTEM**

Doctoral Dissertation

Scientific supervisor:

Prof. dr hab. Mateusz Pipień

Kraków, 2024

## Contents

LIST OF ABBREVIATIONS.....	4
Introduction.....	6
Chapter-1 The procyclical nature of the banking sector activity - a review of the main research streams.....	17
1.1 Importance of procyclicality of the banking sector after the global financial crisis .....	18
1.2 Financial cycle as a revival of research on fluctuations of the activity of economic units.....	20
1.3 The economic insight into procyclicality processes - theories and conceptual framework .....	28
1.3.1 Early origins of procyclicality (18 <sup>th</sup> and 19 <sup>th</sup> century) .....	29
1.3.1.1 Classical economics .....	29
1.3.1.2 Juglar business cycle.....	30
1.3.1.3 Marshall's model .....	33
1.3.2 The Great depression and procyclicality .....	34
1.3.2.1 Austrian business cycle theory.....	34
1.3.2.2 Keynesian perspective on business cycle .....	36
1.3.3 Business cycle theories in post-World War II period .....	37
1.3.3.1 Neoclassical model of capital accumulation .....	38
1.3.3.2 Lucas's equilibrium business cycle theory (EBCT) .....	39
1.3.3.3 Minsky's Financial Instability Hypothesis .....	40
1.3.3.4 Kydland-Prescott Real Business Cycle theory.....	42
1.3.4 Modern theories.....	43
1.3.4.1 Holmstrom-Tirole model .....	43
1.3.4.2 Bernanke, Gertler and Gilchrist (BGG) model .....	44
1.3.4.3 Kiyotaki-Moore model.....	46
1.4 Procyclicality debate post financial crisis of 2007-08.....	47
1.5 Review of empirical works performed in the area of procyclicality.....	49
1.5.1 Empirical work in procyclicality of the credit growth.....	50
1.5.2 Empirical work in procyclicality of credit risk.....	53
1.5.3 Empirical work in procyclicality of regulatory capital .....	59
1.6 Summary indicating the research gaps in analyses of the procyclicality of the financial system....	66
Chapter 2- The Model of Seemingly Unrelated Regression Equations (SURE) as an econometric environment for testing country heterogeneity of the banking sector's procyclicality .....	71
2.1 SURE Framework and estimation schemes.....	71
2.1.1. The SURE model .....	72

2.1.2 Empirical Analyses in a SURE Framework .....	75
2.2 Procyclicality analysis using a SURE model .....	78
2.3 Selection of EU-15 countries for analysis of procyclicality.....	82
2.4 Summary of databases and software.....	85
Chapter 3- Empirical importance of procyclicality of credit supply for banks in selected EU countries .....	87
3.1 Determinants of Loan Supply and Hypotheses development.....	87
3.1.1 Macroeconomic determinants of credit supply .....	89
3.1.2 Banking specific determinants of credit supply .....	90
3.2 Estimation Equations.....	92
3.3 Results and discussion.....	93
Chapter 4- Empirical importance of procyclicality of loan loss provisions for banks in selected EU countries.....	110
4.1 Determinants of Loan Loss Provisions.....	110
4.1.1 Macroeconomic determinants of Loan Loss Provisions.....	113
4.1.2 Banking Specific determinants of Loan Loss Provisions.....	114
4.2 Estimation Equations.....	115
4.3 Results and discussion.....	116
Chapter 5- Procyclicality of Capital Buffer for banks in EU Countries.....	132
5.1 Determinants of Capital Buffer .....	134
5.1.1 Macroeconomic determinants of capital buffer .....	135
5.1.2 Banking specific determinants of capital buffer .....	136
5.2 Estimation Equations.....	137
5.3 Results and discussion.....	138
Conclusions.....	154
REFERENCES .....	164
LIST OF TABLES .....	184
LIST OF FIGURES .....	186
Abstract (Polish) .....	187
Abstract (English) .....	190

## LIST OF ABBREVIATIONS

A-IRB	Advanced Internal Ratings-based
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
CLNRM	Classical Linear Normal Regression Model
DSGE	Dynamic Stochastic General Equilibrium
EAD	Exposure at Default
EBA	European Banking Authority
EBCT	Equilibrium Business Cycle Theory
ECB	European Central Bank
ECL	Expected Credit Loss
EEC	European Economic Community
EU	European Union
FCA	Financial Conduct Authority
FE	Fixed Effect
FIH	Financial Instability Hypothesis
F-IRB	Foundation Internal Ratings-based
FSF	Financial Stability Forum
GDP	Gross Domestic Product
GLS	Generalized Least Squares
IFRS	International Financial Reporting Standards

IMF	International Monetary Fund
LGD	Loss Given Default
LLP	Loan Loss Provisions
LLR	Loan Loss Reserves
NPL	Non-Performing Loans
OLS	Ordinary Least Squares
PD	Probability of Default
PIT	Point in Time
PRA	Prudential Regulation Authority
RBC	Real Business Cycle
ROE	Return on Equity
RWA	Risk Weighted Assets
SURE	Seemingly Unrelated Regression Equations
TTC	Through the Cycle

## Introduction

The global financial crisis of 2007-2008 had a significant impact on the world economy. Many countries were forced to bail out heavily indebted banks to prevent their banking systems from collapsing. European countries were hit particularly hard, as the crisis led the European Union (EU) into a sovereign debt crisis. Countries like Greece, Portugal, Spain, and Cyprus struggled to repay or refinance their debts. They requested assistance from other EU countries, the European Central Bank (ECB), and the International Monetary Fund (IMF) to mitigate the default. This raised global concerns about the procyclical nature of the banking industry. Consequently, there has been a renewed interest in the role of procyclicality in the credit markets, especially in the context of capital regulations.

Pro-cyclicality in banking refers to the mutually reinforcing feedback loops between the real economy and the financial system, which amplify fluctuations in business and financial cycles (Boehl et al., 2016). In periods of economic growth, banks tend to increase lending by either reducing net interest margin or loosening credit screening criteria. This increase in lending can eventually lead to a decline in the quality of credit as riskier borrowers gain access to loans. Conversely, during economic downturns, the demand for loans and the level of deposits typically decrease, reducing available credit (Caporale et al., 2013). The global financial crisis of 2007-2008 highlighted the complex but strong relationship between the financial sector and the real economy, demonstrating that credit markets played a crucial role in the downturn. Researchers and policymakers agree that financial cycles, mainly observed in the case of house prices or credit, are significantly longer than business cycles. This distinction is

critical, as the interaction between financial and business cycles can exacerbate economic recessions, especially when both cycles enter a contraction phase simultaneously. The crisis has spurred interest in macroprudential policies, emphasising the need to manage financial cycles differently from business cycles to maintain economic stability.

The debate around procyclicality has become more prominent in the periods following the financial crisis, but the issue itself has been recognised for a long time. The concept of procyclicality dates back to classical economics, particularly in the works of Thomas Malthus (1836) and Clément Juglar (1862). Juglar studied the fluctuations in prices, discount rates, and gold reserves of banks in France, England, and the USA, showing how these fluctuations aligned with cycles of increasing business activity, investments, and employment. He identified three distinct phases—prosperity, crisis, and liquidation—and explained how these phases sequentially follow one another.

Marshall was not satisfied with this explanation of economic fluctuations and proposed the quantity theory of money to account for them. In his research, Marshall (1887) observed that fluctuations in the price level, or "inflation rate", were caused by changes in supply and demand for money. These fluctuations, in turn, led to significant changes in the aggregate demand and supply of goods and services, which Marshall referred to as the "credit cycle" or "business cycle." Keynes further developed the business cycle concept, noting that every economy experiences periods of expansion and contraction, often resulting in widespread unemployment. These ups are known as "Peaks", which happen when the economy expands, while the downs are known as the "trough", which happens when the economy is contracting. These variations are known as business fluctuations.

By the early 20th century, research on business cycles and procyclicality had gained more prominence, especially after the Great Depression of the 1930s. Two leading schools of thought emerged during this time: the 'Austrian' theory and the 'Keynesian' theory. The 'Austrian' theory of business cycles was developed by several Austrian economists, most notably Ludwig von Mises and Friedrich Hayek, in the first half of the 20th century. This school of thought argued that recessions stemmed from the interference of monetary authorities in setting interest rates. During economic upturns, credit expansion supported by central banks could drive investment demand beyond society's long-term savings, creating a mismatch between the economy's productive capacity and consumers' intertemporal spending plans, eventually leading to a recession. The Austrian business cycle theory competed with Keynesian ideas during the 1920s and 1930s.

Keynes explained the concept of the business cycle as a pattern where every economy experiences periods of growth and decline in economic activity, sometimes leading to widespread unemployment. The growth phases are called "peaks," occurring during economic expansion, while the decline phases are referred to as "troughs," which happen when the economy is contracting. These variations are known as business fluctuations (Friedman, 1997). The traditional Keynesian business cycle model advocates for a countercyclical policy: implementing contractionary measures during economic booms and expansionary measures during recessions to stabilise output fluctuations.

The understanding of business cycles was further developed by Neoclassical economics through the works of Cass (1965), Koopmans (1965), Solow (1957), and Hicks (1965). In his seminal paper, Robert Solow (1957) argued that, along with capital per worker, technical change was a significant driver of variations in output per capita. Before Solow's theory,

factors influencing growth were believed to have only minor effects on economic fluctuations. The term "growth theory" was intentionally used to differentiate it from business cycle theory. The Solow residual represents the portion of an economy's output growth that the accumulation of capital and labour cannot explain, the primary factors of production. This concept later became the foundation for Kydland and Prescott's development of the Real Business Cycle (RBC) theory. Their model (1982) suggested that approximately 75% of the postwar economic fluctuations in the US could be attributed to technology shocks, extending the basic neoclassical growth model with exogenous productivity shocks to explain business cycles.

Robert Lucas proposed analysing business cycles as equilibrium phenomena, developing the equilibrium business cycle theory (EBCT), which is similar to the Austrian business cycle theory (Kyun, 1988). Minsky further elaborated on this idea in his Financial Instability Hypothesis (FIH), which describes how risks from debt can accumulate during periods of growth until they become excessive in an economy that otherwise seems stable. A key element of Minsky's theory is the procyclical, self-reinforcing feedback loop between the behaviour of individual economic actors and the overall state of the economic system (Wray, 2011). Modern theories that aim to explain the connections between economic growth patterns and credit cycles share three common features: they are based on optimisation, involve explicit microeconomic modelling of the behaviour of economic agents, and are formalised in structure. Seremak (2001) divides these modern approaches into two main groups. The first group of models focuses on the challenges in the loan market under conditions of asymmetric information and specific aspects of financial intermediation, with little emphasis on macroeconomic factors. A classic example of this approach is the Holmstrom-Tirole model (Holmstrom-Tirole, 1997). The

second group of models examines the correlations between economic variations and specific characteristics of credit markets. Typical examples of this second approach include the Bernanke, Gertler, and Gilchrist (BGG) Model (Bernanke et al., 1998), the Kiyotaki-Moore Model (Kiyotaki and Moore, 1997) and the Monetary Transmission Mechanism (Kashyap and Stein, 2000).

Banking is inherently a procyclical industry (Vanhoose, 2010). Its procyclicality can be seen in various critical aspects of the banking sector. Initially, our research aimed to concentrate on the procyclicality of credit risk measures. However, as our research investigation progressed, we recognized the need to broaden our focus to include other factors closely intertwined with the operations of the banking sector. Procyclicality in the financial system is primarily transmitted through two key mechanisms: credit supply and credit risk. Yet, within the framework of banking regulations and the ongoing discourse surrounding their influence on banks' regulatory capital, the procyclicality of capital requirements has emerged as a pivotal area of study. That is the reason why we focused not only on credit risk measures, but also examined other critical elements, such as credit supply and capital requirements, which play a fundamental role in shaping the dynamics of the banking system. By addressing these interconnected measures, we aim to provide a more comprehensive understanding of how procyclicality affects the banking sector and, by extension, the broader economy.

The cyclicity of business credit supply has been a major focus of research. A substantial body of empirical literature indicates that banks' credit supply tends to increase during economic booms and decrease during recessions (Vanhoose, 2010; Marcucci and Quagliariello, 2008; Ivashina and Scharfstein, 2010; Jimenez et al., 2011; Bebczuk et al., 2011). This pattern often leads to a decline in credit quality following periods of rapid loan growth (Caporale et al.,

2014), as banks may increase lending by either reducing net interest margin or relaxing credit screening criteria for new borrowers. Lowering screening criteria can result in lending to riskier borrowers previously deemed insufficiently creditworthy, increasing the likelihood of defaults, especially during adverse economic conditions.

In addition to exploring the relationship between credit growth and the business cycle, many researchers have investigated how the losses incurred by banks on credit can be linked to the economy, contributing to the procyclicality of loan loss provisioning. Loan loss provisions (LLP) are crucial for risk management in banks for several reasons. First, they contribute to loan loss reserves (LLR), which buffer against expected losses in a bank's loan portfolio. Maintaining these reserves at a prudent level helps protect the bank's capital from being eroded during periods of credit losses, which is particularly important during crises when non-performing loans (NPLs) increase. Additionally, these provisions impact profitability by affecting retained earnings and future capital (Skala, 2021). Second, LLPs are clearly disclosed in banks' income statements, unlike NPLs, providing transparency. This makes LLP a useful tool for signalling and conveying credit risk information that capital market participants can easily understand and interpret. Managers may use LLP to communicate private information to the market, particularly regarding the bank's future outlook and expected earnings (Bouvatier and Lepetit, 2008).

The core argument about the procyclicality of capital requirements for banks is well established. During a recession, banks face increased losses that deplete their capital, while at the same time, risk-based capital requirements, as stipulated by Basel II and Basel III, become more stringent. If banks cannot raise sufficient new capital, their lending capacity is constrained, which may exacerbate the recession by leading to a credit crunch (Repullo and

Suarez, 2013). Conversely, in an expansionary phase, lower losses allow banks to have additional lending capacity due to ample capital available, reinforcing the credit market's expansionary conditions. However, relaxing capital requirements to mitigate potential contractionary effects during recessions can be problematic because banks may already be dealing with high loan defaults. Additionally, the business cycle can affect capital buffers: if banks fail to accumulate sufficient capital during economic upswings, they may encounter inadequate capital levels during downturns. This situation could compel them to raise equity capital at a high cost or reduce their assets to meet regulatory minimum capital requirements (Repullo and Suarez, 2013; Borio and Zhu, 2012; Valencia and Bolanos, 2018).

The review of existing literature highlights that no reference variable describes the conjectured procyclical impact on the economy. Researchers have mostly considered credit supply (Goodhart and Segoviano, 2004; Kashyap and Stein, 2000; Altunbas et al., 2002; Hempell and Sorensen, 2010; Peek and Rosengren, 1995; Kishan and Opiella, 2000; Ivashina and Scharfstein, 2010; Jimenez et al., 2011; Bebczuk et al., 2011; Pipień and Anand, 2023) and loan loss provisions (Laeven and Majnoni, 2002; Bikker and Metzmakers, 2005; Bouvatier and Lepetit, 2012; Olszak and Pipień, 2016) for studying procyclical impact on the economy. We are using three variables- loan supply, loan loss provisions, and capital buffer- to examine the procyclicality in the banking sector of EU countries.

Based on the reviewed literature, it is evident that while procyclicality in the banking sector is frequently discussed, there is no definitive empirical support in favour or against procyclicality (Gambacorta and Mistrulli, 2004; Bikker and Metzmakers, 2005; Jiménez et al., 2011; Banerjee, 2011; Kelly et al, 2013, Imran and Nishat, 2013; Ibrahim, 2016; Albaity et al., 2020; Laeven and Majnoni 2003; Bikker and Metzmakers 2005; Bouvatier and Lepetit 2008)

The literature's analyses so far have focused on a particular country or a panel of countries modelled using panel regression techniques. Analyses of country heterogeneity of the procyclical effect seem omitted (with the exception of Olszak and Pipień, 2016; Pipień and Anand, 2023 ). Hence, we are using seemingly unrelated regression equations (SURE methodology). Omitting this approach in regression specifications could result in correlated disturbance terms across equations.

Based on the existing literature and the research gaps, the main objective of the thesis was defined as:

**Empirical analysis of the procyclicality in the Banking sector and cross-country heterogeneity with Seemingly Unrelated Regression Equation system for selected European Union countries**

With the main objective as stated above, the following detailed objectives were established:

O1: Presentation and discussion of main ideas of Procyclicality and conceptual relationship with the banking sector

O2: Empirical verification of the procyclicality hypothesis of loan supply for the banking sector and its heterogeneity across the analysed EU countries

O3: Empirical verification of the procyclicality hypothesis of loan loss provisions for the banking sector and its heterogeneity across the analysed EU countries

O4: Empirical verification of the procyclicality hypothesis of capital buffers for the banking sector and its heterogeneity across the analysed EU countries

O5: Application of the Seemingly Unrelated Regression Equations (SURE) methodology for procyclicality analysis

**The main goal of the doctoral dissertation is to examine the procyclicality of the banking sector across three dimensions: loan supply, loan loss provisions, and capital buffer.**

The following are the main hypotheses of the dissertation:

H1: Loan supply of banks is procyclical.

H2: Banks hold lower loan loss provisions following higher economic growth.

H3: Capital requirements for banks, as mandated by banking regulators, create procyclical effects.

H4: The Seemingly Unrelated Regression Equations (SURE) model is an empirically important generalisation of the panel regression in procyclicality analysis.

Based on the research hypotheses and objectives, the Seemingly Unrelated Regression Equations (SURE) model is central to the analyses presented in this dissertation. The primary advantage of using the SURE model (and the Zellner (1962) estimator) in testing the procyclicality hypothesis is its ability to capture parameter variability across the objects analysed, such as different countries considered jointly. In contrast, panel regression methods, commonly used by many cited authors, assume that parameters remain constant across all entities. This approach compels researchers to treat the procyclicality effect as a uniform phenomenon, without accounting for country-specific differences. The SURE model, on the other hand, allows for the inclusion of cross-country variations and enables formal

comparisons of various hypotheses, with the procyclicality of the banking sector being a key focus. The results obtained from this model setup demonstrate the heterogeneity of the procyclicality hypothesis across EU countries. This thesis examines four scenarios: a novel approach that treats the group of countries as a single entity with correlated error terms (M1, Zellner estimator), and a more traditional approach where countries are analysed individually (M0, OLS estimator).

It is important to highlight why the European Union (EU) countries are particularly suitable for testing procyclicality and the related hypotheses using the SURE model. Selecting an appropriate sample for empirical analysis is crucial to ensure the results are both interpretable and applicable. For analysing the procyclicality of bank credit supply, choosing a group of countries based on rational justification and sampling criteria is essential.

The European Union, comprising 27 member countries that span much of the European continent, presents a unique case. The global financial crisis of 2007-2008 significantly affected developed economies, including those within the EU, leading to widespread bank failures and the near-collapse of financial systems. In response to the deepening Greek financial crisis in 2012, which threatened the fiscal sustainability of EU member countries, the European Banking Authority (EBA) was established. The EBA was created to address systemic issues in European banks and to develop a unified regulatory and supervisory framework for the entire EU banking sector. It contributes to creating a standardised set of banking rules across the EU and fosters cooperation among national authorities overseeing banking groups operating in multiple countries. While Europe has made significant strides in economic and banking integration, the EU remains a diverse group with member countries at varying stages of development. These countries differ in economic growth, domestic banking industries, and

national banking supervision, making the EU an ideal setting for studying procyclicality in banking.

The dissertation is theoretical-empirical in nature. It is structured in five chapters, with an introduction and conclusion.

Chapter 1 deals with the theoretical aspects of the business cycles that derived the concept of procyclicality. The covered topics include origin and progress of the procyclicality concept. It also provides an extensive literature review of studies around the procyclicality and empirical works performed related to procyclicality in the banking sector.

Chapter 2 presents the empirical model used for procyclicality testing. It deals with the assumptions of Seemingly Unrelated Regression Equations (SURE) and methods of estimation. Later, it shows how the procyclicality hypothesis can be verified within this framework.

Chapters 3, 4 and 5 provide an empirical analysis of the procyclicality of credit supply, loan loss provisions and capital buffers for banks in EU countries. They explain the determinants of credit supply, loan loss provisions for banks and capital buffers for banks respectively- including macroeconomic and bank-specific variables. They also provide empirical results with and without the SURE model.

The summary of the thesis is last and concludes with final remarks.

## Chapter-1 The procyclical nature of the banking sector activity - a review of the main research streams

The procyclicality of financial systems has received increasing attention from policymakers, researchers, and regulators in recent years. It implies feedback loops between the real economy and the financial system, in a way mutually amplifying business and financial cycle fluctuations. Real economic developments (business cycle) can be measured using alternative indicators (Boehl et al., 2016). A large empirical literature shows that the growth rate of loans tends to be positive during economic booms and negative during recessions. Consequently, periods of fast loan growth are followed by a decline in credit quality (Caporale et al., 2013). Banks can increase lending supply in two ways- either by reducing net interest margin or by loosening lending terms and criteria for new borrowers. In the case of loosening lending terms and criteria, there could be more potential borrowers who had earlier declined due to insufficient creditworthiness. Such borrowers are riskier and have a higher probability of default in case of any adverse scenarios like an economic slowdown. Understanding business cycles and their associations with the banking system activity remains a primary challenge for researchers and economists after the global financial crisis of 2007-08.

Banking is naturally a procyclical industry (Vanhoose, 2010); however, prior to the global financial crisis, in the mainstream literature, it played only a side role as a sector needed for financial intermediation. During the expansion period, people have more ability to save, which increases the deposits held by them at banks. In addition, during this period, both consumers and entrepreneurs tend to increase their spending, which results in an increase in overall demand for loans and credit from banks. Banks have the ability to supply additional credit due

to an increase in deposits, and by supplying additional credit, banks boost their profits. On the contrary, during the recession, people in general withdraw their funds in order to support themselves during hard periods, which results in a decrease in deposits held by banks, thereby decreasing the overall supply of loans in the economy. The demand for loans in the economy also moves downwards during recession due to excess unemployment, decrease in consumption and investment activities. Thus, it is expected that aggregate levels of loans supplied by banks should typically move up during expansion periods and go down during recession periods.

In this chapter we describe the significance of procyclicality especially in the era of the post global financial crisis. We also review theoretical background of procyclicality and corresponding schools of economic thought regarding its evolution. Finally, we review existing empirical literature on procyclicality of credit supply, credit risk and regulatory capital.

## 1.1 Importance of procyclicality of the banking sector after the global financial crisis

Since the beginning of the global financial crisis in 2007-08, there has been a renewed interest in the linkage of financial markets and real economy as well as its implications towards the design of monetary and fiscal policies. Researchers and policymakers widely agree that credit markets seem to have played a significant role in the events leading to severe global recession of 2007-08. In its Global Financial Stability report, IMF (2010) argues that losses incurred by banks caused a contraction in credit supply which in turn contributed to the economic downturn in the United States and beyond. The recession was clear evidence that the relationship between financial sector and real economy has not been well understood and has not been properly incorporated in macroeconomic models (Gambetti and Musso, 2012). It is

also important to understand the relative role of supply and demand forces in driving credit and output as these factors may call for different responses of monetary and fiscal policy (Fourie et al., 2011). The global financial crisis has increased the concern over pro-cyclicality of banks' risk-based capital requirements (Jokivuolle et al., 2015). As risk-based capital requirements rise in recession, they make banks more capital constrained than constant capital requirements. As a result, banks may be forced to cut back lending more strongly. This could potentially aggravate the recession (Kashyap and Stein, 2004).

Empirical view on the procyclicality refers to the tendency of financial variables to fluctuate around a trend during the economic cycle (Landau, 2009). A variable is procyclical if its deviations from trend are positively correlated with deviations from trend in macroeconomic variables e.g., GDP. On the other hand, a variable is countercyclical if its deviations from trend are negatively correlated with deviations from trend in GDP. Variables which are neither procyclical nor countercyclical are called acyclical. Financial systems are complex systems and are based on interdependence between multiple units and counterparties where transmissions occur through various networks impacted by financial innovations and regulations. The question arises whether procyclicality should be avoided. Landau (2009) argues that procyclicality is not necessarily bad. He mentions that 'Intrinsic procyclicality' which is created inside and by the financial system is a concern while cyclicality in the real economy can be beneficial for long term growth. The global financial crisis of 2007-08 highlighted the vulnerability of the financial system and its ability to generate economic instability through endogenous credit booms (Bernstein et al., 2016).

The rapid, uncontrolled liberalization and deregulation of the financial sector preceding the financial crisis consequently necessitated a range of initiatives relating to regulatory,

macroprudential and accounting principles in order to mitigate systemic risk in the financial system (Schularick and Taylor, 2012). The Basel III framework, introduced in 2010, intended to improve the quality and quantity of bank capital, enhance liquidity and leverage ratios, broaden risk coverage and make financial systems' stress testing approaches more robust (Bernstein et al., 2016).

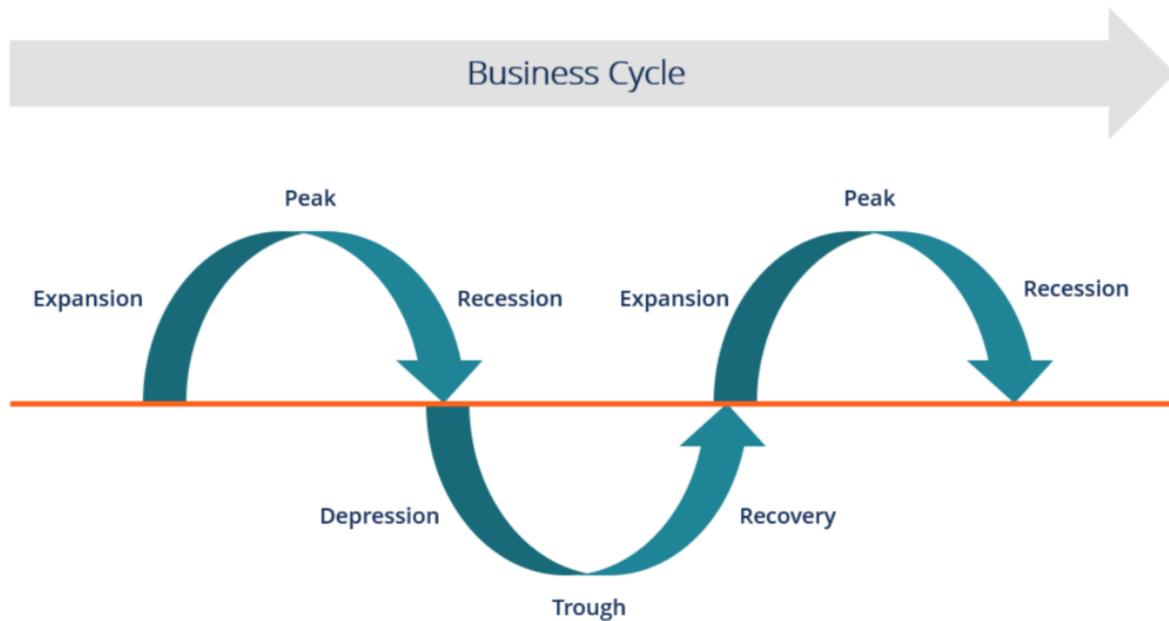
## 1.2 Financial cycle as a revival of research on fluctuations of the activity of economic units

Until the late 1990s, the only "cycle" people would talk about in macroeconomics was the business cycle. The notion refers to those ups and downs in production that drive employment and incomes (Borio, 2019). However, the concept of financial cycle and its usage by researchers and policy makers has seen a meteoric rise since global financial crisis of 2007-08. The global financial crisis resulted in recessions in advanced and emerging economies. A common characteristic of these recessions was that they had been accompanied by various types of financial disruptions, including contractions in the supply of credit and sharp decline in asset prices (Claessens et al, 2011). These events led to an intensive debate regarding the links between economy and finance, which propelled the study of interactions between business cycle and financial cycles to the forefront of research.

Business cycle describes fluctuations in economy, the rise and fall in production output of goods, services and economy. This applies to many areas of the economy, and sometimes the impact can be both short (year) and long (10-12 years) term, whereby it is not periodic, but recurrent (Burns

1946). This phenomenon can be shown on a graph, where it takes the form of repetitive waves, as shown in figure 1.

Figure 1: Different Phases of Business Cycle



Source- [corporatefinanceinstitute.com](http://corporatefinanceinstitute.com)

As shown in figure-1, there are six distinct stages of a business cycle:

1. Expansion – the stage of economic growth; lower unemployment, more investment and employment but also higher prices
2. Peak – maximum level of economic growth, economic indicators stop for a moment
3. Recession – prices are falling, the economy is starting to recede, unemployment is rising
4. Depression – continued deterioration of the economic situation, the number of bankruptcies is increasing
5. Trough – the climax of the economic crisis, marks the beginning of the next stage

6. Recovery – end of the economic cycle, the economy is slowly recovering, demand and economic activity are increasing

In practice, peak and trough are used to determine cyclicity, which allocate a given period to one of two categories: expansion (between a trough and a peak) and recession (between a peak and a trough). This position was initially adopted by the NBER (National Bureau of Economic Research), an American research organization in the United States that deals with economic analysis and determining time horizons for business cycles. Claessens et al. (2011) argue that a complete business cycle has two phases- the recession phase (from peak to trough) and the expansion phase (from trough to the next peak). In addition, there is a recovery phase, which is the early part of the expansion phase, and is usually defined as the time it takes output to return from its low point to the level it reached just before the decline began. Decline phase is the late part of the recession phase.

However, determining time horizons for cycles was complicated by issues with the number of periods analyzed. It often varied depending on the length of time for which cyclical curves or long-term trends were applied, as well as the choice of functions used for these curves (Bry and Boschan, 1971). Researchers continue to discuss not only the task of identifying turning points but also the challenge of selecting the analytical approach to business cycles, whether the classical approach or the growth cycle approach.

The first issue of empirical business cycle analysis is searching for turning points that will allow to markup recession or expansion periods. The algorithms created to help in this task are divided into the following two groups (Mazzi and Scocco, 2003)

- Non-parametric methods - consist of extracting a signal from a time series by using a weighted moving average on its observations. They have their origin in NBER, which also

defined the problem of business cycle analysis as finding turning points. The most well-known algorithm using the non-parametric method is the Bry-Boschan algorithm.

- Parametric methods - consist of creating a statistical model, estimating its parameters and applying the extracting signal algorithm. This category includes the Markov Switching model.

The second issue to be resolved when analyzing the business cycle is to determine the form of the variable we study. Depending on which form is chosen, it can affect the turning points position in the series. The two approaches- classical and growth approaches, have emerged significantly in the literature on cyclicity (Mazzi and Scocco, 2003).

- Classical approach – comes from the following definition of Burns and Mitchell (1946)

*'Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.'* (Burns and Mitchell, 1946)

According to Burns and Mitchell (1946) definition, the classical approach to business cycle analysis uses certain macroeconomic variables to determine the course of the cycle. In order to eliminate irregular components, they are subjected to seasonal adjustment, using smoothing methods such as moving average or logarithm. Only in such a transformed form the turning points items are calculated.

- Growth cycle view – an approach also based on the definition of Burns and Mitchell, but recognizing the use of macroeconomic variables alone as insufficient for correct analysis in the event of the rare occurrence of one of the phases of the cycle.

Growth cycle view uses its deviation from trend instead of the variable itself. This has the following effects: peaks tend to lead the corresponding peaks in the classical cycles, cycles are more symmetric in duration and amplitude and have strong connection with inflationary cycles. The above-mentioned measure, deviation from trend, requires first extracting the long-term trend, which can be obtained by detrending. This method is used, among others through the following filters: Baxter-King (1995), Hodrick-Prescott (1997) and Christiano-Fitzgerald (1999).

In practice, there is no imposed algorithm for usage, however, the majority of institutions dealing with business cycle analysis use Bry-Boschan algorithm in order to search for turning points. Greater diversity prevails within the form of the examined variable, where one cannot say about the dominance of any of the methods, and there are also cases of mixing both methods by e.g., using detrending on created economic indices that do not represent a deviation from the trend.

Instability of the financial system during the financial crisis of 2007-08 generated lot of interest among researchers and policymakers to study distinction as well as interaction between business cycle and the financial cycle. Policymakers developed macroprudential approaches to banking supervision and regulation and one of the foundations of the new macroprudential policy is that financial cycles differ from business cycles (Runstler, 2016). Drehmann et al. (2012) show that house price and credit cycles are considerably longer than business cycles. While the length of business cycles is usually assumed to be between two and eight years, they find that financial cycles range from 8 to even more that 20 years. They conclude that business cycle and financial cycle are distinct phenomena and business cycle recessions are much deeper when they coincide with the contraction phase of the financial cycle.

Claessens et al. (2011) show that occurrence of turning points is more often in GDP series than in house prices and credit volumes, but major recessions still coincide with troughs in the financial series. Runstler and Vlekke (2016) analyze the cyclical components in credit volumes, house prices and GDP of USA and five major European economies (France, Germany, Italy, Spain and the United Kingdom). They find that there are important differences in the length and size of financial cycles across these countries, however financial cycles are longer than GDP cycles in most of the countries. Yan and Huang (2020) study the relationship between financial cycle and business cycle in time and frequency domain and show that the business cycle is closely related to the financial cycle, especially at medium-term frequencies (8–30 years). Hiebert et al. (2018) empirically analyse financial and business cycles of 13 European Union countries and observe that financial cycles have larger amplitude, are longer and more symmetric than business cycles.

There is no consensus about the formal definition of a financial cycle as shown in table 1. Authors tend to describe it in a narrative way, relying mostly on the reader’s intuition.

Table 1: Definition of the financial cycle

Author	Definition
Ng (2011)	The financial cycle refers to fluctuations in perceptions and attitudes about financial risk over time. It is often marked by swings in credit growth, asset prices, terms of access to external funding, and other financial developments
Borio (2012)	The self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts. These interactions can

	amplify economic fluctuations and possibly lead to serious financial distress and economic dislocations.
ECB Economic Bulletin (2017)	The financial cycle can be thought of as economic fluctuations that are amplified by – or stem directly from – the financial system. It typically manifests itself as a co-movement between credit aggregates and asset prices with a possible impact on real economic developments as well.
Filardo et al. (2019)	Financial cycles are a type of fluctuation found in aggregate financial conditions of the nations that organize their intermediation in the financial markets and the financial intermediaries such as banks.

While there is no single definition of the financial cycle, the term reflects how interactions between economic and financial variables coupled with the financing and credit conditions in the economy, result in generating cycles of peak and low in the main financial variables (Garcia-Arenas, 2020).

Borio (2012) describes four features to reflect relationship of financial cycle with business cycle-

- i) Credit and property prices appear to be the most parsimonious way to capture linkages between financial cycle, business cycle and financial crises.
- ii) Financial cycles have much lower frequency than traditional business cycles.
- iii) Peaks of financial cycle are closely associated with systematic banking crises or financial crises.
- iv) Financial cycle helps detect financial distress risks with good accuracy

There is also a distinction made between domestic financial cycle and global financial cycle, referred by Borio (2019) as a tale of two cycles. The domestic financial cycle is characterised by the evolution of credit and housing prices whereas the global cycle refers to the financial factors that are generated in the world's major financial hubs - mainly the US - and how these are transmitted to the rest of the world through capital flows and financial asset prices. Borio (2019) identifies two key differences between domestic and global financial cycles.

First is in terms of geography, the domestic financial cycle describes conditions in individual countries whereas global financial cycle denotes cross-border co-movements mainly driven by large economies of the world. The second difference is in terms of duration - domestic financial cycles are longer than global financial cycles. The global financial cycle has important implications for economic policy. Traditionally, policymakers supported the view that independent domestic monetary policies could only be achieved, in the presence of perfectly mobile capital, with flexible exchange rates (the renowned trilemma, or impossible trinity, of international macroeconomics). However, the existence of a global financial cycle has disrupted this traditional view: the financial conditions of the main global financial hubs are transmitted to the macrofinancial conditions of all other countries, such that domestic monetary policy cannot be fully independent, even if the exchange rate is flexible (Garcia-Arenas, 2020).

In discussions of bank lending activity, the notion of cycles in lending standards typically begins with expansion; standards fall with heightening competition in expansions and rise in contractions as banking respond to their own capital shortfalls or constraints of regulators (Weinberg, 1995). Significant shifts in financial variables are frequently linked to substantial volatility in economic activity (Bliss and Kaufman, 2003). An episode is identified as a financial

disruption if the decline in available credit during a downturn falls within the bottom quartile of all observed changes. Such disruptions are referred to as either credit crunches or credit busts. Conversely, if the increase in available credit during an upturn is in the top quartile, the episode is classified as a credit boom. (Bliss and Kaufman, 2003).

### 1.3 The economic insight into procyclicality processes - theories and conceptual framework

The concept of 'cyclicality' has existed in economic literature for many decades. The theoretical considerations of the economic cycle have its roots in the mid-19<sup>th</sup> century. Juglar (1857) is considered to be the founding father of business cycle theory by some of the economists, most notably Joseph Schumpeter. Schumpeter (1954) recognized that some of the topics related to business cycle were touched upon by other writers before Juglar, but he described Juglar as the discoverer of the continent while his predecessors had only hit on some of the islands near it. Juglar(1862) identified three phases: prosperity, crisis, and liquidation, and discussed how they succeed with each other.

As the business cycle affects the entire economy, the amount of money circulating becomes a key factor in driving these cycles. Banking is closely connected to this process, as people hold most of their money in banks or similar financial institutions, making banks essential to understanding business and financial cycles. Banks were assumed to play a secondary role to a large extent in economic theories gradually moving to a central role in implementation of both monetary and fiscal policies. However, the global financial crisis has regenerated debate regarding pivotal role of banking in financial cycle. As a result, it becomes significant to understand the theory of procyclicality on the premise of evolution of role of banking in the economy.

In this section we look at theories and concepts of procyclicality and its evolution over the period. The theories regarding business cycle and its evolution have been categorized in three time periods - first period when the concept of business cycle originated in 19<sup>th</sup> century, second period between two world wars when there were major changes in economic theories driven by Keynes and Austrian business school, and lastly, we look at some of the modern theories on procyclicality with demarcation being made between business cycle and financial cycle coinciding with a pivotal role played by banks.

### 1.3.1 Early origins of procyclicality (18<sup>th</sup> and 19<sup>th</sup> century)

In the works of pre-Keynesian economists, examination of money and credit was predominant. Although the phenomenon of business cycles was recognized in the 19<sup>th</sup> century, it did not get much prominence from the classical economists (Kyun, 1988). Two noteworthy approaches to business cycle in this period include the Juglar cycle theory and Marshall's Model.

#### 1.3.1.1 Classical economics

Adam Smith in his work '*The Wealth of Nations*' (1776), emphasized upon the ability of the economy to produce an expanding supply of goods and services capable of enhancing living standards for all classes in society. However, he and other contemporary writers of 18<sup>th</sup> century did not develop any systematic theory about business cycle. Classical economists, including prominent figures like Adam Smith, Thomas Malthus, David Ricardo, and John Stuart Mill, shared many core beliefs about the economy, markets, and economic theory. They all agreed that labor is the primary source of all value and wealth. However, while Smith held an optimistic view of humanity's long-term prospects, Malthus, Ricardo, and Mill were more pessimistic in their outlook. (Schafer, 2008). Malthus in his famous book '*Essay on the Principle of*

Population' (1798) wrote about potential destructive changes resulting from population expansion, leading to more and more pressure exerted on land and existing resources. It also helps to explain why Thomas Carlyle (1849) called Economics "the dismal science" after reading Malthus's essay.

Malthus (1836), in an attempt to explain post-Napoleonic depression, developed an 'underconsumption theory' of crisis. He observed that there was an underconsumption of commodities in the postwar period, which would lead to a fall in prices and profits, which would undermine the country's wealth.

Commodities would be everywhere cheap. Capital would be seeking employment but would not easily find it; and the profits of stock would be low. There would be no pressing and immediate demand for capital, because there would be no pressing and immediate demand for commodities. (Malthus, 1836, p. 415)

While most of the other classical economists dismissed this possibility, because they believed that "supply creates its own demand" according to the law propounded by the French economist Jean-Baptiste Say (1803), it was clear that Malthus had pinpointed a very serious problem in the functioning of economic systems and markets. Say's law of markets means that production cannot outrun demand, since demand depends on purchasing power, which in turn depends on production. Therefore, depressions are at most transitory phenomena during which an economy moves from one equilibrium to another, and production is redirected toward more profitable areas.

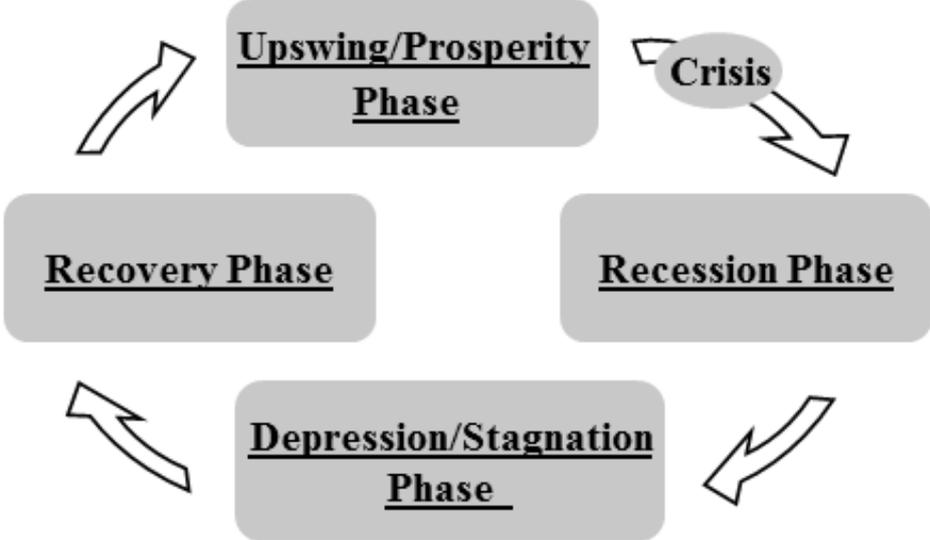
#### 1.3.1.2 Juglar business cycle

Primarily economists did not realize that crises and gluts were phases of a longer process – the business cycle. The most distinguished work in this context was Clément Juglar's *Des crises commerciales et de leur retour periodique* (1862), where he developed a method of business

cycle analysis. Juglar is often credited with having marked the definite transition from the theories of crises to the theories of business cycles. Juglar investigated fluctuations of prices, discount rates and gold reserves of banks in France, England, and the USA and showed their correlation with cycles of increasing business activity, investments (and speculations), and employment (Grinin and Korotayev, 2018).

Juglar identified three phases: prosperity, crisis, and liquidation, and discussed how they succeeded with each other. The presentation, as well as the cycle itself, is asymmetric. The focus is on crises: their origin, their nature, their outbreak, their liquidation (Besomi, 2009).

Figure 2: The Model of a Juglar Cycle



Source: Grinin and Korotayev, 2018

According to Grinin and Korotayev (2018), Juglar cycle consists of four phases-

- recovery phase (which we could subdivide into the start sub-phase and the acceleration sub-phase);
- upswing/prosperity/expansion phase (which we subdivide into the growth sub-phase and the boom/overheating sub-phase);

- recession phase (within which we single out the crash/bust/acute crisis sub-phase and the downswing sub-phase);
- depression/stagnation phase (which we could subdivide into the stabilization sub-phase and the breakthrough sub-phase).

Juglar found that the fundamental nature of crises lies in the successive phases of a recurring movement. Thus, the problem is not one of crises but one of the phases of cycles. That is, the causes of depression cannot be analysed separately from the causes of prosperity, and both depression and prosperity may be caused by the same fundamental forces working within the economic system. In his own words, "The only cause of depression is prosperity" (Schumpeter, 1954, p. 1124).

Schumpeter made a significant contribution to business cycle theory. It was Schumpeter who named short, intermediate and long-term business cycles Kitchin, Juglar and Kondratieff cycles respectively, after the economists who first identified them. In order to account for cycles that can be observed historically and statistically from the late 1700s onwards, Schumpeter distinguishes three types of cycles: long waves of about fifty years in duration (Kondratieffs); intermediate waves of about nine to ten years in duration (Juglars); and short waves of about forty months in duration (Kitchins).

An interesting exogenous explanation was the famous sun-spot theory of Jevons (1884). Investigating the records of English trade from 1721 to 1878, Jevons found sixteen crises with an average interval of 10.466 years, which corresponded almost exactly to the periodicity of the sun-spot cycles - 10.45 years (Kyun, 1988).

### 1.3.1.3 Marshall's model

Alfred Marshall was one of the economists that had a great influence on economic thought, in addition, he was one of the main founders of the Neo-Classical school of thought. He was largely influenced by prominent classical economists, but he focused on the human behaviour in functioning of market economy.

Marshall (1887) cited the degree of confidence or what he called 'the influence of business confidence' as the main cause of business cycles. He considered that an upswing in the economy is achieved when the credits are largely grown due to high degree of confidence and on the other hand, a downswing in the economy is reached when there is a contraction in the credits due to lack of confidence. Marshall's model is based on psychology. Fluctuations in economic activity and changes in bank lending behavior are driven by psychology. Marshall argued that, to avoid the fluctuations of the business cycle, the economy should not reach its peak through excessive credit expansion. Once a peak is reached, the economy will go through a period of contraction, eventually hitting a trough that could lead to a prolonged depression before the cycle of expansion and peak repeats.

However, Marshall was not convinced with this explanation of fluctuations in the economy and presented the quantity theory of money to explain this fluctuation. In this theory he saw that both the supply of money and the demand of money create fluctuations in the price level "inflation rate" that in turn cause serious fluctuations in the aggregate demand and supply of goods and services that Marshall called "the credit cycle" or what is known as "the business cycle" (Laidler, 2003). According to Marshall theory, economic fluctuations happen when the economy is in the expansion stage where the demand and the supply of money increase causing the prices to increase, and the profits made by "the money borrowers" to increase. This expansion will continue until the lenders begin to be unconfident of the ability of the

borrowers to repay the money; in this case the lenders will refuse to give any more credits or “tight the credits” this in turn will cause some businessmen to resell their products and a collapse of prices will occur in a series of panic actions that derive the economy to the stage of recession (Laidler, 2003).

### 1.3.2 The Great depression and procyclicality

In the early 20th century, business cycle research began to grow. The main concern of business cycle analysis changed from a single crisis to the cycle as a whole and its interconnection between its various phases. This was when a seeming contradiction between classical theory and the cycle phenomenon began to be recognised, and efforts were initiated to incorporate the business cycle into classical equilibrium economics. There were two competing schools of thought which were popular. On one side was the Austrian School of Economics, led by Ludwig Von Mises and Friedrich Hayek, and on the other side was John Maynard Keynes, widely considered the father of Macroeconomics.

#### 1.3.2.1 Austrian business cycle theory

The ‘Austrian’ theory of business cycle was developed in first half of 20th century by a number of Austrian economists, most notably Ludwig von Moses and Friedrich Hayek. This school of economic thought claimed that the origin of recessions lay in the interference of monetary authorities in the setting of interest rates. During upturns, credit created with the support of central bank would propel the investment demand beyond society’s long-term willingness to save, thus generating a mismatch between the economy’s productive capacity and consumers’ intertemporal spending plans leading eventually to recession (Oppers, 2002). The

theory also argued that expansionary policies during recession could only postpone the necessary structural adjustment.

In the exchange economy, production is governed by prices, independently of any knowledge of the whole process on the part of individual producers, so that it is only when the pricing process is itself disturbed that a misdirection of production can occur. Hayek (1933).

In this sense, cyclical fluctuations are nothing but an inevitable consequence of the individual's misled equilibrating process, caused by a monetary disturbance and by the individual's limited ability to observe such monetary aggregates accurately.

Recognizing that conventional equilibrium theory was essentially static, Hayek (1928) developed the concept of intertemporal equilibrium. Individuals' planning horizons are assumed finite, and expectations during this period are perfect in the sense that the outcome of the resource allocation among individuals during the period is consistent with the decision made at the beginning of the period. In this case - perfect foresight within a period - the role of the price mechanism is basically the same as that in a static equilibrium system.

The ideas of Austrian business cycle theory and those of Keynes competed in the 1920s and 1930s, before the Austrian school theory was eventually rejected in the post-war "Great Keynesian Consensus". In 1967, John Hicks (1904-1989) summarized the consensus opinion of the profession:

*When the definitive history of economic analysis during the nineteen thirties comes to be written, a leading character in the drama (it was quite a drama) will be Professor Hayek. . . . Hayek's economic writings . . . are almost unknown to the modern student; it is hardly remembered that there was a time when the new theories of Hayek were the principal rival of the new theories of Keynes. Which was right, Keynes or Hayek?*

### 1.3.2.2 Keynesian perspective on business cycle

In his book *The General Theory of Employment, Interest and Money*, British economist John Maynard Keynes (1936) introduced concepts that were intended to help explain the Great Depression. Unlike the classical and neoclassical school which believed that a free market would adjust itself in the short and medium run, and that supply created its own demand, Keynes argues that government intervention was necessary. He said that full employment can be achieved by attaining a sufficient level of aggregate demand using an expansionary monetary and fiscal policy.

Keynes explained the concept of business cycle where each economy in the world has “ups” and “downs” in economic activity involving occasional periods of widespread unemployment. These “ups” are known as “Peaks” which happens when the economy expand while the “downs” are known as the “trough” which happens when the economy is contracting. These are called business fluctuations (Friedman, 1997). The traditional Keynesian model of the business cycle calls for a countercyclical policy that is contractionary during the period of economic acceleration and expansionary during the time of recession to stabilize output fluctuations. Keynes argued that there are reasons that the self-correcting mechanisms that many economists claimed should work during a downturn might not work. He argued that there are multiple possible equilibrium points and it’s possible for the economy to become stuck around one of these undesirable points. He suggested that as a result of the crash, the economy had become stuck around one of these undesirable points. Keynes proposed three types of propensities to understand business cycles- propensity to save, propensity to consume, and propensity of marginal efficiency of capital. He also developed a concept of multiplier that represents changes in income level produced by the changes in investment.

Keynes view was that shocks to the marginal efficiency of capital are of primary importance in generating cycles (Dejong et al., 2000).

Importantly, Keynes strongly believed in government intervention to restore and maintain natural equilibrium. The economy could be restored to its usual cycle around the usual equilibrium if it were given a push. Aggregate demand can't accelerate the economy when it's stuck around an undesirable equilibrium point. Keynes contended that aggregate demand needed a boost. If the government increased spending, that extra demand added to the economy, if big enough, could pump enough life into the economy to restore it to its former healthy state.

### 1.3.3 Business cycle theories in post-World War II period

The 1960s were a time of great optimism for macroeconomists. The Keynesian model was the reigning paradigm, and it facilitated all necessary levers for manipulating monetary and fiscal policy to impact aggregate demand (Plosser, 1989). For many economists very stable growth of the American economy in 1950's and 1960's seemed to confirm positive influence of effective fiscal and monetary policy toward keeping the pace close to equilibrium. However, oil peak in 70's and other external shocks, resulting with high rates of inflation exposed the flaw in Keynesian framework. The absence of consistent foundation based on the theory of choice elaborated for microeconomic units was the fundamental problem of the Keynesian paradigm. Two seminal papers by Friedman (1968) and Lucas (1976) illustrated this flaw and paved the way for modern macroeconomics. In the late 1970s and early 1980s, there were also developments in studying financial crises as a separate line of enquiry (Kindleberger, 1978; Minsky, 1982; Sinai, 1976), not integrated with the leading mainstream economic analyses, mainly related to business cycles (Sinai, 1992). According to Banerjee (2011), of all

the popularized post-Keynesian analysis of financial crises, Minsky's theory of financial instability of capitalist economy ranks among the best in terms of contribution to economic theory.

#### 1.3.3.1 Neoclassical model of capital accumulation

Neoclassical model seems the most basic environment to study economic dynamics. The frameworks for this model were propagated by works of Cass (1965), Koopmans (1965), Solow (1957) and Hicks (1965). A simple economic environment to consider is an economy populated by many identical agents (households) that live forever. The utility of each agent is some function of the consumption and leisure they expect to enjoy over their (infinite) lifetime. The choices each consumer must make are how to allocate their hours between work and leisure, and how to allocate their supply of the single good between investment in future capital and current consumption.

In his seminal paper, Robert Solow (1957) argued that, beyond the accumulation of capital per worker, technological change is a major driver of variations in output per capita. Solow's theory challenged previous assumptions that factors influencing economic growth had only secondary effects on economic fluctuations. By coining the term "growth theory," Solow deliberately sought to differentiate it from business cycle theory, emphasizing that growth drivers and cyclical fluctuations could be analyzed separately.

A key contribution of Solow's work was the concept of the *Solow residual*, which represents the portion of an economy's output growth that cannot be attributed to the accumulation of capital and labor alone, and is instead due to improvements in technology and efficiency. This residual quantified the impact of technological progress and set the stage for understanding

productivity's role in economic expansion. The Solow residual later became a foundational element for the development of real business cycle (RBC) theory.

Kydland and Prescott (1982) built on Solow's framework in their RBC model, proposing that fluctuations in the business cycle could be largely explained by exogenous technology shocks, an extension of the classical growth model. Their analysis suggested that approximately 75% of postwar U.S. economic fluctuations were due to technology shocks, underscoring the role of productivity changes as a primary source of cyclical variation in output (Paquet and Robidoux, 1997). By integrating productivity shocks into the neo-classical model, Kydland and Prescott provided a new perspective on business cycles, suggesting that these fluctuations could be seen as natural responses to technological advancements rather than deviations from steady growth.

Hicks provided an explanation of trade cycle theory in his book 'A Contribution to the Theory of the Trade Cycle' (1950) by combining multiplier with accelerator theory of investment, which is also assumed to provide basis for real business cycle theory.

#### 1.3.3.2 Lucas's equilibrium business cycle theory (EBCT)

Robert Lucas proposed to analyze business cycle as an equilibrium phenomenon, developing an equilibrium business cycle theory (EBCT). Lucas's EBCT theory is founded upon two "classical" premises: (a) markets clear at all times, and (b) agents act in their own self-interest. In addition, he added two additional factors for his business cycle theory- first, agents are expected to be rational and second, information is imperfect. It has often been claimed that Austrian cycle theory shares some important similarities with the EBCT (Kyun, 1988). Lucas (1980) argues that Hayek's theory of cycles is an intellectual precursor of the EBCT and that

the EBCT has resumed the interwar-period tradition of the equilibrium approach to business cycles, which was superseded by the Keynesian revolution.

Lucas perceived that there was a big problem in macroeconomics. Models that didn't allow human beings to adjust their behavior couldn't be used for policy, because if you tried to use them, people would alter their behavior until the models no longer worked. This is known as the "Lucas Critique". Lucas said the solution was to explicitly model the behavior of human beings, and to only use macro models that took this behavior into account:

Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models. (Lucas, 1976)

Lucas added that one of the main reasons for existence of fluctuations to the economy is that agents are acting in lack of information in a way that they took economic decisions with no clear information available at their hand (Laidler, 2009). Another reason for the business cycle is that the agents act with no differentiation between the relative price and aggregate prices changes which in turn with any monetary disturbance the economy faces severe fluctuations represented by contraction and expansion into the economic activities in all markets. In other words, if the change in the aggregate prices leads to a change in the relative prices a disturbance in the economy will take place. This will cause a shock in the economy and contraction in the economic level will occur (Karni, 2009).

#### 1.3.3.3 Minsky's Financial Instability Hypothesis

According to Lenart and Pipień (2015), Hyman Minsky (1982) developed a concept of the Wall Street paradigm, a financial theory of investment and an investment theory of the business cycle, often called the financial instability hypothesis (FIH). Minsky (1990) argued that because

production occurs before the exchange of goods and production factors in economic systems, finance must also precede production. Consequently, finance should be integral to any theory of economic growth, as credit not only plays a crucial role in the development process within capitalism but may also be essential in financing the allocation of production factors. When explaining the development of the financial system Minsky indicated that Schumpeterian forces of creation and destruction are not only good in explaining processes in production and manufacturing but seem to be particularly good choice for units constituted financial system. Minsky claimed that it is hard to find a more evident example of the existence of evolution, change and Schumpeterian entrepreneurship than banking and finance. Also, in this case the drive for profit is the most important factor making for change and development.

Minsky in his FIH theory outlined how risks from debt can build up during periods of growth until they become excessive in an economy that otherwise appears to be stable. Minsky's theory of instability has as a central element the procyclical self-reinforcing feedback loop between the individual behavior of economic players and the state of the economic system as a whole (Wray, 2011). Minsky's theories were rediscovered during the global financial crisis of 2007-08, as few economists referred to the global financial crisis as a 'Minsky moment'. The term 'Minsky moment' is credited to U.S. economist Paul McCulley, who initially used it during the Russian financial crisis of 1998, around two years after Minsky died. In a 2009 speech, former U.S. Federal Reserve chief Janet Yellen, spoke on the lessons that Minsky offered central bankers, saying "the dramatic events of the past year and a half are a classic case of the kind of systemic breakdown that he and relatively few others envisioned."

#### 1.3.3.4 Kydland-Prescott Real Business Cycle theory

Finn Kydland and Edward Prescott introduced three revolutionary ideas in their 1982 paper, "Time to Build and Aggregate Fluctuations" (Rebelo, 2005). The first idea was business cycles can be studied using dynamic general equilibrium models. The second idea was that it is possible to unify business cycle and growth theory by insisting that business cycle models should be consistent with the empirical regularities of long-run growth. The third idea was that models could be calibrated from microeconomic studies and long-run properties of the economy, and then these calibrated models can be compared with actual data. Kydland and Prescott (1982) developed their model by its ability to replicate the main statistical features of U.S. business cycles. These features are summarized in Hodrick and Prescott (1980), where they detrend U.S. macro time series with what became known as the "HP filter".

Kydland and Prescott developed a real business cycle (RBC) model to predict the effects of specific policy rules on economic agents' behavior. This model included a decision framework for consumption and investment allocation to examine fluctuations between them, a time allocation decision to assess changes between market and non-market time, and a production function where capital and labor inputs generate output (Ohanian, 2010). This straightforward model laid the groundwork for significant early contributions to the RBC approach, such as labor supply elasticities (Hansen, 1985; Rogerson, 1988), endogenous growth and fluctuations (King et al., 1988), and general equilibrium analysis in open economies (Backus et al., 1992). In their model, the exogenous, stochastic elements include "shocks to technology" and "imperfect indicators of productivity," which introduce random productivity fluctuations, altering the economic growth trend. Examples of such shocks include technological innovations, weather changes, sudden price surges in imported energy, and stricter environmental regulations.

Dynamic stochastic general equilibrium (DSGE) models contributed significantly to the procyclicality analysis as it established a significant base of knowledge on how model economies respond to a variety of abstract shocks. DSGE models have two schools of analysis—classic RBC models and the New-Keynesian DSGE models. Under new-Keynesian DSGE models, introduced by Rotemberg and Woodford (1997), prices are assumed to be set by monopolistic firms and cannot be adjusted instantaneously and costlessly.

#### 1.3.4 Modern theories

According to Xu (2012), modern theories aim to explain the connections between economic growth patterns and credit cycles, sharing three core principles: they are based on optimization, employ explicit microeconomic models of economic agents' behavior, and are formally structured. Seremak (2001) divides these modern approaches and their contributions into two primary groups. The first group of models addresses challenges within the loan market related to asymmetric information and certain aspects of financial intermediation, generally placing less emphasis on macroeconomic factors. A well-known example of this approach is the Holmstrom-Tirole (1997) model. The second group of models explores the connections between economic fluctuations and specific characteristics of credit markets, with notable examples including the Bernanke, Gertler, and Gilchrist (BGG) Model, the Kiyotaki-Moore Model, and the Monetary Transmission Mechanism.

##### 1.3.4.1 Holmstrom-Tirole model

In this model, the maximum debt a firm can incur is tied directly to its net worth. Firms with low net worth, therefore, are more dependent on bank credit as they cannot readily access direct financing sources, such as issuing bonds or equity (Holmstrom-Tirole, 1997).

Consequently, it is essential for financial intermediaries, like banks, to prioritize robust project monitoring and oversight to manage the high risk associated with lending to these firms. Enhanced supervision helps to reduce the likelihood of loan defaults and ensures more prudent credit management.

The model then examines key factors that impact the supply and demand for credit within the market. On the supply side, credit availability is shaped by the financial health of banks, which includes the strength of their balance sheets, adequacy of their capital reserves, and the volume and structure of their deposit liabilities. A financially sound banking system is more capable of extending credit, as it has a buffer to absorb potential losses. Conversely, the demand for credit is influenced by the net worth of borrowing firms, which affects their creditworthiness, as well as the value and availability of collateral offered by both current and prospective borrowers.

Holmstrom and Tirole (1997) categorize these market conditions as different types of financial "squeezes," including the *credit squeeze*, where credit availability tightens; the *collateral squeeze*, where collateral values or availability constrain borrowing; and the *savings squeeze*, where reduced deposit inflows limit banks' lending capacity.

#### 1.3.4.2 Bernanke, Gertler and Gilchrist (BGG) model

This framework is embedded within the new Keynesian model and demonstrates a "financial accelerator" effect, where developments within credit markets serve to propagate and amplify economic shocks (Bernanke et al., 1999). It presents a dynamic general equilibrium model aimed at clarifying the role of credit market frictions in business fluctuations from both qualitative and quantitative perspectives. The model synthesizes prominent approaches in the

existing literature. Notably, it features a “financial accelerator,” where developments in credit markets amplify and propagate macroeconomic shocks. Additionally, we incorporate several elements to enhance the model's empirical relevance. First, we introduce money and price stickiness, enabling us to explore how credit market frictions affect the transmission of monetary policy. We also account for investment lags, allowing the model to produce hump-shaped output dynamics and a lead-lag relationship between asset prices and investment, aligning with observed data. Lastly, we incorporate firm heterogeneity to reflect the varying access borrowers have to capital markets. With reasonable parameterizations, the financial accelerator significantly impacts business cycle dynamics.

The financial accelerator concept illustrates how fluctuations in credit conditions can intensify economic cycles, thereby magnifying the impact of initial shocks. Central to this mechanism is the “external finance premium,” which refers to the difference between the cost of raising funds externally (e.g., through borrowing) and the opportunity cost of using internal funds available to the firm. This premium is closely linked to the net worth of potential borrowers, defined as the difference between a borrower’s liquid assets and outstanding liabilities.

As borrowers' net worth tends to move with the business cycle—rising in economic booms due to higher profits and asset values, and falling during downturns—this procyclicality impacts the external finance premium. Specifically, as net worth increases in upswings, the external finance premium tends to decrease, making external borrowing less costly. Conversely, in downturns, as net worth declines, the premium rises, making external financing more expensive. This countercyclical behavior of the external finance premium has significant implications for firms’ access to credit and investment decisions (Bernanke et al., 1998). Consequently, firms tend to rely more on cheaper, internally generated funds rather than

more expensive unsecured external borrowing, which links investment levels to firm profitability and the broader economic cycle. The model also emphasizes that the risk premium on borrowing is influenced by the borrower's creditworthiness, meaning firms with stronger financial positions pay lower borrowing costs than weaker ones. This relationship not only drives firms' access to credit but also amplifies fluctuations in output and investment, as riskier firms face tighter financial constraints in downturns, further reducing economic activity (Banerjee, 2011).

#### 1.3.4.3 Kiyotaki-Moore model

In the Kiyotaki-Moore Model, credit market imperfections result in credit limits that are based on the value of assets used as collateral. Lenders have limited ability to enforce loan repayments unless these loans are backed by tangible security (Kiyotaki and Moore, 1997). Kiyotaki and Moore's (1997) theoretical study demonstrated how credit constraints interact with economic growth and output fluctuations across the business cycle. Specifically, the dynamic link between credit limits and asset prices used as collateral serves as a powerful transmission mechanism that allows the effects of economic shocks to persist, intensify, and spread across different sectors.

Kiyotaki and Moore (1997) noted that financial institutions' lending decisions are largely driven by fluctuations in asset prices, which borrowers use as collateral. Asset prices, in turn, respond to broader macroeconomic conditions and shifts in demand. This dependency on collateral values reinforces business cycle movements, as rising asset prices during economic upturns expand borrowing capacity, while falling prices during downturns restrict it. Banerjee (2011) further argues that credit rationing can magnify minor economic shocks, leading to

substantial swings in output and contributing to pronounced pro-cyclicality in economic activity.

## 1.4 Procyclicality debate post financial crisis of 2007-08

The global financial crisis of 2007-08 has reignited debate regarding procyclicality of financial variables and also how the financial cycle is impacted by the business cycle. In its April 2008 Report on Enhancing Market and Institutional Resilience, the Financial Stability Forum (FSF) noted that it would examine the forces that contribute to procyclicality in the financial system and develop options for mitigating it. Addressing that procyclicality in the financial system is an essential component of strengthening the macroprudential orientation of regulatory and supervisory frameworks (Financial Stability Forum, 2009). The financial crisis of 2007-08 was a systemic event of large proportions that illustrates the disruptive effects of the procyclicality effect. Institutions that experienced extensive losses faced growing difficulties in replenishing capital. This, in turn, induced them to cut credit extension and dispose of assets. Their retrenchment precipitated a weakening of economic activity, thereby raising the risk of a further deterioration in their financial strength, incurring huge costs to the broader economy.

Banking sector plays a key role in determining the supply, pricing and allocation of credit in the economy. The emphasis on regulatory capital is also justified given its key role in influencing bank decisions related to balance sheet leverage and overall risk appetite. However, there is one aspect of regulatory capital which needs to be addressed. Basel II and III frameworks are designed to be risk sensitive. As a result of higher risk sensitivity, capital requirements on a given portfolio tend to behave procyclically. They tend to fall during expansions, when the measured risk is low, and rise, possibly abruptly, during contractions, as

the measured risk increases, and the credit quality of balance sheets manifestly deteriorates. This can amplify the risk of financial instability and hence the business cycle fluctuations (Financial Stability Forum, 2009).

Policymakers and regulators needed to come up with additional measures and strategies to counter endogenous procyclicality in the financial sector. A key policy target in dealing with procyclical patterns in leverage is to calibrate prudential instruments so that buffers are created during the upswing of the cycle that can subsequently be used to absorb the strains during the downturn. Keeping this into consideration, countercyclical capital buffers were introduced in Basel III framework with implementation timeline of 2015. The Basel Committee on Banking Supervision (BCBS) also highlighted the weaknesses and gaps in stress testing practices of the financial institutions and hence recommended strengthening the governance, design and execution of stress testing programs at banks. The BCBS also introduced leverage ratio and net stable funding ratio (NSFR) as part of Basel III framework to address liquidity risk and procyclicality issues in long-term and short-term funding for the banks.

There is a long-standing debate between bank regulators and accounting standard setters over the calculation of loan loss provisions by banks. Accounting standard setters have long employed a relatively straightforward incurred loss model which requires banks to record loss provisions for expected loan losses based solely on information that a loss is probable at the balance sheet date (Huizinga and Laeven, 2018). Bank regulators, however, are focused on the safety and soundness of banks. From January 2018, EU moved from incurred loss model of provisioning to a more comprehensive expected credit loss (ECL) model, with implementation of International Financial Reporting Standards (IFRS) 9 on financial instruments. The expected credit loss model of IFRS9 requires banks to set provisions for all loans rather than just for

loans where loss is probable or has occurred. This accounting rule change would make banks potentially less procyclical by impacting provisions.

## 1.5 Review of empirical works performed in the area of procyclical

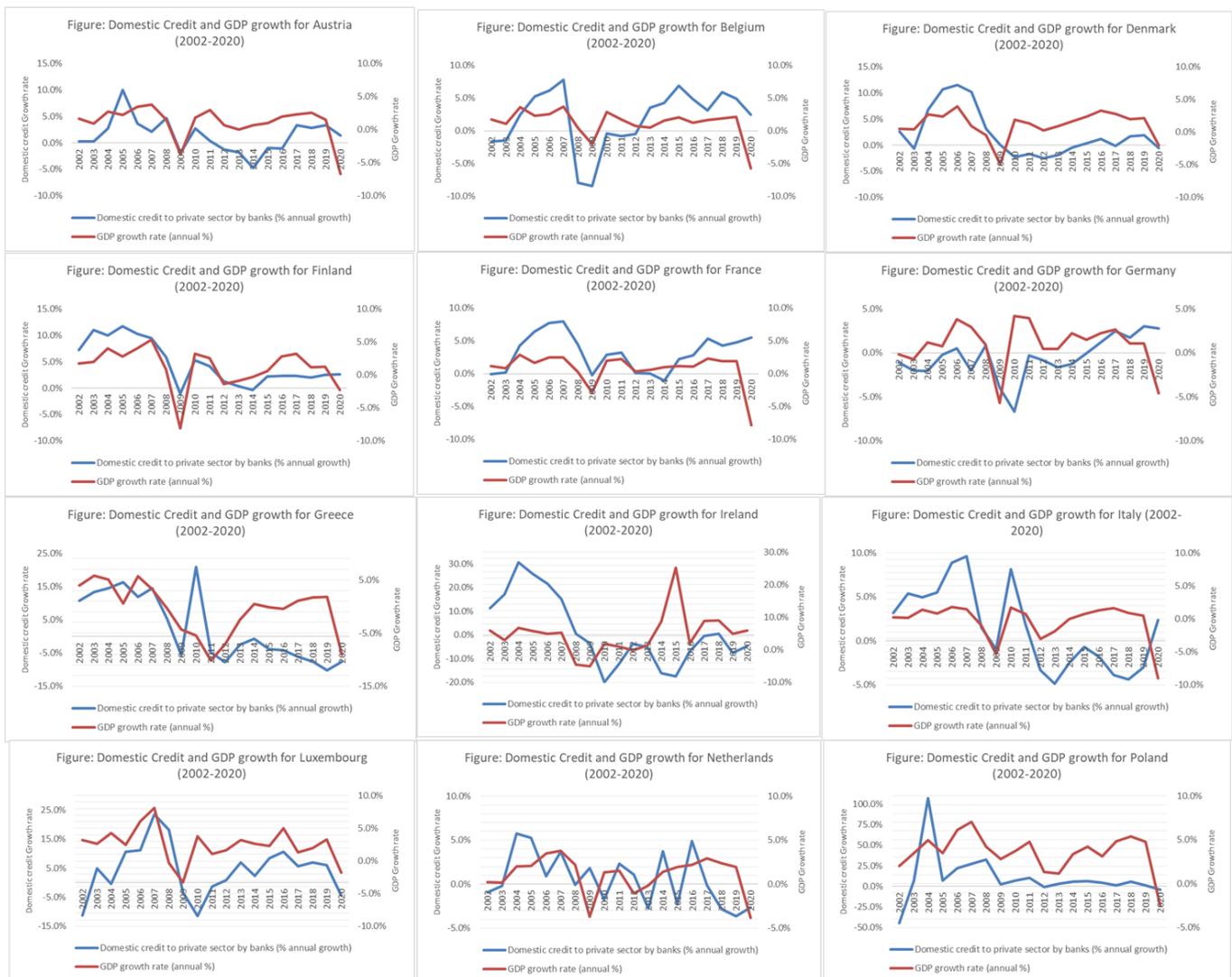
The term “procyclical” has historically been used by economists in the context of the effects of conducting fiscal policy initially, as the antonym of “countercyclical” dynamic behaviour. In an early reference, describing historical fiscal positions in the United States, Firestone (1960) observes that “government expenditures rose throughout the expansion phase and fell during the first half of the contraction,” a pattern referred to as “procyclical” in corresponding book review by Culbertson (1962). In their macroeconomics textbook, Abel and Bernanke (1995) explicitly define procyclical as “an economic variable that moves in the same direction as aggregate economic activity (up in expansions, down in contractions)” and provide a list of economic and financial variables that fit this definition. Lane (2003) further discusses the degree of co-movement, labeling a series that “varies positively but less than proportionately with output fluctuations” as “weakly procyclical.” Thus, the historical context supports the common interpretation of procyclical as a description of co-movement rather than a causal relationship, particularly within the economic research literature (BIS, 2021).

There is a growing body of empirical research done in the area of procyclicality of banking sector activity. For this research, we are focused on studying procyclicality of banking sector from three different perspectives. First, we review literature on the procyclicality of credit supply provided by the banks. Second, we focus on procyclicality of credit risk measures and, last but not the least, we assess procyclicality of regulatory capital especially in the context of Basel regulations.

#### 1.5.1 Empirical work in procyclicality of the credit growth

There is a growing body of empirical research work related to the procyclical nature of banking business. Vanhoose (2010) shows that aggregate level of loans in the economy typically increases during expansions and falls during recessions. Goodhart and Segoviano (2004) explain that regulators are much stricter during recessions while reviewing banks due to higher default risk. This leads to a contraction in loan supply to the economy and consequently may deepen the economic slowdown. On the contrary, during expansions, regulators are less strict, leading to an increase in loan supply to the economy by banks. Credit growth is one of the important indicators of the financial system that can drive the country economic growth, but on the other hand credit growth can also cause risks in the financial system due to the economic actors' moral hazard.

Figure 3: Domestic Credit Growth and GDP growth in selected EU Countries (2002- 2020)



Source: World Bank Database

Figure 3 demonstrates the co-movement of lending (growth of domestic credit to the private sector by banks) and economic activity (GDP growth) in the selected top EU countries (by banking assets) for the period 2002-2020.

All 15 countries, except for Germany and Ireland, show positive co-movement of credit growth and GDP growth implying a case for procyclical nature of credit growth in these countries. Germany has shown a negative relationship especially post 2009. In this case GDP growth has shown a downward trend from a peak of 4.2% in 2010 whereas credit growth has mostly remained negative till 2014 before growing steadily and rising to 3% in 2019. Similarly for Ireland, credit

growth has mostly remained negative falling sharply in years 2010-2016 whereas GDP growth rate has been positive during the same period reaching a peak of 25.2% in 2015. An interesting observation is although GDP growth rate declined for all countries (except Ireland) in 2020, credit growth increased in 2020 for these countries except for Austria, Belgium, Denmark, Luxembourg and Poland.

The relationship between credit growth and GDP growth as demonstrated in figure 3 leads to research question regarding procyclicality of credit supply in these countries. This issue has gained significant attention from the regulators and policy makers, especially post the global financial crisis. However, this stream of research always existed as a part of the problem of assessment of effectiveness of the monetary transmission mechanism. In particular Kashyap and Stein (2000) test the bank lending channel and impact of the monetary policy on lending for US banks and find that capital and size of the bank are important determinants for loan supply in US economy. They use quarterly bank data covering the period from 1976 to 1993 to investigate how bank liquidity, measured by the ratio of securities holdings to total assets, affects the loan supply of US banks. Altunbas et al. (2002) also examine evidence for a bank lending channel in Europe and find a positive correlation between capital and loan supply for banks in EMU countries. They use panel of annual data of 11 EMU banks from the period 1991 to 1999. They do not find the size of the bank to be a significant determinant of the loan supply, however, they observe that undercapitalized banks tend to have higher responsiveness of loan growth to monetary policy shocks. Hempell and Sorensen (2010) examine the impact of supply constraints on bank lending in the euro area with focus on 2007-08 crisis period. They use a unique confidential data set based on results from the Eurosystem's bank lending survey and find that liquidity and capital are the most important factors constraining the loan supply during the crisis period.

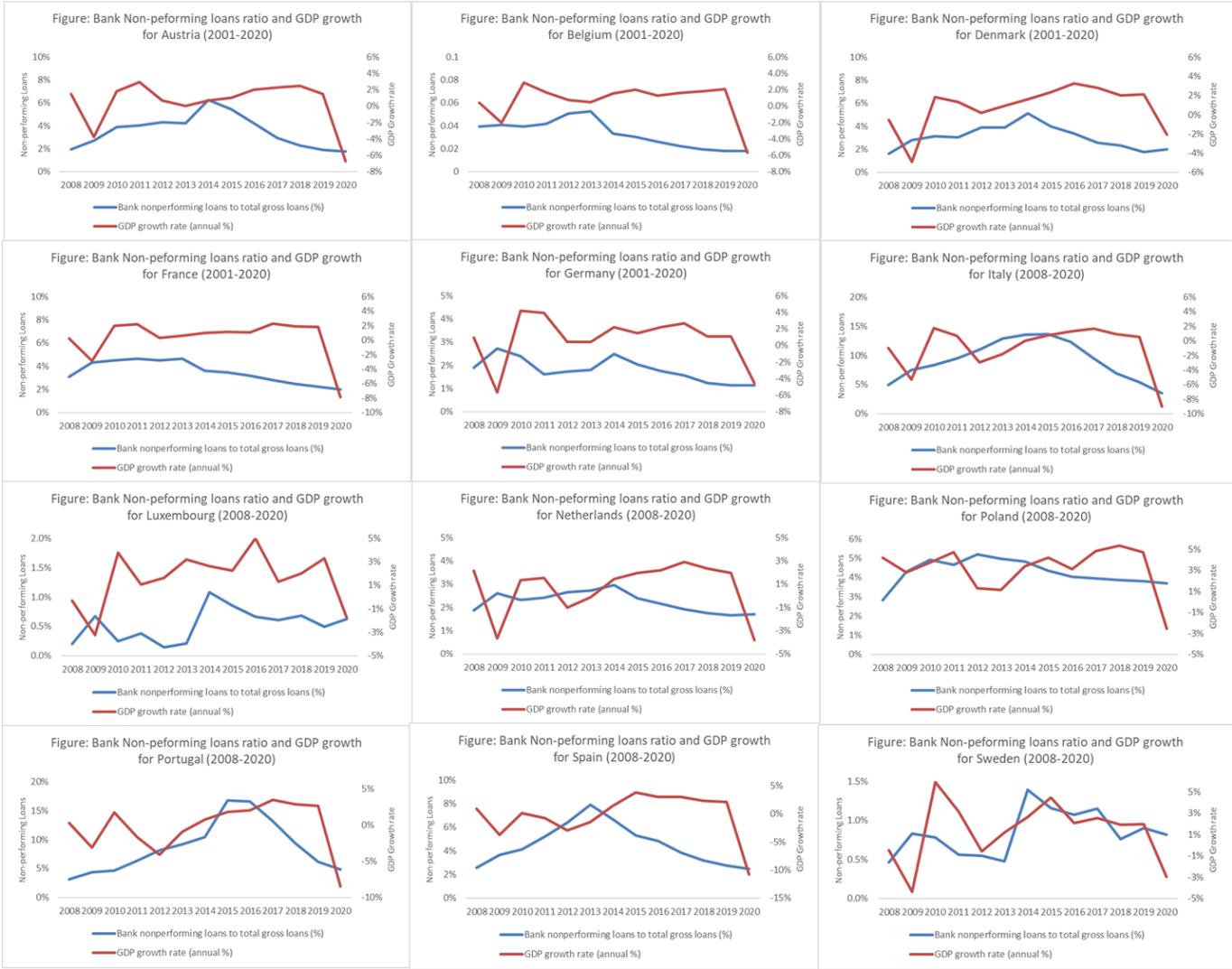
Cyclicality in the supply of business credit has been focused on a considerable amount of research. However, empirical evidence of cyclicality of credit supply is available in literature

only for a small number of countries. examine the procyclicality of banking in relationship with credit risk by employing a VAR model consisting of five variables: the aggregate default rate, output gap, inflation rate, three-month interbank interest rate, and real exchange rate. They use quarterly dataset for the aggregate default rate of Italian banks together with macroeconomic data for the period 1990 to 2004. Marcucci and Quagliariello (2008) find that the effects of the business cycle on credit risk are more pronounced during downturns but also when credit risk conditions are poor. Ivashina and Scharfstein (2010) study the procyclicality of supply of syndicated loans in the US market. The advantage of syndicated lending is that it enables originating banks to share risk across the syndicate. They find a clear negative relationship between total loan supply and lead bank's share. They also find a positive and significant estimated effect of credit standards on lead share for the whole period of 1990 to 2009. Jimenez et al. (2011) provide strong evidence of procyclical loan supply using a large monthly data of loan applications for the period 2002 to 2008 from the Banco de España. They find that a decrease in GDP growth is estimated to decrease the probability of granting loans from banks, suggesting a procyclical pattern in loan supply. They also find that the procyclicality of loan supply is higher for low-capitalized (low liquidity) banks. Bebczuk et al. (2011) investigate relationship between credit changes and output changes by analyzing a sample of 144 countries over a period of 1990-2007. They find credit to be procyclical for 45% of countries while using annual data and only 23% of countries based on quarterly data. They also find that granger causality runs from GDP to credit for majority of cases, whereas causality from credit to GDP is less frequent.

### 1.5.2 Empirical work in procyclicality of credit risk

Similarly as it was reviewed above, many authors try to investigate to what extent the loss incurred by banks on the credit could also have linkages with the economy resulting into procyclicality of loan loss provisioning. The degree of loan-loss provisioning is an important quantitative indicator for assessing the health of the banking sector. A loan loss provision is an income statement expense set aside to take account of the likelihood that some loans may not be repaid in full (ECB, 2004).

Figure 4: Non-performing loans ratio and GDP growth in selected EU Countries (2008- 2020)



Source: World Bank Database

Figure 4 demonstrates the co-movement of credit risk (non-performing loans ratio) and economic activity (GDP growth) in the selected top EU countries (by banking assets) for the period 2008-2020.

Unlike credit growth, credit risk as measured by non-performing loans ratio, does not show a uniform co-movement with economic growth. For Austria, Greece, Italy and Sweden, non-performing loans ratio show a similar trend as GDP growth and have a positive co-movement. However, the relationship between non-performing loans ratio and GDP growth is complicated given that it depends on the quality of credit which could have originated much before the default (non-performing status) occurred. Usually, the banks are more stringent during the economic contraction period and have more relaxed criteria during the upturn period.

The relationship between credit risk and GDP growth as demonstrated in figure 4 needs to be further investigated. This leads to a couple of research questions which need to be addressed. The first question is whether credit risk metrics like non-performing loans ratio or loan-loss provisions are procyclical in nature. The second question is whether excessive loans granted during expansionary phase explain the more than proportional increase in non-performing loans during contractionary period.

Laeven and Majnoni (2002) examine procyclicality of loan loss provisions by analysing data for provisioning and GDP per capita from 1988 to 1999. They find that many banks tend to delay loan loss provisioning until too late, when cyclical downturns have already set in, possibly magnifying the impact of the economic cycle on banks' income and capital. They also observe a negative correlation between loan loss provisions and GDP growth. Similar conclusion regarding GDP relation with loan loss provisions is also obtained by Bikker and Metzmakers (2005), however, they find that loan growth rate has positive relation with loss provisioning,

implying that losses are built up during expansion period. They also investigate the provisioning behaviour of banks and their dependency on the business cycle and find that provisioning depends significantly on business cycle as evidenced by direct negative relation between GDP growth and provisioning. Also provisioning behaviour differs substantially across countries and regions driven by diverging legal, regulatory or institutional frameworks including tax and accounting regimes. This result is contrary to Laeven and Majnoni (2002), reporting significant negative effect of loan growth. Bouvatier and Lepetit (2013) examine effect of backward-looking provisioning system on bank lending. They conclude that backward-looking provisioning practices amplify the cyclicity of bank lending, with a stronger impact for emerging countries. Olszak and Pipień (2016) examine the impact of financial integration on transmission of economic shocks from one country to another and consequently on the sensitivity of loan loss provisions to the business cycle. Using data from a panel of 13 countries for 1995 to 2009, they find that loan loss provisions is procyclical and the effect is more pronounced with cross-country linkages.

Caporale et al. (2014) analyze macroeconomic and financial determinants of bad loans to investigate whether excessive loans granted during expansionary phase can explain more than proportional increase in non-performing loans during contractionary periods. They use 17 monthly series over the period of June 1998-June 2012 for Italian banking system. They find that loans increase rapidly in periods of growth and tend to stabilize or even contract during recessions. Bad loans, considered as a measure of credit quality, are relatively stable during periods of strong economic growth, and then they grow exponentially during recessions.

The proliferation of credit risk measurement models in banking may accentuate the procyclical tendencies of banking, with potential macroeconomic consequences. Credit risk models tend

to over lend during boom times whereas during recession they become more stringent thereby reducing the extent of lending by the bank (Allen and Saunders, 2005). As banks play a significant role in the economy and provide credit supply which directly affects economic activity, risk-based capital requirements would work to amplify the business cycle or induce procyclicality if two following conditions are met. First, capital requirements would need to increase in economic downturns and decline in upturns. Second, credit supply would need to be inversely related to capital requirements (ECB, 2009).

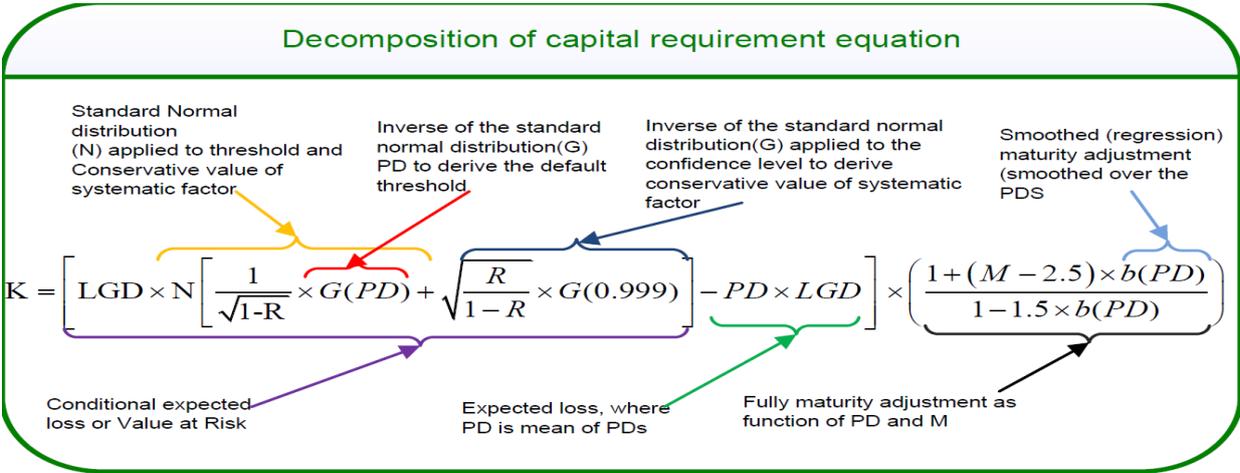
Credit risk measurement has three key components which also contribute to calculations of regulatory capital requirements by the bank- Probability of default (PD), Loss given default (LGD) and Exposure at default (EAD). PD is the likelihood of default by an obligor over a one-year period. It provides an estimate of the likelihood that a borrower will be unable to meet its debt obligations (BIS, 2001). There is substantial literature to suggest that macroeconomic conditions affect the probability of default (PD). Fama (1986) and Wilson (1997) suggest cyclical PDs, especially in the case of economic downturns when PDs rise significantly (Allen and Saunders, 2005). Catarineu-Rabell et al. (2003) recommend that regulators encourage banks to adopt through-the-cycle (TTC) ratings as opposed to point-in-time (PIT) ratings, provided that the data used to calculate the PDs cover a period sufficiently long to include at least one business cycle.

EAD represents the total outstanding amount at the time of default. As an obligor moves towards default it will usually try to leverage more, as mostly the reason for default is a liquidity problem. EAD will thus try to assess the company's ability to increase its exposure while approaching default, which in turn will depend on type of product the obligor has and also bank's ability to prevent excessive draw down on the facilities.

LGD represents the percentage of EAD which banks expect to lose if a counterparty goes into default (BIS, 2001). There are several scenarios which may occur after a company goes into default. The two most extreme are – i) The counterparty recovers without any loss to the bank and ii) Sale of assets and collateral is required. There are also scenarios in between these two extremes with various possible associated losses. The outstanding amount could be restructured (a new term structure for instance) or the exposure could be sold to another bank.

One of the fundamental changes proposed in Basel II regulatory framework was the concept of Internal Ratings Based (IRB) approach for credit risk measurement. Under the IRB approach, the amount of capital that a bank will have to hold against a given exposure will be a function of the estimated credit risk of that exposure. Estimated credit risk in turn is taken to be a predetermined function of four parameters: probability of default, loss given default, exposure at default, and maturity (BIS, 2004). Figure 5 represents the regular capital requirement equation to credit risk under IRB approach.

Figure 5: Decomposition of capital requirement function into various risk components



Source- Paudel, 2007

Banks operating under the Advanced IRB (A-IRB) approach are responsible for providing all four required parameters themselves, based on their own elaborated internal models. Banks operating under the Foundation IRB (F-IRB) approach are responsible only for providing the PD parameter, with the other three parameters to be set externally by the Basel committee (BIS, 2004). Allen and Saunders (2005) demonstrate, based on US data, that increases in interest rates and decreases in asset prices both work to raise the corporate sector PDs and LGDs, which enter the calculation of capital requirements. Paudel (2007) reviews the IRB approach for minimum capital requirement proposed by Basel II and assesses the regulatory function and its various risk components.

### 1.5.3 Empirical work in procyclicality of regulatory capital

There has been a strong interest among both policy makers and researchers in understanding the interactions between macroeconomic conditions and regulatory capital, especially in the aftermath of the financial crisis of 2007-08. One of the key concerns, from a macroeconomic perspective, is that changes of the capital requirements according to banking regulations may induce significant procyclicality in the system, thereby amplifying macroeconomic fluctuations (Covas and Fujita, 2010). During economic upturns, bank capital requirements would decrease, which would encourage banks to take on risk. Consequently, banks would extend credit without building up sufficient capital for potential future losses. This holds true even during economic upturns, when profits increase relatively easily, and it is cheaper to raise external capital. During economic downturns, borrowers are more likely to be downgraded, so banks must increase their capital. Since it is difficult for banks to raise capital with the use of external sources during recessions, they would reduce loans and dispose of assets to meet

the regulatory minimum capital requirements (Repullo and Suarez, 2013; Borio and Zhu, 2012).

Economic theory suggests that there is a relationship between banks’ capital requirements and the overall economic condition of financial markets although it is quite complex. Firstly, the business cycle can have an effect on capital requirements through the usage of macroeconomic variables in banks’ models, i.e., in periods of economic downturn the capital held by banks is higher what motivates banks to either increase their lending rates or limit their crediting activity in order to maintain a certain level of profitability. This in return affects the economy as credits given to economic counterparties constitute a significant share in Gross Domestic Product (GDP) or other macroeconomic indicators.

The adoption of Basel II was expected to take place gradually, but with the breakout of the global financial crisis, Basel III was implemented. It called for improvements to macro-prudential regulations, particularly related to the pro-cyclicality issue. One of the main objectives of the new Basel Accord is to increase the risk sensitivity of minimum capital requirements for the banks. This has raised a debate among policymakers and researchers about the potential procyclical effects of regulatory requirements on the economy (Bikker and Metzmakers, 2005). Regulators across the globe acknowledge the potential issue of procyclicality resulting out of regulatory requirements. Table 2 represents the perspectives of some of the regulators regarding procyclicality and its effects.

Table 2: Regulators Perspectives on Procyclicality

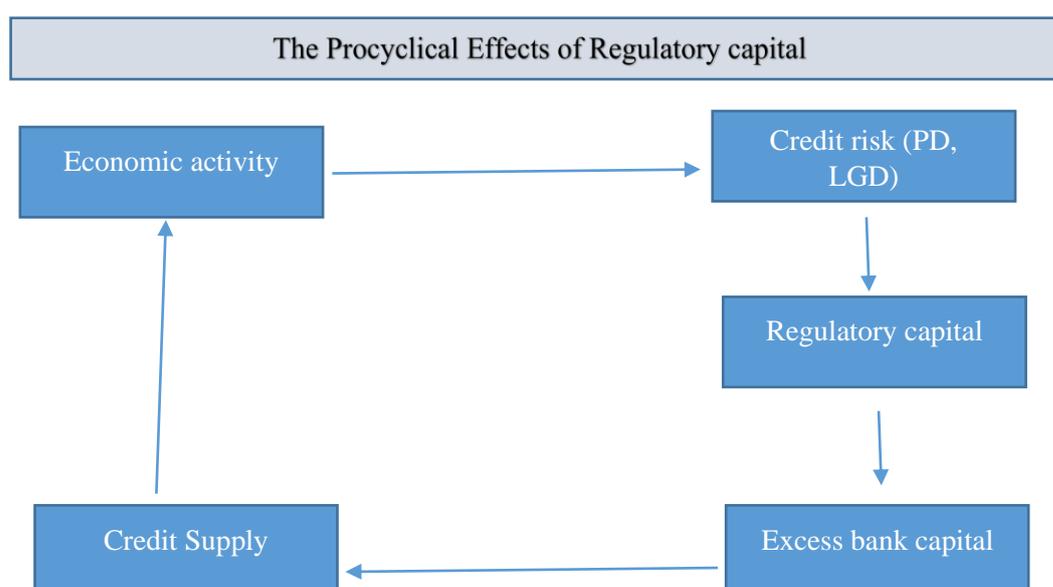
Definition/Comment	Regulator
--------------------	-----------

<p>Cyclicality is defined as pattern of a specific series (capital requirements) over time significantly reflecting the development of real economic activity (business cycle). Procyclicality consequently implies feedback loops between the real economy and the financial system, in a way mutually amplifying business and financial cycle fluctuations.</p>	<p><i>European Banking Authority, 'Cyclicality of capital requirements', report under art 502 CRR</i></p>
<p>Procyclicality refers to the tendency of financial variables to fluctuate around a trend during the economic cycle. Increased Procyclicality thus simply means fluctuations with broader amplitude.</p>	<p>Deputy Governor of the Bank of France (2009)</p>
<p>A rise in asset prices makes it easier for households and firms to obtain loans, while a decline makes it more difficult. This mechanism is pro-cyclical because asset prices tend to be positively correlated with the business cycle and because credit availability feeds back onto investment and consumption, and hence into economic growth.</p>	<p>Bank of Italy (2009)</p>
<p>A non-cyclical or 'through-the-cycle' (TTC) rating system does not respond to an economic downturn with grade migration, but the default rate within a grade increases instead.</p>	<p>Prudential Regulatory Authority (PRA), UK (2022)</p>
<p>The term "variable scalar" is used to describe approaches in which the outputs of an underlying, relatively PIT, rating system are transformed to produce final PD estimates used for regulatory capital requirements that are relatively non-cyclical. [...] both the initial calculations of, and subsequent changes to, the scalar must be able to take account of changes in default risk that are not purely related to the changes in the cycle.</p>	<p>Financial Conduct Authority (FCA), UK (2020)</p>
<p>Financial accelerator dynamics that make borrowers appear to be most creditworthy at the top of the cycle will necessarily result in fewer projected defaults, lower projected losses, and higher</p>	<p>Federal Reserve Bank of Philadelphia, USA (2019)</p>

projected net income when the starting point for the hypothetical economic stress is closer to the top of the cycle.	
--	--

In terms of risk management for banks, Basel II was a significant improvement, making the paradigm ‘one size fits all’ no longer valid, as it was in case of the Basel I. However, there has been an ongoing concern which has been voiced repeatedly - is that the Basel II capital requirements amplify the business cycle fluctuations. In economic downturns, credit risk measured by the borrower’s probability of default (PD) and loss given default (LGD), would be high, as would capital requirements (ECB, 2009).

Figure 6: Mechanism of Procyclical Effects of Regulatory Capital

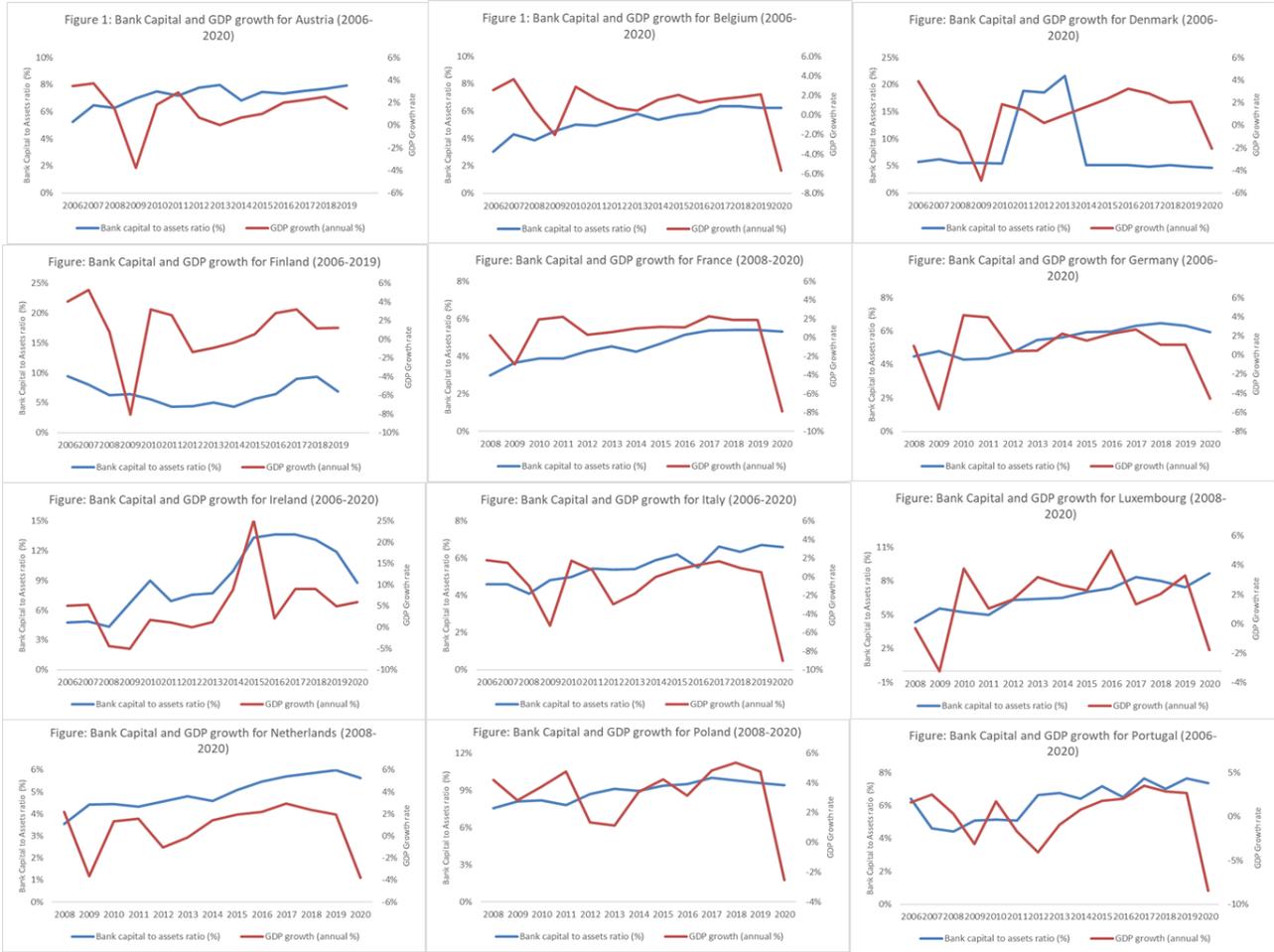


Source- ECB, 2009

Figure 6 depicts a mechanism for how the regulatory capital requirements are procyclical in nature and amplify macroeconomic conditions. In economic downturns, credit risk as measured by PD and LGD will significantly go up thereby raising regulatory capital for the bank.

The combination of higher capital requirements and the difficulty of raising new capital could induce banks to reduce credit supply to firms and households, and eventually amplify the downturn. Conversely, during a boom period, banks holding excess capital would face lower capital needs thereby expanding credit supply to firms and households which could potentially amplify the boom (ECB, 2009).

Figure 7: Bank capital ratio and GDP growth in selected EU Countries (2008- 2020)



Source: World Bank Database

Figure 7 demonstrates the co-movement of regulatory capital (banks' capital to assets ratio) and economic activity (GDP growth) in selected top EU countries (by banking assets) for the period 2006-2020.

As bank capital to assets ratio is risk sensitive, it is expected to be higher in the contraction period and lower in the expansionary phase. However, relationship is not straight forward as similar to non-performing loans or loan-loss provisions, regulatory capital ratio also depends on the quality of credit and overall credit supply by the banks (as assets is denominator for the ratio). Countries like Austria, Finland, Greece and Ireland show a positive co-movement for capital ratio and GDP growth.

The relationship between regulatory capital and GDP growth as demonstrated in figure 7 leads to the research question regarding procyclicality of regulatory capital in these countries. This issue has gained significant attention from the regulators and policy makers, especially post the global financial crisis. The BCBS introduced a countercyclical buffer for banks to manage inherent procyclicality in regulatory capital and lending behavior of the banks.

Many years before the global financial crisis Peek and Rosengren (1995) investigated the relation between banking regulation and lending behavior of banks. They found that banks with formal regulatory enforcement actions shrink their loan supply more drastically than others during the US credit crunch in the early 1990s. Kishan and Opieal (2006) also show that the implementation of Basel I and a more stringent bank regulation in the US in the 1990s affected the loan growth of small and undercapitalized banks. Olszak et al. (2018) assess the impact of bank capital ratios on loan supply in the EU and found that capital ratios are important determinant of lending in large EU banks. They also show that loan growth of banks that have more procyclical loan loss provisions and that engaging less in income smoothing is more sensitive to capital ratios.

Boehl et al. (2016) analyze whether risk-sensitive capital requirements, as mandated by the regulators, create unintended procyclical effects by reinforcing the endogenous relationships between the financial system and the real economy and thereby amplifying the real economic cycle. They consider a sample of 144 active banks in the EU (covering 95% of EU banking sector assets) for a period of 2008-2015. Based on the analysis, they conclude that the impact of regulatory capital requirements on the EU economic cycle appears to be limited. One of the main conclusions that emerges from the academic debate on the pro-cyclical effects of capital requirement under Basel II is that risk-sensitive capital requirements should have pro-cyclical effects mostly on undercapitalized banks. Hence, at the aggregate level, the extent of pro-cyclical effects of regulatory capital may depend on the degree of undercapitalization of the banking sector as a whole (ECB, 2009).

Regulators impose minimum capital requirements for banks, which depend on the level of risk-weighted assets (RWA) held by the banks. The current Basel II capital requirements are risk sensitive because RWA depends on the credit quality of borrowers. This means that in an economic downturn, RWA tends to be higher due to a decline in credit quality and in good times tend to be lower for the exact opposite reasons. This procyclicality may lead banks to excessive risk-taking during good times and to risk averse during bad times resulting in credit crunch, thereby amplifying the business cycle effects. In order to address this potential issue of procyclicality, Basel Committee on Banking supervision (BCBS) introduced a framework for countercyclical capital buffers above the minimum requirement with the objective of dampening any excess cyclicity of the minimum capital requirement as well as protecting the banking sector from periods of excess credit growth (BIS, 2010).

## 1.6 Summary indicating the research gaps in analyses of the procyclicality of the financial system

In empirical literature, there is no decisive support in favor or against hypothesis conjecturing the procyclical impact of the financial sector. The notion of the financial cycle predates the much more popular business cycle (Borio, 2012). However, for most of the post-world war period, it had less prominence in mainstream literature and was accounted by only a few economists (Kindleberger, 1978; Minsky, 1982). The financial crisis of 2007-08 changed it all and re-generated debate about the role of financial cycle in macroeconomics. The procyclicality of banking sector with respect to credit can be analyzed in three key areas- credit growth, credit risk and regulatory capital. Most of the literature on procyclicality of banking has focused on procyclicality of credit growth usually indicated by volume of bank loans. However, during the post financial crisis there has been an emphasis on analyzing cyclical behavior of other two credit metrics- credit risk and regulatory capital separately especially with enhanced and stringent banking regulations.

Basel Committee on Bank Supervision (2011) also articulated the gap in empirical literature on bank credit and real economy-

*"... A key gap in our knowledge is on the influence of lending on real economic activity. Specifically, while there is a sizeable body of research on the question of how bank balance sheet positions influence lending, there is significantly less research on the question of how lending affects real activity....." (BIS, 2011).*

Cyclicality in the supply of bank credit has been the focus of considerable amounts of research. However, empirical evidence of cyclicality of credit supply is available only for a small number of countries (see e.g., Gambacorta and Mistrulli, 2004; Marcucci and Quagliariello, 2008;

Ivashina and Scharfstein, 2010; Becker and Ivashina, 2011; Jiménez et al., 2011). There is a lack of evidence of cross-country linkages for procyclicality analysis of credit growth. Increasing interconnectedness of financial institutions and markets, and more highly correlated financial risks have intensified cross-border spillovers through a range of channels (see Claessens et al., 2011; Olszak and Pipień, 2016, Fernandez-Gamez et al., 2020). Arčabić and Škrinjarić (2021) analyze the spillovers and synchronization of business cycles in the European Union and find that spillovers are very pronounced for EU implying importance of cross-country linkages study for EU countries. Kouretas et al. (2020) investigates the impact of market structure on EU bank loans and finds heterogeneities between advanced and transitioning EU banking sectors.

Loan loss provisions or non-performing loans ratio are usually applied in financial research to measure the level of credit risk and examine its procyclicality (Borio et al, 2004; Albertazzi and Gambacorta 2009; Athanasoglou et al., 2011; Fiordelisi et al., 2011; Olszak and Pipień, 2016). This risk measure is documented to be procyclical, as it increases when the economy is in downswings and decreases during economic upswings. Laeven and Majnoni (2003), Bikker and Metzmakers (2005), Bouvatier and Lepetit (2008), and Albertazzi and Gambacorta (2009) have analyzed in an international sample of banks the relation between credit risk and gross domestic product (GDP) growth and other variables. This research supports the procyclical behavior of credit risk metrics as credit risk metric is negatively related to GDP growth (Olszak and Pipień, 2016). Globalization of economies over the last few decades has led to increased financial integration and interconnectedness of financial institutions and markets leading to cross-border spillovers through various channels (see Claessens et al., 2011). However, most

of the studies dealing with procyclicality of credit risk measure have not considered cross-country effects (Olszak and Pipień, 2016).

There has been much debate over the procyclical nature of bank capital requirements since the 2004 release of the Basel II guidelines by BCBS. The procyclicality of the financial sector can amplify business fluctuations and may lead to financial instability. Therefore, addressing the issue of procyclicality in the banking system may be an important factor in further strengthening the regulatory requirements for the banks (Lin, 2020). Francis and Osborne (2010) suggest that capital requirements will influence banks' capital management practices and therefore capital management practice is crucial in dealing with procyclicality issue. However, the evidence on procyclicality of capital management is rather mixed. Some previous studies (Ayuso et al., 2004; Stolz and Wedow, 2011; Shim, 2013; Chen et al., 2014; Huang and Xiong, 2015) provide evidence that capital buffers behave in a pro-cyclical manner, whereas others show contrary results; that is, capital buffers behave counter-cyclically (Jokipii and Milne, 2008; Atici and GURSOY, 2012; Kasman and Busun, 2015; Lin, 2020). These studies use data from different countries or regions in the U.S. and Europe, however they do not address the issue of interconnectedness among countries.

Reviewing the empirical literature on procyclicality of credit growth, credit risk and regulatory capital, there are four following significant research gaps:

- a. There is lack of literature documenting empirical evidence of procyclicality of credit risk. There is substantial literature available on procyclicality of credit supply (e.g., Goodhart and Segoviano, 2004; Kashyap and Stein, 2000; Altunbas et al., 2002; Hempell and Sorensen, 2010; Peek and Rosengren, 1995; Kishan and Opiella, 2000; Ivashina and Scharfstein, 2010; Jimenez et al., 2011; Bebczuk et al., 2011). However,

the topic of procyclicality of credit risk is still insufficiently analysed. Researchers have explored procyclicality of loan loss provisions as indicator of credit risk and its relationship with real economy through various channels (e.g., Laeven and Majnoni, 2002; Bikker and Metzemakers, 2005; Bouvatier and Lepetit, 2013; Olszak and Pipień, 2016).

- b. Similar to credit risk, procyclicality of regulatory capital is also not sufficiently researched in the financial literature (Ayuso et al., 2004; Jokipii and Milne, 2008; Boehl et al., 2016; Valencia and Bolanos, 2018; Lin, 2020). There are also a few studies addressing the impact of capital ratios on loan supply (Gambacorta and Marquez-Ibanez, 2011; Olszak et al., 2018). However, given the evolution of banking regulation from Basel I to Basel III in the last two decades, it is imperative to understand the procyclicality of regulatory capital of banks.
- c. There is a lack of evidence of cross-country linkages for procyclicality analysis of credit growth, credit risk and regulatory capital. Increasing interconnectedness of financial institutions and markets, and more highly correlated financial risks have intensified cross-border spillovers through a range of channels (see Claessens et al., 2011; Olszak and Pipień, 2016, Fernandez-Gamez et al., 2020). A large section of literature does not take into consideration the heterogeneity among countries while performing cross-country analysis for procyclicality.
- d. Most empirical studies have focused on individual or a panel of countries, with limited research addressing economic blocs, particularly within the context of the European Union. There is not much literature on empirical evidence of procyclicality of banking sector for EU countries (Boehl, 2016; Olszak et al., 2017; Olszak and Pipień, 2016; Pipień and Anand, 2023).

The key objective of this research is to empirically analyse the procyclicality of credit growth, credit risk and regulatory capital for EU countries. However, there are two key departures from previous studies done in procyclicality analysis of the financial sector. Firstly, the analysis is focused on EU countries and covers more than 95% of assets in EU banking system. Secondly, the analysis performed to study procyclicality of credit growth, credit risk and regulatory capital, considers country heterogeneity factors.

In order to study cross-country linkages of procyclicality analysis of EU countries, we perform empirical estimation in two steps. First, we apply the Fixed Effect (FE) panel regression approach, resulting in an identification of the procyclicality effect common to all analyzed countries. This is due to taking into account data from many different countries and to the constancy of parameters across countries. In the second step we apply the system of Seemingly Unrelated Regression Equations (SURE). In this novel setting it is possible to make parameters of interest variable across countries. Consequently, our approach enables testing cross-country heterogeneity of the procyclicality effect. Most importantly it may also serve as an econometric environment suitable for analyzing empirical importance of the standard panel regression outcomes, assuming similar procyclicality effects for each of the analysed countries. Our main research hypothesis states that procyclicality effect is a country specific phenomenon, expressing substantial variability across various economies.

## Chapter 2- The Model of Seemingly Unrelated Regression Equations (SURE) as an econometric environment for testing country heterogeneity of the banking sector's procyclicality

### 2.1 SURE Framework and estimation schemes

Arnold Zellner (1962) introduced the model of seemingly unrelated regression equations (SURE) and showed that the resulting estimators could be more precise than those obtained through ordinary least squares (OLS) equations. The SURE model can be viewed as a special case of the generalized linear regression model. In the point of departure let us consider classical linear normal regression model (CLNRM) given by the following formula:

$$y = X\beta + \varepsilon \quad (1)$$

In equation (1),  $y = (y_1, \dots, y_T)$  is the vector of  $n$  observations of dependent variable.  $X$  is a matrix of independent variables with  $T \times K$  elements, where  $x_k$  is independent variable with  $n$  observations and  $k = 1, \dots, K$ .  $\varepsilon = (\varepsilon_1, \dots, \varepsilon_T)$  is the column vector with  $T$  error terms.

The basic assumptions of CLNRM are the following:

1. Linearity: The relationship between dependent variable and independent variable is linear;  $y = X\beta + \varepsilon$  as in equation (1)
2.  $X$  is a nonrandom matrix with  $T \geq K$
3. No collinearity:  $\text{rank}(X) = K$
4.  $E[\varepsilon | X] = 0$
5. Homoscedasticity: The variance of the error terms is finite and the same for each  $i = 1, \dots, T$   $\text{Var}(\varepsilon_i) = \sigma^2 < +\infty$
6. No correlation of different error terms:  $\varepsilon_i$  is not correlated with  $\varepsilon_j$  if  $i \neq j$

7. Normality of error terms: for each  $i = 1, \dots, T$ ,  $\varepsilon_i$  is normally distributed

According to assumptions 4 and 5 the covariance matrix of the vector  $\varepsilon$  is given by the formula:

$$V(\varepsilon|X) = E[\varepsilon\varepsilon' | X] = \sigma^2 I_n$$

The generalized linear normal regression model (GLNRM) is an extension of CLNRM obtained by relaxing assumptions 4 and 5 towards possible heteroscedasticity and cross correlation. In this case the covariance matrix of the vector  $\varepsilon$  is given as follows:

$$V(\varepsilon|X) = E[\varepsilon\varepsilon' | X] = \sigma^2 \Omega \tag{2}$$

where  $\Omega$  is a symmetric, non-singular and positive definite matrix representing correlation of error terms or different scale.

#### 2.1.1. The SURE model

A basic characteristic of multiple regression model is that it describes the impact of a set of explanatory variables on a dependent variable. However, when the objective is to explain the analysed phenomenon in a system manner, more than one multiple regression equation may be necessary. For example, in a set of individual linear multiple regression equations, each equation may explain some economic phenomenon. One approach to handle such a set of equations is to consider the setup of simultaneous equations model in which one or more of the explanatory variables in one or more equations are itself the dependent variable associated with another equation in the full system.

For simplicity one may consider on the other hand the system, where none of the variables in the system are simultaneously both explanatory and dependent in nature. There may still be interactions between the individual equations if the random error components associated with at least some of the different equations are correlated with each other. This means that

the equations may be linked statistically, even though not structurally – through the jointness of the distribution of the error terms and through the non-diagonal covariance matrix. Such behaviour is reflected in the Seemingly Unrelated Regression Equations (SURE) model in which the individual equations are in fact related to one another, even though superficially they may not seem to be. Estimating the equations separately will not utilize the information that the same set of parameters appears in all the equations (Greene, 2003).

The basic philosophy of the SURE model is as follows. The jointness of the equations is explained by the structure of the SURE model and the covariance matrix of the associated disturbances. Such jointness introduces additional information which is over and above the information available when the individual equations are considered separately. So it is desired to consider all the separate relationships collectively to draw the statistical inferences about the model parameters. Moon and Perron (2006) indicate two main motivations for use of SUR. The first one is to gain efficiency in estimation by combining information on different equations. The second motivation is to impose and/or test restrictions that involve parameters in different equations.

The basic SURE model assumes, for each observation  $i$ , there are  $M$  dependent variables, each with its own linear regression model

$$y_{ti} = \sum_{j=1}^{k_i} x_{tij} \beta_{ij} + \varepsilon_{ti}$$

$t= 1,2, \dots T; i= 1,2, \dots, M; j=1,2, \dots, k$  (3)

where  $y_{ti}$  is the  $t^{th}$  observation on the  $i^{th}$  dependent variable which is to be explained by the  $j^{th}$  regression equation,  $x_{tij}$  is the  $t^{th}$  observation on  $j^{th}$  explanatory variable appearing in the

$i^{th}$  equation,  $\beta_{ij}$  is the coefficient associated with  $x_{tij}$  at each observation and  $\varepsilon_{ti}$  is the  $t^{th}$  value of the random error component associated with  $i^{th}$  equation of the model.

The multiple equations can be written in following form:

$$\begin{aligned} y^{(1)} &= X^{(1)}\beta^{(1)} + \varepsilon^{(1)} \\ y^{(2)} &= X^{(2)}\beta^{(2)} + \varepsilon^{(2)} \\ &\vdots \\ y^{(M)} &= X^{(M)}\beta^{(M)} + \varepsilon^{(M)} \end{aligned} \quad (4)$$

These M equations can be expressed as:

$$y^{(i)} = X^{(i)}\beta^{(i)} + \varepsilon^{(i)}, i= 1,2,\dots, M \quad (5)$$

where  $y^{(i)}$ s ( $T \times 1$ ) vector with elements  $y_{ti}$ ;  $X^{(i)}$  is ( $T \times K_i$ ) matrix whose columns represent the T observations on an explanatory variable in the  $i^{th}$  equation;  $\beta^{(i)}$  is a ( $K_i \times 1$ ) vector with elements  $\beta_{ij}$ ; and  $\varepsilon^{(i)}$  is a ( $T \times 1$ ) vector of error terms.

Alternatively, in matrix form it can be expressed as:

$$\begin{bmatrix} y^{(1)} \\ y^{(2)} \\ \vdots \\ y^{(M)} \end{bmatrix} = \begin{bmatrix} X^{(1)} & 0 & \cdot & \cdot & \cdot & 0 \\ 0 & X^{(2)} & \cdot & \cdot & \cdot & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ 0 & 0 & \cdot & \cdot & X^{(M)} & \cdot \end{bmatrix} \begin{bmatrix} \beta^{(1)} \\ \beta^{(2)} \\ \cdot \\ \cdot \\ \cdot \\ \beta^{(M)} \end{bmatrix} + \begin{bmatrix} \varepsilon^{(1)} \\ \varepsilon^{(2)} \\ \cdot \\ \cdot \\ \cdot \\ \varepsilon^{(M)} \end{bmatrix} \quad (6)$$

or  $y = X\beta + \varepsilon$

In (6), each of the M equations can be treated as the classical regression model and conventional assumptions can be made for  $i = 1, 2, \dots, M$  as following:

- $X_i$  is fixed
- $rank(X_i) = K_i$
- $\lim_{T \rightarrow \infty} \left( \frac{1}{T} X_i' X_i \right) = Q_{ii}$  where  $Q_{ii}$  is nonsingular with fixed and finite elements.
- $E(\varepsilon_i) = 0$

- $E (\varepsilon_i \varepsilon_i') = \sigma_{ii}^2 I_T$  where  $\sigma_{ii}^2$  is the variance of disturbances in  $i^{\text{th}}$  equation for each observation in the sample.

Considering the interactions between the M equations of the model, we assume

- $\lim_{T \rightarrow \infty} \left( \frac{1}{T} X_i' X_j \right) = Q_{ij}$  (7)

- $E (\varepsilon_i \varepsilon_j') = \sigma_{ij}^2 I_T ; i, j = 1, 2, \dots, M$  (8)

Where  $Q_{ij}$  is a singular matrix with fixed and finite elements and  $\sigma_{ij}^2$  is the covariance between the disturbances of  $i^{\text{th}}$  and  $j^{\text{th}}$  equations for each observation in the sample.

It can be written as:

$$E (\varepsilon) = 0$$

$$E (\varepsilon \varepsilon') = \begin{bmatrix} \sigma_{11}^2 I_T & \sigma_{12}^2 I_T & \cdot & \cdot & \cdot & \sigma_{1M}^2 I_T \\ \sigma_{21}^2 I_T & \sigma_{22}^2 I_T & \cdot & \cdot & \cdot & \sigma_{2M}^2 I_T \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \sigma_{M1}^2 I_T & \sigma_{M2}^2 I_T & \cdot & \cdot & \cdot & \sigma_{MM}^2 I_T \end{bmatrix} = \Sigma \otimes I_T = \Psi \quad (9)$$

Where  $\otimes$  denotes the Kronecker product operator,  $\Psi$  is (MT X MT) matrix and  $\Sigma = \sigma_{ij}^2$  is (M X M) positive definite symmetric matrix. The positive definiteness of  $\Sigma$  avoids the possibility of linear dependencies among the contemporaneous disturbances in the M equations of the model.

### 2.1.2 Empirical Analyses in a SURE Framework

Zellner (1962) used an investment equation using data on 10 firms over 20 years. He used SURE model of 10 equations estimated with 20 time-series observations on each firm and showed that the resulting estimators could be more precise than those obtained by ordinary least-squares applied for each equation separately. The correlation among the disturbances

of these 10 investment equations could be due to existence of the macroeconomic environment affecting all 10 firms, where events like a recession in the economy or low interest rates, which if not included in the regression specification would end up in the disturbance term and correlate across equations. Other important applications of SURE models in economics include the estimation of a system of demand equations or a translog cost function along with its share equations (Berndt, 1991). For a system of demand equations that explains household consumption of several commodities, the correlation among these equations could be due to unobservable household specific attributes that influence the consumption of these commodities. Usually, this is estimated subject to budget restrictions, so the share of expenditures on these commodities should add up to one (Baltagi, 2020).

In practice, the variance-covariance matrix of the disturbances ( $\Sigma$ ) is not known and has to be estimated. Zellner (1962) recommended feasible generalized least squares (GLS) estimation based on estimating this variance-covariance matrix of the disturbances using ordinary least squares (OLS) residuals in the first step. In fact, one can iterate this procedure—that is, compute feasible GLS residuals and second-round estimates of this variance-covariance matrix using the GLS residuals. If this procedure is iterated until convergence, it is known as iterative SURE (ISURE) or iterative Zellner efficient procedure (Baltagi, 2020).

Srivastava and Giles (1987) dedicated a monograph to SUR models illustrating treatment of the SURE framework which includes the serially correlated case, the heteroskedastic case, the nonlinear case, the misspecified case, and the case with unequal number of observations, to mention a few. Fiebig (2001) provided a survey of research in this area including extensions to Bayesian methods, improved estimation, misspecification, and robust estimation. Moon and Perron (2006) describe SURE estimators used in the basic model as well as its extensions.

The popularity of SURE is related to its applicability to a large class of modelling and testing problems and also the relative ease of estimation and explanation. Also, an increased availability of data in recent years representing a sample of cross-sectional units observed over several time periods provides researchers with a rich source of information. The SURE methodology has not been widely used in analysis of banking sector despite its advantages especially in cross-country analysis for long panel data. To my knowledge, Olszak and Pipień (2016) are the first to use SURE methodology for procyclicality analysis in the banking sector. Olszak and Pipień (2016) applied the SURE methodology in order to verify the impact of some specific variables on loan loss provisions at aggregated (country) level. The sample consisted of 13 OECD countries for the time period ranging 1995-2009. They established that procyclicality of loan loss provisions is statistically significant almost in whole sample of countries by applying SURE methodology, in contrast to independent regression OLS analysis and most importantly when analysing standard panel regression techniques. They also established that in SURE specification the relationship with bank specific variables is of higher statistical significance than in the individual country regression approach.

The basic model used by Olszak and Pipień (2016) reads as follow:

$$\frac{LLP_{j,t}}{TA_{j,t}} = \alpha_{j,0} + \alpha_{j,1} \frac{LLP_{j,t-1}}{TA_{j,t-1}} + \alpha_{j,2} \Delta GDPG_{j,t} + \alpha_{j,3} INF_{j,t} + \alpha_{j,4} \frac{PROFIT_{j,t}}{TA_{j,t}} + \alpha_{j,5} \Delta Loans_{j,t} + \alpha_{j,6} \frac{CAP_{j,t}}{TA_{j,t}} + \varepsilon_{j,t} \quad (10)$$

Pipień and Anand (2023) later extended the framework (10) used by Olszak and Pipień (2016) to analyse procyclicality of loans supplied by the banks using same set of 13 countries for a time period ranging 2005-2020. They operate on the following system of regressions:

$$\frac{LOANS_{tj}}{TA_{tj}} = \alpha_{0,j} + \alpha_{1,j} \Delta GDPG_{tj} + \alpha_{2,j} INF_{tj} + \alpha_{3,j} UNEMP_{tj} + \alpha_{4,j} \frac{PROFIT_{tj}}{TA_{tj}} + \alpha_{5,j} \frac{LLP_{tj}}{TA_{tj}} + \alpha_{6,j} \frac{DEP_{tj}}{TA_{tj}} + \varepsilon_{tj}, \quad (11)$$

where the dependent variable is the loan supply (LOANS) of a bank divided by this bank's total assets (TA), annual growth of the real Gross Domestic Product is denoted by  $\Delta GDPG_{tj}$ , inflation rate is  $INF_{tj}$  and unemployment rate is  $UNEMP_{tj}$ . In formula (11) profits before taxes is denoted by  $\left(\frac{PROFIT_{tj}}{TA_{tj}}\right)$ , loans loss provisions by  $\left(\frac{LLP_{tj}}{TA_{tj}}\right)$ , and customer deposits of the bank  $\left(\frac{DEP_{tj}}{TA_{tj}}\right)$ . These three bank specific variables are expressed in relation to total assets.

Pipień and Anand (2023) find presence of procyclicality in many countries, which is amplified in significance by use of the SURE model. they also observe that bank-specific variables are more significant as determinants of loan supply compared to macroeconomic variables.

## 2.2 Procyclicality analysis using a SURE model

The research methodology used for procyclicality analysis in this thesis is based on the SURE model described in detail in previous section. The procyclicality analysis is performed for three variables measuring credit supply, credit risk and regulatory capital as described in chapter 1.

The basic model (based on Pipień and Anand, 2023) elaborated within panel regression environment reads as follows:

$$\frac{LOANS_{tj}}{TA_{tj}} = \alpha_0 + \alpha_1 \Delta GDPG_{tj} + \alpha_2 INF_{tj} + \alpha_3 UNEMP_{tj} + \alpha_4 \frac{PROFIT_{tj}}{TA_{tj}} + \alpha_5 \frac{LLP_{tj}}{TA_{tj}} + \alpha_6 \frac{DEP_{tj}}{TA_{tj}} + \varepsilon_{tj}, \quad (12)$$

where all variables are observed for  $j$ -th country ( $j=1,\dots,n$ ) at year  $t=1,\dots,T$ . The dependent variable is the loan supply (LOANS) of a bank divided by this bank's total assets (TA). The independent variables can be subdivided into two groups. In the first group we collect the macroeconomic variables, like annual growth of the real Gross Domestic Product ( $\Delta\text{GDPG}_{t,j}$ ) inflation rate ( $\text{INF}_{t,j}$ ) and unemployment rate ( $\text{UNEMP}_{t,j}$ ). The second group of variables consist of various bank-specific variables, like profits before taxes ( $\frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}}$ ), loans loss provisions ( $\frac{\text{LLP}_{t,j}}{\text{TA}_{t,j}}$ ), and customer deposits of the bank ( $\frac{\text{DEP}_{t,j}}{\text{TA}_{t,j}}$ ). All banking sector specific variables are normalized by the bank total average assets (TA) to mitigate potential estimation problems with heteroscedasticity. Following Pipień and Anand (2023), we move forward by relaxing assumption in (12) about cross-country homogeneity of parameters  $\alpha_i$ . In order to perform this task, we refer to the system of Seemingly Unrelated Regression Equations (SURE) elaborated by Zellner (1962). To start let us rewrite equation (12) making all regression parameters variable across  $j$ :

$$\frac{\text{LOANS}_{t,j}}{\text{TA}_{t,j}} = \alpha_{0,j} + \alpha_{1,j} \Delta\text{GDPG}_{t,j} + \alpha_{2,j} \text{INF}_{t,j} + \alpha_{3,j} \text{UNEMP}_{t,j} + \alpha_{4,j} \frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}} + \alpha_{5,j} \frac{\text{LLP}_{t,j}}{\text{TA}_{t,j}} + \alpha_{6,j} \frac{\text{DEP}_{t,j}}{\text{TA}_{t,j}} + \varepsilon_{t,j},$$

(13)

The standard assumption that, for each  $t$ , Gaussian error terms  $\varepsilon_{t,j}$  and  $\varepsilon_{t,i}$  in (13) are uncorrelated if  $i \neq j$ , makes the system of equations (13) independent. We denote this case by  $M_0$ . Application of such a system corresponds to the econometric strategy based on estimation of regression parameters separately for each country analysed. However, in general, error terms  $\varepsilon_{t,j}$  and  $\varepsilon_{t,i}$  can be correlated and the system (13) can be treated as falling

under the Seemingly Unrelated Regression Equations (SURE) model. We define this case as  $M_1$ , while  $\varepsilon_t = (\varepsilon_{t,1}, \dots, \varepsilon_{t,n})$  stands for the vector of error terms at time  $t$  with the covariance matrix  $\Sigma$ . In the case of model  $M_1$  the matrix  $\Sigma$  is symmetric and positive definite with  $n(n+1)/2$  free elements  $\sigma_{ij}^2$ ,  $i=1, \dots, n$  and  $j=1, \dots, n$ , such that  $\sigma_{ij}^2 = \sigma_{ji}^2$ . In the standard notation the variance of the error terms in the  $i$ -th country is denoted by  $\sigma_{ii}^2 > 0$  and the covariance between error terms in  $j$ -th and  $i$ -th country is denoted by  $\sigma_{ij}^2 \in R$  (refer to section 2.1.1; equations (7), (8) and (9)) We apply the following notation to the dependent variable and the vector of explanatory variables:

$$y_{t,j} = \frac{\text{LOANS}_{t,j}}{\text{TA}_{t,j}},$$

$$x_{t,j} = \left( 1, \text{GDPG}_{t,j}, \text{INF}_{t,j}, \text{UNEMP}_{t,j}, \frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}}, \frac{\text{LLP}_{t,j}}{\text{TA}_{t,j}}, \frac{\text{DEP}_{t,j}}{\text{TA}_{t,j}} \right).$$

The system of equations (13) can be formulated in the following closed form:

$$y^{(j)} = x^{(j)}\alpha^{(j)} + \varepsilon^{(j)}, j=1, \dots, n,$$

where  $y^{(j)} = (y_{1,j}, \dots, y_{T,j})'$ ,  $x^{(j)} = (x'_{1,j}, \dots, x'_{T,j})'$ ,  $\varepsilon^{(j)} = (\varepsilon_{1,j}, \dots, \varepsilon_{T,j})'$  and  $\alpha^{(j)} = (\alpha_{0,j}, \alpha_{1,j}, \dots, \alpha_{6,j})'$ . In the next step we stack the observations presenting the system of equations as a regression of the following form:

$$Y = X\alpha + \varepsilon, \tag{14}$$

where  $Y_{[nTx1]} = (y^{(1)'}, \dots, y^{(n)'})'$ ,  $\varepsilon_{[nTx1]} = (\varepsilon^{(1)'}, \dots, \varepsilon^{(n)'})'$ ,  $\alpha_{[n7x1]} = (\alpha^{(1)'}, \dots, \alpha^{(n)'})'$  and:

$$X_{[nTxn7]} = \begin{pmatrix} x^{(1)} & 0_{[Tx7]} & \dots & 0_{[Tx7]} \\ 0_{[Tx7]} & x^{(2)} & \dots & \vdots \\ \vdots & \ddots & \ddots & 0_{[Tx7]} \\ 0_{[Tx7]} & \dots & 0_{[Tx7]} & x^{(n)} \end{pmatrix}.$$

Simple calculations yield the following form of the covariance matrix for the error term  $\varepsilon$  in

(3)

$$V(\varepsilon) = \Sigma \otimes I_n, \quad (15)$$

According to section 2.1 (equation (2)), the form of the covariance matrix of  $\varepsilon$  makes the system (13) a generalised linear regression. Given  $\Sigma$ , the Aitken Generalised Least Squares estimator of all parameters in the system can be expressed in the following form:

$$\hat{\alpha} = (X'(\Sigma \otimes I_n)^{-1}X)^{-1}X'(\Sigma \otimes I_n)^{-1}y. \quad (16)$$

In the  $M_0$  case, where  $\Sigma = \text{diag}(\sigma_{11}^2, \dots, \sigma_{nn}^2)$  we have:

$$\hat{\alpha} = \hat{\alpha}_{OLS} = (X'X)^{-1}X'y, \quad (17)$$

which is equivalent to the application of the OLS estimator to each equation separately. In the general case,  $M_1$ , we have to estimate the covariance matrix  $\Sigma$ . We apply the Zellner (1962) method, and estimate elements of matrix  $\Sigma$  on the basis of OLS residuals, denoted by  $\hat{\varepsilon}_{[nTx1]} = (\hat{\varepsilon}^{(1)'}, \dots, \hat{\varepsilon}^{(n)'})'$ . The Estimated GLS, elaborated by Zellner (1962) takes the following form:

$$\hat{\alpha}_{EGLS} = (X'(S \otimes I_n)^{-1}X)^{-1}X'(S \otimes I_n)^{-1}y, \quad (18)$$

where:

$$S = \frac{1}{T}(\hat{\varepsilon}^{(1)}, \dots, \hat{\varepsilon}^{(n)})'(\hat{\varepsilon}^{(1)}, \dots, \hat{\varepsilon}^{(n)}). \quad (19)$$

The nondiagonal matrix  $S$  informs about the correlations between error terms from different equations. Hence it can be treated as a measure of the strength of cross-country linkages.

The system of equations (13) (based on Pipień and Anand, 2023) will be extended to perform procyclicality analysis for credit risk and regulatory capital.

The SURE approach elaborated to analyse procyclicality of loans; see formula (13) was also considered in case of testing the procyclicality of credit risk and regulatory capital. In case of

the model built for the credit risk (as measured by non-performing loans) the SURE framework reads as follows:

$$\frac{LLP_{t,j}}{TA_{t,j}} = \alpha_{0,j} + \alpha_{1,j} \Delta GDPG_{t,j} + \alpha_{2,j} INF_{t,j} + \alpha_{3,j} UNEMP_{t,j} + \alpha_{4,j} \frac{PROFIT_{t,j}}{TA_{t,j}} + \alpha_{5,j} \frac{LOANS_{t,j}}{TA_{t,j}} + \alpha_{6,j} \frac{DEP_{t,j}}{TA_{t,j}} + \varepsilon_{t,j}, \quad (20)$$

The basic model for procyclicality analysis of regulatory capital (indicated by capital buffer) within SURE framework reads as follows:

$$CAPBUF_{t,j} = \alpha_0 + \alpha_{1,j} CAPBUF_{t-1,j} + \alpha_{2,j} GDPG_{t,j} + \alpha_{3,j} INF_{t,j} + \alpha_{4,j} UNEMP_{t,j} + \alpha_{5,j} \frac{PROFIT_{t,j}}{TA_{t,j}} + \alpha_{6,j} \frac{LOANS_{t,j}}{TA_{t,j}} + \alpha_{7,j} NPL + \alpha_{8,j} ROE + \varepsilon_{t,j}, \quad (21)$$

Where CAPBUF is capital buffer;  $CAPBUF = (Total\ Capital - Required\ Capital) / Required\ Capital$ .

### 2.3 Selection of EU-15 countries for analysis of procyclicality

The rationale for selecting a sample for an empirical analysis is relevant in order to make sure that the results are interpretable as well as implementable. For analyzing procyclicality of the credit supply by banks, it is important to select a group of countries based on rational justification and sampling criteria.

The European Union (EU) is a unique economic and political union among 27 EU countries that together cover much of the European continent. The EU was conceptualized with formation of European Economic Community (EEC) in 1958 with six countries- Belgium, Germany, France, Italy, Luxembourg and Netherlands. Since then, 22 other countries joined, and EU has developed as an internal single market (see Table 3).

Table 3: List of EU countries by entry year

Year of Entry	Countries
1/1/1958	Belgium, France, Germany, Italy, Luxembourg, Netherlands
1/1/1973	Denmark, Ireland, United Kingdom (left on 31 January 2020)
1/1/1981	Greece
1/1/1986	Portugal, Spain
1/1/1995	Austria, Finland, Sweden
1/5/2004	Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia
1/1/2007	Bulgaria, Romania
1/7/2013	Croatia

Source- <https://europa.eu>, Official website of the European Union

The financial crisis of 2007-08 had a global impact which included most of the developed economies including those of the EU. The crisis posed a threat of widespread bank failures in EU countries and near collapse of their financial systems. The European Banking Authority (EBA) was created to respond to the deepening of the Greek financial crisis in 2012 when the systemic problems of the European banks impacted the fiscal sustainability of member countries. EBA is a regulatory agency formed in order to build a single regulatory and supervisory framework for the entire EU banking sector. EBA provides inputs into the creation of a single, standard set of rules for EU banking and also promotes cooperation between national authorities on supervising banking groups that operate in more than one country. Europe has been at the forefront of removing barriers to economic integration in general and

banking specifically with creation of European Union (Jones, 2013). However, the EU is still a diverse group with countries within EU being at different stages of development and vary in terms of economic growth, domestic banking industry and organization of banking supervision at national level.

Table 4 presents banking size and credit supply contributions as a percentage of total EU banking size and credit supply by country for EU-27 members. Since the data considered is for 16 years (2005-2020), a maximum of 15 countries could be considered for empirical SURE estimation. As a result, only top 15 EU-countries by total assets are finally selected for empirical analysis covering 97.2% of total EU banking assets and 97.3% of total EU credit supply by banks (see Table 5).

Table 4: Share of EU-27 countries in EU banking assets and loans (As of 2020, after Brexit)

<b>Country</b>	<b>Asset%</b>	<b>Loans%</b>
France	33.1%	26.6%
Germany	25.1%	27.0%
Italy	8.2%	8.3%
Spain	7.0%	7.1%
Netherlands	5.7%	6.9%
Belgium	3.1%	3.1%
Denmark	2.6%	3.5%
Sweden	2.4%	3.7%
Austria	2.4%	2.8%
Luxembourg	1.7%	2.3%
Finland	1.7%	1.8%
Ireland	1.5%	1.6%
Portugal	1.0%	0.9%
Poland	0.9%	0.9%
Greece	0.9%	0.8%
Czech Republic	0.6%	0.6%
Hungary	0.4%	0.4%
Romania	0.3%	0.3%
Slovakia	0.3%	0.3%
Cyprus	0.2%	0.3%
Croatia	0.2%	0.2%
Bulgaria	0.2%	0.2%

Slovenia	0.1%	0.1%
Estonia	0.1%	0.1%
Malta	0.1%	0.1%
Lithuania	0.1%	0.0%
Latvia	0.1%	0.0%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>

Source: Own Elaboration based on BankScope data

Table 5: Share of top 15 EU countries in EU banking assets and loans (As of 2020, after Brexit)

<b>Country</b>	<b>Asset%</b>	<b>Loans%</b>
France	33.1%	26.6%
Germany	25.1%	27.0%
Italy	8.2%	8.3%
Spain	7.0%	7.1%
Netherlands	5.7%	6.9%
Belgium	3.1%	3.1%
Denmark	2.6%	3.5%
Sweden	2.4%	3.7%
Austria	2.4%	2.8%
Luxembourg	1.7%	2.3%
Finland	1.7%	1.8%
Ireland	1.5%	1.6%
Portugal	1.0%	0.9%
Poland	0.9%	0.9%
Greece	0.9%	0.8%
<b>Total</b>	<b>97.2%</b>	<b>97.3%</b>

Source: Own Elaboration based on BankScope data

Chapters 3 and 4 select a sample of top EU 15 countries by banking assets. Chapter 5 considers top 10 EU countries- Austria, Belgium, Denmark, France, Germany, Italy, Luxembourg, Netherlands, Spain and Sweden, covering 91.3% of total EU banking assets. The selection for procyclicality analysis for capital buffers is also restricted due to availability of longer time series data related to capital and other analysis variables for EU countries.

## 2.4 Summary of databases and software

In order to perform a procyclicality analysis for banking sector in European Union, data is used for bank related variables and macroeconomic variables. The data for all 27 EU countries have been considered initially for the time period 2005-2020. However, due to SURE estimation assumption ( $T > K$ ), the number of countries considered for final estimation are reduced to 15 based on their share in total EU banking assets.

The data for bank specific variables are collected at bank level from Moody's Analytics BankFocus and then aggregated at country level for the undertaken analysis in this thesis. The BankFocus database contains detailed financials for around 46000 banks spread across regions- North America, EMEA, APAC and LATAM. Data for macroeconomic variables, namely GDP growth rate, Inflation and Unemployment have been taken from the World Bank Development Indicators database.

The data analyses and data preparations are performed using MS Excel. Further, the OLS and SURE estimations are done using Gauss software.

## Chapter 3- Empirical importance of procyclicality of credit supply for banks in selected EU countries

### 3.1 Determinants of Loan Supply and Hypotheses development

There is a large body of empirical literature showing that the growth rate of loans tends to be positive during booms and negative during recessions. Consequently, periods of fast loan growth are followed by a decline in credit quality (Caporale et al., 2014), since banks can increase lending in two ways – either by reducing net interest margin or by lowering the credit screening criteria for new borrowers. In case of lowering screening criteria, there could be more potential borrowers who were earlier declined as not having sufficient creditworthiness. Such borrowers are riskier and have a higher probability of default in case of any adverse scenarios such as an economic downturn. Understanding business cycles and their associations with the banking system remains a primary challenge for researchers and economists after the 2007-2009 global financial crisis.

Bank credit is determined by many factors that can be split generally into two groups containing bank-specific variables and macroeconomic variables. A strong financial system and well-developed economy mutually support each other's growth. Bank capacity to expand long-term business loans depends on various factors including capitalization, size and the availability of long-term liabilities (Imran and Nishat, 2013). Vanhooose (2010) shows that the aggregate level of loans in the economy typically increases during expansions and falls during recessions. Goodhart and Segoviano (2004) explain that regulators are much stricter during recessions while reviewing banks due to higher default risk. This may lead to contraction in loan supply to the economy. On the other hand, during expansions, regulators are less strict, leading to increases in loan supply to the economy by banks. Bouheni and Hasnaoui (2017)

show positive co-movements for bank lending and business cycle for Eurozone banks with differentiated impacts for larger and smaller banks.

The variables chosen as possibly explanatory factors of credit supply are those traditionally applied for the income smoothing hypothesis (see Greenawalt and Sinkey, 1988; Beatty et al., 2002; Liu and Ryan, 2006), modified by the inclusion of business cycle measures (as in Laeven and Majnoni, 2003; Bikker and Metzemakers, 2005; Olszak and Pipień, 2016) (see Table 6).

Table 6: Definitions of variables used in analysis for Procyclicality of Credit Supply

Variable	Measure	Notation	Expected effect on Loan supply
<i>Dependent variable:</i>			
Loan Supply	Gross loans & advances to customers divided by total assets	<i>LOANS/TA</i>	
<i>Determinants:</i>			
<hr/>			
Banking sector specific:			
Profit	Profit before taxes divided by total assets	<i>PROFIT/TA</i>	+
Credit risk	Loans loss reserves divided by total assets	<i>LLP/TA</i>	-
Deposits	Capital to assets ratio.	<i>DEP/TA</i>	+
<hr/>			
Macroeconomic:			
Business cycle measure	Real GDP growth	<i>GDPG</i>	+
Business cycle measure	Inflation (Consumer Prices Index)	<i>INF</i>	+/-
Business cycle measure	Unemployment (% of total labour force)	<i>UNEMP</i>	-
<hr/>			

### 3.1.1 Macroeconomic determinants of credit supply

Three macroeconomic determinants of loans supply are considered denoted by GDPG, INF and UNEMP. The GDPG is real GDP growth and measures the procyclicality of loans. GDPG is the most preferred choice to investigate procyclicality at quarterly or annual frequencies (Banerjee, 2011). Empirical research shows also that GDPG is positively related to the credit supply (Gambacorta and Mistrulli, 2004; Bikker and Metzmakers, 2005; Jiménez et al., 2011; Banerjee, 2011; Kelly et al, 2013, Imran and Nishat, 2013). A negative correlation between

GDP and loan supply may indicate countercyclical behaviour of banks (Ibrahim, 2016; Albaity et al., 2020).

INF is the inflation rate and is measured by the consumer price index, which reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. We employ INF as an exogenous control variable. Inflation has been used as a determinant of credit supply by researchers (Gambacorta and Mistrulli, 2004; Djiogap and Ngomsi, 2012; Klein, 2013). However, if INF is considered as economic cycle variable, increasing in economic booms and decreasing during economic downturns we might expect that this variable is positively related to loans, which would be consistent with the procyclicality hypothesis emphasizing that loan supply increases in economic upswings and decrease in economic downswings (Klein, 2013).

UMEMP is the unemployment rate and refers to the share of the labour force that is without work but available for and seeking employment. Unemployment and GDPG series are negatively correlated, meaning that unemployment will be higher during recessions and vice-versa. Okun's law states that an economy experiences a 1 percentage point increase in unemployment for every 3-percentage point decrease GDPG from its long-run level (also called potential GDP). Conversely, a 3-percentage point increase in GDPG from its long-run level is associated with a 1 percentage point decrease in unemployment. Considering unemployment to be an economic variable, it is expected to be negatively related with loans. Unemployment has been considered as a determinant of LOANS in previous studies (Gambacorta and Mistrulli, 2004; Klein, 2013; Donaldson et al., 2015).

### 3.1.2 Banking specific determinants of credit supply

As determinants of loan supply specific to the banking sector, we use three bank related variables – Profit, Loan Loss Provisions and Deposits.

PROFIT is operating profit before provisions and taxes divided by total assets (PROFIT/TA) of the banks. The relation between this variable and loans is applied to verify whether profits lead to expansion of bank credit. Richter and Zimmermann (2019) find that profits increase net worth and lending capacity of the bank thereby increasing the supply of loans. Profits are positively correlated with credit supply (Barona and Xiong, 2017). Bank profitability could be a motive for banks to expand their loans indicating a positive correlation between profits and credit supply (Awdeh, 2017; Alihodžić and Ekşi, 2018).

Loan Loss provisions divided by total assets (LLP/TA) is introduced as an independent variable as a proxy for credit risk. Changes in total loans outstanding are related to changes in default risk (and also credit risk). If banks use LLP (i.e., their portion set aside to cover expected losses) to manage credit risk, then the relationship between LLP and LOANS is positive. Otherwise, when banks show imprudent loan loss provisioning behaviour, the supply of loans exerts a negative impact on LLP. Empirical results regarding this relationship do vary. Some papers find positive influence of real loan growth on LLP (Bikker and Metzmakers, 2005; Fonseca and González, 2008) implying that banks set aside provisions to cover risks which have built up during economic booms. Other studies document a negative coefficient on loans (Laeven and Majnoni, 2003), which implies the rejection of the hypothesis of prudent loan loss provisioning behaviour.

Total deposits normalized by total assets (DEP/TA) is introduced to test the liquidity hypothesis. Traditionally, the amount of credit provided by banks was directly related to the level of deposits they held. However, over the past 10-15 years, financial innovation broke the link between credit and deposits. The resulting increase in substandard credit has been identified by many authors as one of the main contributing factors to the 2007-09 financial

crisis (Kelly et al., 2013). Given the structure of the banking system, lending normally generates deposits. When a bank grants a loan to a household or firm, the loan proceeds will first be credited to the borrower's bank account. This means that lending will initially be offset by corresponding deposits and thus by an increase in the money stock (Bang-Andersen et al., 2014). Therefore, deposits have a direct and positive relation with credit supply in the economy.

### 3.2 Estimation Equations

The basic model (based on Pipień and Anand, 2023) elaborated within a panel regression environment reads as follows:

$$\frac{LOANS_{t,j}}{TA_{t,j}} = \alpha_0 + \alpha_1 \Delta GDPG_{t,j} + \alpha_2 INF_{t,j} + \alpha_3 UNEMP_{t,j} + \alpha_4 \frac{PROFIT_{t,j}}{TA_{t,j}} + \alpha_5 \frac{LLP_{t,j}}{TA_{t,j}} + \alpha_6 \frac{DEP_{t,j}}{TA_{t,j}} + \varepsilon_{t,j}, \quad (22)$$

where all variables are observed for  $j$ -th country ( $j=1, \dots, n$ ) at year  $t=1, \dots, T$ . The dependent variable is the loan supply (LOANS) of a bank divided by this bank's total assets (TA). The independent variables can be subdivided into two groups. In the first group we collect the macroeconomic variables, like annual growth of the real Gross Domestic Product ( $\Delta GDPG_{t,j}$ ) inflation rate ( $INF_{t,j}$ ) and unemployment rate ( $UNEMP_{t,j}$ ). The second group of variables consist of various bank-specific variables, like profits before taxes ( $\frac{PROFIT_{t,j}}{TA_{t,j}}$ ), loans loss provisions ( $\frac{LLP_{t,j}}{TA_{t,j}}$ ), and customer deposits of the bank ( $\frac{DEP_{t,j}}{TA_{t,j}}$ ). All banking sector specific variables are normalized by the bank total average assets (TA) to mitigate potential estimation problems with heteroscedasticity. Following Pipień and Anand (2023), we move forward by relaxing assumption in equation (22) about cross-country homogeneity of parameters  $\alpha_i$ . In order to perform this task, we refer to the system of Seemingly Unrelated Regression

Equations (SURE) elaborated by Zellner (1962). To start let us rewrite equation (1) making all regression parameters variable across  $j$ :

$$\frac{LOANS_{tj}}{TA_{tj}} = \alpha_{0,j} + \alpha_{1,j} \Delta GDP_{tj} + \alpha_{2,j} INF_{tj} + \alpha_{3,j} UNEMP_{tj} + \alpha_{4,j} \frac{PROFIT_{tj}}{TA_{tj}} + \alpha_{5,j} \frac{LLP_{tj}}{TA_{tj}} + \alpha_{6,j} \frac{DEP_{tj}}{TA_{tj}} + \varepsilon_{tj}, \quad (23)$$

### 3.3 Results and discussion

We used annual data forming the balanced panel for 15 EU countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain and Sweden covering the period from 2005 to 2020. Table 7 and Table 8 present some descriptive statistics for the variables applied in this study.

On average, the banking sectors in our sample have loans of 57% in relation to total assets over the entire period of 2005 – 2020, however this ratio substantially varies across countries, ranging from 22.3% to 83.1%. Greece, Sweden and Portugal have high average LOANS/TA with values 71.3%, 70% and 66.6% whereas France, Luxembourg and Germany have low average LOANS/TA with values of 37.3%, 45.2% and 45.3% respectively. Also, profits, deposits and loan loss provisions with relation to total assets is very diverse across countries. Of our three macroeconomic determinants, two of them (growth rate of GDP and inflation) show comparable mean levels, of 1.2%-1.5%. However, the growth rate of GDP is far more diversified across countries, with minimum and maximum values of -10.82% and 25.18% respectively. Average GDP growth rate combined for all countries during the analysis period is 1.20%. Italy and Greece are two countries with a negative average GDP growth rate (-0.53% and -1.56% respectively) during the analysis period. On the other hand, Ireland and Poland have the highest GDP growth rate (4.70% and 3.61% respectively) during this period. The

average unemployment rate is 8.93% and shows strong heterogeneity across countries, with a possible existence of huge outliers as the sample kurtosis is greater than 6. Greece has the highest average unemployment rate (17.3%) whereas Netherlands has the lowest average unemployment rate (5.1%) during this period.

Table 9 presents the correlation matrix of the regression variables. The overall sample yields information about the relative weak associations between related variable (loans with respect to total assets) and explanatory variables. The strongest correlation is identified in case of variables representing condition of the banking sector. All three variables (profits, deposits, and loan loss provisions) are highly correlated. Surprisingly they are not as strongly correlated with the related variable as one may expect. Later in the article we show that reporting weak relationships between analysed variables is erroneous. The most important factor driving the nature of relationships between analysed variables is cross country heterogeneity evident within the SURE model.

Tables 10, 11 and 12 present the results of estimation of parameters in equations (22) and (23). As a point of departure, we estimated parameters in equation (22) using fixed-effect (FE) panel regression techniques. In this case, no country diversity of impact of explanatory variables to the loans (to total assets) can be achieved. The results are collected in Table 10. Among all factors potentially influencing variability of the loans (to total assets), only loan loss provision is empirically important as we receive statistically significant estimates of parameters corresponding to LLP. Surprisingly, deposits (to total assets) and profits (to total assets) are not as much important as the LLP measure. In contrast to these results, the macroeconomic variables appear not to contribute significantly to the loans (to total assets). Point estimates of corresponding parameters are relatively small and insignificant.

The results of our empirical insight into cross country heterogeneity of analysed relationships are presented in Tables 11 and 12. In Table 11, we report estimation outcomes in case when imposing assumption of no correlations between  $\varepsilon_{t,j}$  and  $\varepsilon_{s,i}$  in the system of equations (23) (model  $M_0$ ). It means that in this setting we run OLS separately for each country in the sample according to equation (4). Such estimation treats the regression for each country separately, and ignores interactions among the equations, at the same time implying that there are no linkages between countries. Table 12 presents the results of estimation in case of model  $M_1$ , i.e., the system (23) with non-diagonal covariance matrix. In this case we follow the Zellner (1962) estimator given by the formula (5). In both cases, namely  $M_0$  and  $M_1$  data clearly support cross country diversity in the nature of the relationship between loans (to total assets) and other variables of interest. Also, in predominant cases, the relationship, as measured by estimates of the corresponding parameter, is statistically significant. Statistical insignificance of the FE outcomes in equation (22) discussed above, has its origin in assumptions imposed within the panel regression neglecting possible heterogeneity of parameters across objects. The statistical significance as well as the direction of the sign of the relationship (positive or negative) between related variable and explanatory variables in (23) are presented in Tables 13 and 14. Such an exhibit replicates to some extent some information from Tables 11 and 12, but it permits qualitative insight into the procyclicality effects and the strength of analysed linkages. Analysing the role of economic growth in describing the loans fluctuations, we reported initially a very weak, slightly negative but statistically insignificant impact; see Table 10 for FE panel regression outcomes. According to the system (23) in both stochastic settings ( $M_0$  and  $M_1$ ) the analysed relationship is very diverse across countries. In general, the SURE model ( $M_1$ ) provides more precise estimates. Consequently, inference about statistical

significance of parameters is much stronger than in case  $M_0$  representing independent regressions in (23). Countries with positive impact of economic growth fluctuations on loans (to total assets) are Austria, Belgium, France, Luxembourg and Netherlands. However, according to the model  $M_1$  this impact may be treated as decisively significant only in the case of Austria, Belgium, France and Netherlands. The lack of significance between growth rate of GDP and loans (to total assets) in case of other countries merits attention. There are also countries with a negative impact of economic growth fluctuations to loans (to total assets). Table 14 shows that among the set of such countries, namely Finland and Sweden, only in the case of Sweden we may report strong significance.

The impact of inflation to loans (to total assets) was also insignificant, provided the FE estimates presented in Table 10. In case of model  $M_1$  we see some diversity. Negative and significantly supported by the data impact was obtained in case of Austria, Belgium, France, Germany, Netherlands and Poland. Positive and statistically significant influence may be reported for Greece, Ireland, Italy, Luxembourg, Portugal and Spain. In case of other countries, the relationship between inflation and loans (to total assets) is insignificant.

The unemployment indicator was the third and last category in the set of macroeconomic variables used in our analyses. Just as in case of growth rate of GDP and inflation, the FE panel estimates indicate empirical unimportance of the relationship between inflation and loans (to total assets). According to Table 14, in case of SURE model ( $M_1$ ), the predominant statistically significant impacts are negative and are attached to Austria, Finland, France, Netherlands, Poland and Portugal. In case of Belgium, Greece, Ireland, Luxembourg and Spain, the unemployment rate has a positive and significant impact to loans (to total assets).

In the panel regression (22) and in the system (23) we also considered as explanatory variables some observed categories representing activity of the banking sector. Among them, loan loss provisions (both to total assets) are significant in the FE panel regression at the 0.01 level. The results obtained for model  $M_1$  show a very interesting side of the nature of analysed relationships. The impact of profit to loans (both to total assets) is positive and statistically significant at least at level 0.1 in case of Finland, Ireland, Poland, Spain and Sweden. In case of Austria, Belgium, France, Germany, Italy and Portugal, the impact is also statistically significant but negative. Also, regarding the relationship between the loan loss provision and loans (to total assets), the model  $M_1$  (Table 14) indicates an increasing relationship for twelve out of fifteen countries. The predominant identified cases are characterised by statistically significant parameters in (23). Only for Ireland and Spain, there is strong data evidence in favour of negative impact of loan loss provisions to loans (both to total assets).

Table 10 shows that the FE panel regression estimates indicate statistically insignificant relationships between loans (to total assets) and bank-related variables namely loan loss provisions, profits and deposits (all to total assets). The OLS model ( $M_0$ ) and the SURE specification ( $M_1$ ) provide contrasting results compared to FE panel outcomes and result in significant linkages between loans (to total assets) and bank-related variables. Profits (to total assets) has a mixed impact to loans (to total assets). Out of 15 countries, 6 countries have positive and significant linkages whereas 5 countries have negative significant association. In comparison, LLP (to total assets) have strong evidence of positive relationship with loans (to total assets) for 12 out of 15 countries with only Ireland and Spain having negative and significant relationship. Deposits (to total assets) is also insignificant for FE model (Table 10). However, it is significant and have positive linkages with loans (to total assets) for 7 countries

whereas for 3 countries, this variable has negative association. For remaining 5 countries, deposits (to total assets) are not empirically significant (Table 14).

Table 15 presents the results of estimation of the elements of the covariance matrix  $\Sigma$  necessary in case of the SURE specification. We report point estimates of the variances (bold font), contemporaneous covariances (in italics, above the diagonal) and contemporaneous correlations (below the diagonal) of error terms. Analysing the estimates of correlations, it is clear, that the system regression approach, applied in case of model  $M_1$ , is empirically important. Simple analysis, based on the country independent regressions formally imposing assumption of diagonality of the covariance matrix, ignores cross country financial linkages, which seem to be substantial. The strongest correlations in the system are positive with some exceptions. The strongest financial linkage, as measured by the correlation of the error terms, is observed between Netherlands and Ireland (0.77). Also, in case of pairs France- Belgium, France-Finland, Germany-Greece, Poland-Denmark, Poland-France, Poland-Greece, Poland-Ireland, Poland-Netherlands, Spain-Belgium, Spain-Denmark, Spain-Poland, the positive correlation exceeds 0.5. The few exceptions with strong negative correlations (exceeding 0.5) are pairs of Belgium-Sweden and Poland-Luxembourg. It is also interesting to note that Poland has significant financial linkages, as measured by correlation of the error terms, with 6 countries (5 positive and 1 negative).

Table 7: Descriptive statistics of the analysed series for Credit Supply

	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$	$\frac{LLP_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	GDPG <sub>t,j</sub>	UNEMP <sub>t,j</sub>	INF <sub>t,j</sub>
Mean	0.5668	0.4111	0.0183	0.0044	1.2018	8.7226	1.4860
Median	0.5782	0.4058	0.0089	0.0056	1.6681	7.6750	1.4948
Maximum	0.8314	0.7340	0.1917	0.0223	25.1763	27.4700	4.8971
Minimum	0.2227	0.0850	0.0006	-0.1107	-10.8229	3.1400	-4.4781
Std. Dev.	0.1120	0.1412	0.0289	0.0099	3.5704	4.7686	1.3158
Skewness	-0.5895	0.1522	3.9334	-6.9979	0.4312	1.9018	-0.1685
Kurtosis	3.1629	2.6770	20.7262	78.2323	11.9696	6.6683	4.0632
Jarque-Bera Probability	14.1664 0.0008	1.9699 0.3735	3761.0500 0.0000	58557.7700 0.0000	811.9724 0.0000	279.2333 0.0000	12.4392 0.0020
Sum	136.0244	98.6632	4.4008	1.0527	288.4403	2093.4200	356.6465
Sum Sq. Dev.	2.9998	4.7661	0.1993	0.0235	3046.6350	5434.7990	413.7647
No. of observations	240	240	240	240	240	240	240

Table 8: Country-wise statistics of the analysed series for Credit Supply

Country	Avg of Loans/TA	Avg of Deposit/TA	Avg of LLP/TA	Avg of Profit/TA	Avg of GDP	Avg of UNEMP	Avg of INF
Austria	0.55	0.47	0.01	0.00	0.99	5.14	1.85
Belgium	0.48	0.42	0.01	0.00	1.10	7.45	1.86
Denmark	0.64	0.17	0.01	0.00	1.14	5.88	1.43
Finland	0.52	0.30	0.00	0.01	0.87	7.93	1.37

France	0.37	0.29	0.01	0.00	0.64	8.93	1.22
Germany	0.45	0.40	0.00	0.00	1.12	6.03	1.39
Greece	0.71	0.56	0.09	-0.01	-1.56	17.29	1.28
Ireland	0.57	0.37	0.03	0.00	4.70	9.08	1.00
Italy	0.59	0.42	0.03	0.00	-0.53	9.49	1.35
Luxembourg	0.45	0.39	0.00	0.00	2.34	5.38	1.78
Netherlands	0.53	0.44	0.01	0.00	1.16	5.14	1.60
Poland	0.65	0.68	0.03	0.01	3.61	8.38	2.08
Portugal	0.67	0.55	0.03	0.00	0.15	10.12	1.33
Spain	0.60	0.48	0.02	0.01	0.51	17.21	1.59
Sweden	0.70	0.23	0.00	0.01	1.79	7.39	1.17

Table 9: Matrix of sample correlation of the analysed series for Credit Supply

	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$GDPG_{t,j}$	$INF_{t,j}$	$UNEMP_{t,j}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LLP_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
$\frac{LOANS_{t,j}}{TA_{t,j}}$	1	-0.0596	-0.06685	0.3039***	-0.0621	0.4209***	0.2548***
$\Delta GDPG_{t,j}$	-0.0596	1	0.1168	-0.2090	0.4028***	-0.0826	-0.0079
$INF_{t,j}$	-0.0669	0.1168	1	-0.2772***	0.0918	-0.2689***	-0.0038
$UNEMP_{t,j}$	0.3039***	-0.2090	-0.2772***	1	-0.3275***	0.6820***	0.2444***
$\frac{PROFIT_{t,j}}{TA_{t,j}}$	-0.0621	0.4028***	0.0918	-0.3275***	1	-0.3553***	0.0697
$\frac{LLP_{t,j}}{TA_{t,j}}$	0.4209***	-0.0826	-0.2689***	0.6820***	-0.3553***	1	0.3885***
$\frac{DEP_{t,j}}{TA_{t,j}}$	0.2548***	-0.0079	-0.0038	0.2444***	0.0697	0.3885***	1

Note: \*\*\* denotes significance at 1% level

Table 10: Determinants of  $\frac{LOANS_{t,j}}{TA_{t,j}}$  - the FE panel estimates of parameters in equation (22)

	Intercept	$\frac{DEP_{t,j}}{TA_{t,j}}$	$\frac{LLP_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	GDPG <sub>t,j</sub>	UNEMP <sub>t,j</sub>	INF <sub>t,j</sub>
FE panel regression estimates							
Est.	0.4941***	0.0602	1.5993***	1.3085	-0.0022	0.001	0.0046
Std. error	0.0262	0.0526	0.3497	0.8025	0.0021	0.0019	0.0053
p-value	0.0000	0.2611	0.0001	0.1128	0.3017	0.6102	0.3958

Note: \*\*\* denotes significance at 1% level

Table 11: Cross country heterogeneity of determinants of  $\frac{LOANS_{t,j}}{TA_{t,j}}$  – estimates of parameters in equation (23) provided the model  $M_0$  (independent regressions)

		Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LLP_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
Country	The system of independent regressions; $M_0$							
Austria	Est.	0.3726	0.0043	-0.0111	-0.0110	-3.4328	2.7895	0.5084
	Std. error	0.0514	0.0014	0.0053	0.0062	1.6958	0.7929	0.0565
	p-value	0.0000	0.0048	0.0430	0.0850	0.0514	0.0013	0.0000
Belgium	Est.	-0.0664	0.0119	-0.0154	0.0266	-12.8501	-0.3829	1.0116
	Std. error	0.0678	0.0018	0.0033	0.0061	1.5542	2.5155	0.1069
	p-value	0.3349	0.0000	0.0001	0.0001	0.0000	0.8800	0.0000
Denmark	Est.	0.7639	0.0022	0.0027	-0.0149	-1.5394	9.4396	-0.6515
	Std. error	0.0681	0.0025	0.0059	0.0110	2.7507	4.3212	0.2792
	p-value	0.0000	0.4004	0.6481	0.1845	0.5796	0.0364	0.0261
Finland	Est.	0.2957	-0.0037	0.0096	-0.0058	15.8513	19.8205	0.3226
	Std. error	0.0737	0.0020	0.0057	0.0083	3.2715	8.1846	0.0907
	p-value	0.0003	0.0790	0.1021	0.4922	0.0000	0.0213	0.0012
France	Est.	0.2577	0.0068	-0.0120	-0.0111	-6.7006	8.3209	0.6122
	Std. error	0.0357	0.0014	0.0045	0.0051	1.6173	2.1204	0.0721
	p-value	0.0000	0.0000	0.0126	0.0378	0.0002	0.0004	0.0000
Germany	Est.	0.0886	0.0011	-0.0043	0.0011	-3.6973	2.1862	0.9149
	Std. error	0.0437	0.0009	0.0031	0.0016	2.0232	1.6798	0.0898
	p-value	0.0510	0.2001	0.1735	0.4809	0.0770	0.2024	0.0000
Greece	Est.	0.5352	0.0000	0.0226	0.0047	0.0781	0.7704	-0.0043
	Std. error	0.0967	0.0026	0.0067	0.0027	0.3994	0.2600	0.1365
	p-value	0.0000	0.9853	0.0018	0.0876	0.8461	0.0057	0.9752
Ireland	Est.	0.1815	0.0007	0.0167	0.0290	3.4827	-2.7085	0.4824
	Std. error	0.1556	0.0020	0.0073	0.0117	2.1039	1.2719	0.2271

	p-value	0.2522	0.7254	0.0290	0.0189	0.1076	0.0410	0.0415
Italy	Est.	0.5400	-0.0014	0.0197	-0.0082	-3.1323	1.1344	0.1991
	Std. error	0.0577	0.0020	0.0062	0.0068	1.6377	0.8777	0.1634
	p-value	0.0000	0.4832	0.0033	0.2354	0.0648	0.2055	0.2321
Luxembourg	Est.	-0.9236	0.0162	0.0454	0.1089	0.6702	111.8377	0.9288
	Std. error	0.3394	0.0068	0.0235	0.0389	8.2833	31.3032	0.8698
	p-value	0.0104	0.0224	0.0626	0.0086	0.9360	0.0011	0.2936
Netherlands	Est.	0.2544	0.0065	-0.0099	-0.0238	-0.9938	29.3472	0.5988
	Std. error	0.0787	0.0024	0.0080	0.0069	1.4161	5.0020	0.1437
	p-value	0.0029	0.0112	0.2221	0.0017	0.4879	0.0000	0.0002
Poland	Est.	1.2963	-0.0014	-0.0098	-0.0260	7.5402	13.4959	-1.2601
	Std. error	0.2775	0.0039	0.0044	0.0036	2.5263	2.0125	0.4039
	p-value	0.0001	0.7153	0.0320	0.0000	0.0054	0.0000	0.0038
Portugal	Est.	0.9072	0.0025	0.0050	-0.0027	-1.8491	0.6431	-0.4227
	Std. error	0.0366	0.0014	0.0028	0.0016	1.1265	0.4918	0.0479
	p-value	0.0000	0.0844	0.0833	0.0984	0.1105	0.2003	0.0000
Spain	Est.	0.5623	-0.0002	0.0038	0.0051	3.1246	-2.6224	-0.0558
	Std. error	0.0837	0.0022	0.0052	0.0027	2.1874	2.2432	0.1284
	p-value	0.0000	0.9411	0.4769	0.0644	0.1628	0.2510	0.6668
Sweden	Est.	0.3780	-0.0115	0.0003	-0.0041	42.7824	40.4235	-0.2072
	Std. error	0.1077	0.0028	0.0063	0.0103	8.1683	10.0428	0.1639
	p-value	0.0014	0.0003	0.9596	0.6931	0.0000	0.0003	0.2152

Table 12: Cross country heterogeneity of determinants of  $\frac{LOANS_{t,j}}{TA_{t,j}}$  – estimates of parameters in equation (23) provided the model  $M_1$  (SURE specification)

		Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LLP_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
Country	The SURE Model: $M_1$							
Austria	Est.	0.3788	0.0041	-0.0100	-0.0115	-2.8111	3.1739	0.4803
	Std. error	0.0331	0.0008	0.0026	0.0034	0.6316	0.4855	0.0444
	p-value	0.0000	0.0000	0.0005	0.0019	0.0001	0.0000	0.0000
Belgium	Est.	-0.0705	0.0114	-0.0126	0.0245	-12.4242	0.0618	1.0335
	Std. error	0.0340	0.0012	0.0019	0.0028	0.7196	1.0833	0.0529
	p-value	0.0461	0.0000	0.0000	0.0000	0.0000	0.9548	0.0000
Denmark	Est.	0.7573	0.0017	-0.0011	-0.0112	-1.5589	7.4482	-0.6159
	Std. error	0.0321	0.0016	0.0036	0.0052	0.9458	1.9606	0.1453
	p-value	0.0000	0.2866	0.7613	0.0369	0.1091	0.0006	0.0002
Finland	Est.	0.3659	-0.0019	0.0060	-0.0136	13.9755	24.4005	0.2982
	Std. error	0.0598	0.0017	0.0050	0.0066	2.4851	5.6042	0.0658
	p-value	0.0000	0.2634	0.2362	0.0478	0.0000	0.0001	0.0001
France	Est.	0.2490	0.0070	-0.0108	-0.0125	-6.7083	8.2814	0.6847
	Std. error	0.0202	0.0009	0.0021	0.0028	1.0945	1.0650	0.0524
	p-value	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Germany	Est.	0.0889	0.0016	-0.0046	0.0006	-3.4457	2.8872	0.9116
	Std. error	0.0284	0.0006	0.0020	0.0010	1.1566	0.8510	0.0592
	p-value	0.0038	0.0069	0.0319	0.5465	0.0055	0.0019	0.0000
Greece	Est.	0.4656	-0.0002	0.0274	0.0060	-0.0960	0.7727	0.0638

	Std. error	0.0661	0.0020	0.0049	0.0020	0.2464	0.1904	0.0911
	p-value	0.0000	0.9017	0.0000	0.0055	0.6993	0.0003	0.4886
Ireland	Est.	0.2251	0.0002	0.0162	0.0227	3.1034	-2.0640	0.4776
	Std. error	0.1043	0.0012	0.0055	0.0075	1.3177	0.8390	0.1633
	p-value	0.0386	0.8430	0.0058	0.0050	0.0248	0.0195	0.0063
Italy	Est.	0.5418	-0.0017	0.0209	-0.0047	-3.1034	0.9887	0.1187
	Std. error	0.0436	0.0016	0.0047	0.0043	0.8667	0.5422	0.1304
	p-value	0.0000	0.3060	0.0001	0.2910	0.0011	0.0776	0.3697
Luxembourg	Est.	-0.7598	0.0140	0.0459	0.1032	5.9671	110.8511	0.5395
	Std. error	0.2617	0.0056	0.0195	0.0269	5.5087	25.8156	0.6293
	p-value	0.0066	0.0183	0.0249	0.0005	0.2868	0.0002	0.3977
Netherlands	Est.	0.2267	0.0062	-0.0075	-0.0222	-0.4161	27.2060	0.6551
	Std. error	0.0404	0.0017	0.0036	0.0043	0.5894	3.1038	0.0767
	p-value	0.0000	0.0009	0.0488	0.0000	0.4853	0.0000	0.0000
Poland	Est.	1.1293	-0.0002	-0.0089	-0.0222	4.7493	12.3356	-0.9674
	Std. error	0.1395	0.0022	0.0031	0.0021	1.3636	1.5711	0.2156
	p-value	0.0000	0.9157	0.0066	0.0000	0.0015	0.0000	0.0001
Portugal	Est.	0.8842	0.0026	0.0061	-0.0020	-1.3391	0.5404	-0.3946
	Std. error	0.0215	0.0009	0.0016	0.0010	0.4282	0.2059	0.0306
	p-value	0.0000	0.0052	0.0006	0.0434	0.0037	0.0132	0.0000
Spain	Est.	0.4905	0.0006	0.0062	0.0040	2.4983	-2.5030	0.1317
	Std. error	0.0359	0.0012	0.0026	0.0013	0.8386	0.7538	0.0848
	p-value	0.0000	0.6254	0.0250	0.0036	0.0055	0.0023	0.1305
Sweden	Est.	0.4112	-0.0091	-0.0018	-0.0083	39.2439	41.8738	-0.1264
	Std. error	0.0778	0.0022	0.0049	0.0075	5.6512	6.9001	0.1229
	p-value	0.0000	0.0002	0.7174	0.2740	0.0000	0.0000	0.3112

Table 13: The sign and significance of impact in equation (23) – the model  $M_0$  (independent regressions)

	Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}}$	$\frac{\text{LLP}_{t,j}}{\text{TA}_{t,j}}$	$\frac{\text{DEP}_{t,j}}{\text{TA}_{t,j}}$
Austria	+***	+***	-**	-*	-*	+***	+***
Belgium	-	+***	-***	+***	-***	-	+***
Denmark	+***	+	+	-	-	+**	-**
Finland	+***	-*	+	-	+***	+**	+***
France	+***	+***	-**	-**	-***	+***	+***
Germany	+*	+	-	+	-*	+	+***
Greece	+***	-	+***	+*	+	+***	-
Ireland	+	+	+**	+**	+	-**	+**
Italy	+***	-	+***	-	-*	+	+
Luxembourg	-**	+**	+*	+***	+	+***	+
Netherlands	+***	+**	-	-***	-	+***	+***
Poland	+***	-	-**	-***	+***	+***	-***
Portugal	+***	+*	+*	-*	-	+	-***
Spain	+***	-	+	+*	+	-	-
Sweden	+***	-***	+	-	+***	+***	-

Note: the positive/negative impact of a particular variable is denoted by +/- respectively. We also put notation reporting the significance at level 0.01, 0.05 and 0.1 by \*\*\*, \*\* and \*.

Table 14: The sign and significance of impact in equation (23) – the model  $M_1$  (independent regressions)

	Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}}$	$\frac{\text{LLP}_{t,j}}{\text{TA}_{t,j}}$	$\frac{\text{DEP}_{t,j}}{\text{TA}_{t,j}}$
Austria	****	****	***	***	***	****	****
Belgium	**	****	***	****	***	+	****
Denmark	****	+	-	**	-	****	***
Finland	****	-	+	**	****	****	****
France	****	****	***	***	***	****	****
Germany	****	****	**	+	***	****	****
Greece	****	-	****	****	-	****	+
Ireland	**	+	****	****	**	**	****
Italy	****	-	****	-	***	+	+
Luxembourg	***	**	**	****	+	****	+
Netherlands	****	****	**	***	-	****	****
Poland	****	-	***	***	****	****	***
Portugal	****	****	****	**	***	**	***
Spain	****	+	**	****	****	***	+
Sweden	****	***	-	-	****	****	-

Note: the positive/negative impact of a particular variable is denoted by +/- respectively. We also put notation reporting the significance at level 0.01, 0.05 and 0.1 by \*\*\*, \*\* and \*.

Table 15: Point estimates of the variances (bold), contemporaneous covariances (in italics above the diagonal) and contemporaneous correlations (shaded cells below the diagonal) of error terms in case of model  $M_1$  (SURE specification)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Poland	Portugal	Spain	Sweden
Austria	<b>0.0001</b>	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0001
Belgium	-0.0185	<b>0.0001</b>	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	-0.0003	0.0000	0.0001	0.0000	0.0001	-0.0001
Denmark	-0.4609	0.4214	<b>0.0003</b>	0.0000	0.0001	0.0000	0.0001	0.0003	-0.0001	-0.0004	0.0001	0.0003	0.0000	0.0002	0.0000
Finland	0.1018	0.3376	0.0306	<b>0.0004</b>	0.0001	0.0000	0.0003	0.0001	-0.0001	-0.0006	0.0000	0.0002	0.0000	0.0001	-0.0001
France	-0.1044	0.5351	0.3538	0.5411	<b>0.0001</b>	0.0000	0.0001	0.0002	0.0000	-0.0001	0.0000	0.0001	0.0000	0.0001	-0.0001
Germany	0.4233	0.3298	-0.1805	0.2569	-0.2254	<b>0.0000</b>	0.0001	-0.0001	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Greece	0.2194	0.2703	0.2048	0.4445	0.2942	0.5936	<b>0.0010</b>	0.0002	-0.0002	-0.0005	0.0000	0.0005	0.0002	0.0002	0.0000
Ireland	0.0323	0.2362	0.4556	0.1252	0.4709	-0.2088	0.1106	<b>0.0018</b>	0.0000	-0.0007	0.0005	0.0006	0.0001	0.0002	-0.0001
Italy	-0.0665	0.1277	-0.4033	-0.2590	0.0480	-0.0569	-0.2559	-0.0205	<b>0.0004</b>	0.0001	0.0000	0.0000	0.0000	0.0000	-0.0002
Luxembourg	0.0091	-0.4302	-0.4209	-0.4910	-0.1758	-0.1393	-0.2657	-0.2794	0.0662	<b>0.0037</b>	-0.0002	-0.0009	-0.0002	-0.0006	0.0001
Netherlands	0.1827	0.1957	0.3406	-0.0805	0.3289	-0.3654	-0.0770	0.7747	0.1472	-0.2456	<b>0.0002</b>	0.0002	0.0001	0.0001	0.0001
Poland	0.0038	0.4790	0.6501	0.3832	0.6134	0.0758	0.6327	0.5502	-0.0718	-0.5918	0.5313	<b>0.0006</b>	0.0001	0.0003	0.0000
Portugal	0.3180	-0.1591	0.0877	0.1192	-0.1253	0.2130	0.4363	0.1884	-0.1781	-0.3069	0.3232	0.4446	<b>0.0001</b>	0.0001	0.0001
Spain	-0.4688	0.5586	0.6737	0.1318	0.2886	0.1440	0.3471	0.2435	0.0793	-0.4917	0.1976	0.6395	0.3750	<b>0.0005</b>	-0.0002
Sweden	0.3045	-0.5779	-0.0681	-0.1250	-0.3826	-0.1569	-0.0004	-0.1139	-0.4298	0.0743	0.1827	-0.0568	0.2794	-0.4076	<b>0.0004</b>

## Chapter 4- Empirical importance of procyclicality of loan loss provisions for banks in selected EU countries

### 4.1 Determinants of Loan Loss Provisions

Loan loss provisions (LLP) play an important role in risk management for banks, for several reasons. Firstly, they contribute to loan loss reserves (LLR), which serve as a safeguard against anticipated losses within a bank's loan portfolio. When these reserves are consistently established at a cautious level, they protect the bank's capital from depletion during periods of credit losses. This becomes crucial during crises, when non-performing loans (NPLs) rise. Simultaneously, these provisions directly impact profitability, influencing the amount of retained earnings and future capital (Skala, 2021). Secondly, LLP are relatively clear as they are directly disclosed in banks' income statements, unlike NPLs. This transparency makes LLP a potential tool for signaling and conveying credit risk information that capital market participants can readily understand and interpret. Managers may utilize LLP to communicate private information to the market, particularly regarding a bank's future outlook and expected earnings (Bouvatier and Lepetit, 2008).

Loan loss provisions (LLPs), along with write-offs, offer critical insights into loan quality for investors and impact a bank's financial position (BIS, 2021). The link between loan loss provisions and economic cycle varies across banks and countries. However, there are certain factors which determine loan loss provisions for the banks. LLPs are determined by many factors and can be split generally into two groups containing bank-specific variables and

macroeconomic variables (Laeven and Majnoni 2003; Bikker and Metzmakers 2005; Olszak and Pipień, 2016). Table 16 presents the variables chosen as possible explanatory variables of LLPs.

Table 16: Definitions of variables used in analysis for procyclicality of credit supply

Variable	Measure	Notation	Expected effect on Loan supply
<i>Dependent variable:</i>			
Loan Loss Provisions	Loan Loss Provisions divided by total assets	<i>LLP/TA</i>	
<i>Determinants:</i>			
<hr/>			
Banking sector specific:			
Profit	Profit before taxes divided by total assets	<i>PROFIT/TA</i>	+
Loan Supply	Gross loans & advances to customers divided by total assets	<i>LOANS/TA</i>	+
Deposits	Deposits to assets ratio.	<i>DEP/TA</i>	+
<hr/>			
Macroeconomic:			
Business cycle measure	Real GDP growth	<i>GDPG</i>	-
Business cycle measure	Inflation (Consumer Prices Index)	<i>INF</i>	+
Business cycle measure	Unemployment (% of total labour force)	<i>UNEMP</i>	+
<hr/>			

#### 4.1.1 Macroeconomic determinants of Loan Loss Provisions

Three macroeconomic determinants of loan loss provisions are considered denoted by GDPG, INF and UNEMP. The GDPG is real GDP growth and measures the procyclicality of LLPs. The relationship between LLP and GDPG is the key variable in our study, as its responsiveness to the business cycle measures the cyclicity of LLPs. GDPG is the most preferred choice to investigate procyclicality at quarterly or annual frequencies (Banerjee, 2011). Empirical research indicates that GDP growth (GDPG) is negatively correlated LLPs (Laeven and Majnoni 2003; Bikker and Metzmakers 2005; Bouvatier and Lepetit 2008). A stronger negative coefficient of GDPG implies greater procyclicality. Conversely, a positive relationship between LLPs and GDP would indicate countercyclical provisions.

Inflation has been used as a determinant of loan loss provisions by researchers (Albertazzi and Gambacorta, 2009; Olszak and Pipień, 2016). Their study finds a positive coefficient for Inflation, LLPs rise as consumer prices increase. However, if inflation is viewed as an economic cycle variable—rising during booms and falling during busts—we might expect it to be negatively related to LLPs. This would align with the procyclicality hypothesis, which posits that LLPs decrease during economic upswings and increase during downturns.

There is lack of research which considers unemployment as one of the potential factors to explain fluctuations in LLP for the banks. The expected sign for UNEMP is positive, as less employment would lead to more demand for credit due to increased demand and hence more amounts allocated for LLP.

#### 4.1.2 Banking Specific determinants of Loan Loss Provisions

As determinants of loan loss provisions specific to the banking sector, we use three bank related variables – Profit, Loan supply and Deposits.

PROFIT is operating profit before provisions and taxes divided by total assets (PROFIT/TA) of the banks. The relationship between this variable and LLPs is examined to test the income-smoothing hypothesis of banks. If banks utilize LLPs to smooth earnings, a positive correlation between PROFIT and LLPs would be expected (Olszak and Pipień, 2016). Empirical research on individual banks, both within single countries and across multiple countries, consistently shows that this variable and LLPs are usually positively correlated (Laeven and Majnoni 2003; Bikker and Metzmakers 2005; Liu and Ryan 2006; Bouvatier and Lepetit 2008; Fonseca and González 2008; Olszak and Pipień, 2016). A higher positive coefficient on PROFIT indicates greater income smoothing. Conversely, a negative impact of PROFIT on LLPs suggests that banks do not use LLPs to smooth their earnings.

Loans divided by total assets (LOANS/TA) is introduced as an independent variable as a proxy for credit supply. If banks use LLPs (i.e., the portion set aside to cover expected losses) to manage credit risk, then there is a positive relationship between LLPs and loans. Conversely, if banks exhibit imprudent loan loss provisioning behaviour, Loans negatively impacts LLPs. Empirical results on this relationship vary. Some studies find a positive influence of real loan growth on LLPs (Bikker and Metzmakers 2005; Fonseca and González 2008; Olszak and Pipień, 2016), suggesting that banks set aside provisions to cover risks accumulated during economic booms. Other studies report a negative coefficient on loan growth (Laeven and Majnoni 2003), indicating a rejection of the prudent loan loss provisioning hypothesis.

Total deposits normalized by total assets (DEP/TA) is considered as a liquidity indicator. Deposits are the main source of funds of bank which it uses to give loans and hence it has a positive impact on the credit supply of the banks (Mustafa et al., 2012 ; Bang-Andersen et al., 2014). As increase in deposits would facilitate higher credit, it would lead to increase in LLPs and hence expected sign of this variable is positive.

## 4.2 Estimation Equations

The basic model (based on Olszak and Pipień, 2016; Pipień and Anand, 2023) elaborated within a panel regression environment reads as follows:

$$\frac{LLP_{t,j}}{TA_{t,j}} = \alpha_0 + \alpha_1 GDPG_{t,j} + \alpha_2 INF_{t,j} + \alpha_3 UNEMP_{t,j} + \alpha_4 \frac{PROFIT_{t,j}}{TA_{t,j}} + \alpha_5 \frac{LOANS_{t,j}}{TA_{t,j}} + \alpha_6 \frac{DEP_{t,j}}{TA_{t,j}} + \varepsilon_{t,j}, \quad (24)$$

where all variables are observed for  $j$ -th country ( $j=1,\dots,n$ ) at year  $t=1,\dots,T$ . The dependent variable is the loan loss provision (LLP) of a bank divided by this bank's total assets (TA). The independent variables can be subdivided into two groups. In the first group we collect the macroeconomic variables, like annual growth of the real Gross Domestic Product ( $\Delta GDPG_{t,j}$ ) inflation rate ( $INF_{t,j}$ ) and unemployment rate ( $UNEMP_{t,j}$ ). The second group of variables consist of various bank-specific variables, like profits before taxes ( $\frac{PROFIT_{t,j}}{TA_{t,j}}$ ), loans ( $\frac{LOANS_{t,j}}{TA_{t,j}}$ ), and customer deposits of the bank ( $\frac{DEP_{t,j}}{TA_{t,j}}$ ). All banking sector specific variables are normalized by the bank total average assets (TA) to mitigate potential estimation problems with heteroscedasticity. Building on the approach of Pipień and Anand (2023), we proceed by relaxing the assumption in equation (24) regarding cross-country homogeneity of parameters  $\alpha_i$ . To accomplish this, we employ the Seemingly Unrelated Regression Equations (SURE)

system developed by Zellner (1962). We rewrite equation (24), allowing all regression parameters to vary across  $j$ :

$$\frac{LLP_{tj}}{TA_{tj}} = \alpha_0 + \alpha_{1,j} GDPG_{t,j} + \alpha_{2,j} INF_{t,j} + \alpha_{3,j} UNEMP_{t,j} + \alpha_{4,j} \frac{PROFIT_{tj}}{TA_{tj}} + \alpha_{5,j} \frac{LOANS_{tj}}{TA_{tj}} + \alpha_{6,j} \frac{DEP_{tj}}{TA_{tj}} + \varepsilon_{t,j}, \quad (25)$$

### 4.3 Results and discussion

We used annual data forming the balanced panel for 15 EU countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain and Sweden covering the period from 2005 to 2020. Table 17 and table 18 present some descriptive statistics for the variables applied in this study.

On average, the banking sectors in our sample have loan loss provisions of 1.8% in relation to total assets over the entire period of 2005 – 2020, however this ratio substantially varies across countries, ranging from 0.3% to 9.2%. Greece has the highest average with a value of 9.2%, whereas Finland, Luxembourg and Sweden have low average LLP/TA with a value of around 0.3%. Also, loans, profits and deposits with relation to total assets are very diverse across countries. Of our three macroeconomic determinants, two of them (growth rate of GDP and inflation) show comparable mean levels, of 1.2%-1.5%. However, the growth rate of GDP is far more diversified across countries, with minimum and maximum values of -10.8% and 25.2% respectively. Average GDP growth rate combined for all countries during the analysis period is 1.2%. Italy and Greece are two countries with a negative average GDP growth rate (-0.53% and -1.56% respectively) during the analysis period. On the other hand, Ireland and Poland have the highest GDP growth rate (4.70% and 3.61% respectively) during this period. The average unemployment rate is 8.9% and shows strong heterogeneity across countries,

with a possible existence of huge outliers as the sample kurtosis is greater than 6. Greece has the highest average unemployment rate (17.3%) whereas Netherlands has the lowest average unemployment rate (5.1%) during this period.

Table 19 presents the correlation matrix of the regression variables. The overall sample yields information about the relative weak associations between related variable (LLP with respect to total assets) and explanatory variables, especially GDP and inflation. The strongest correlation is identified in case of unemployment rate. All three bank specific variables (profits, deposits, and loans) are weakly correlated with the related variable. Later in the article we show that reporting weak relationships between analysed variables is erroneous. The most important factor driving the nature of relationships between analysed variables is cross country heterogeneity evident within the SURE model.

Tables 20, 21 and 22 present the results of estimation of parameters in equations (24) and (25). As a point of departure, we estimated parameters in equation (24) using fixed-effect (FE) panel regression techniques. In this case, no country diversity of impact of explanatory variables to the LLP (to total assets) can be achieved. The results are collected in Table 20. All factors potentially influencing variability of the LLP (to total assets) are empirically important as we receive statistically significant estimates of parameters corresponding to LLP.

The results of our empirical insight into cross country heterogeneity of analysed relationships are presented in Tables 21 and 22. In Table 21, we report estimation outcomes in case when imposing assumption of no correlations between  $\varepsilon_{t,j}$  and  $\varepsilon_{s,i}$  in the system of equations (25) (model  $M_0$ ). It means that in this setting we run OLS separately for each country in the sample according to equation (25). Such estimation treats the regression for each country separately, and ignores interactions among the equations, at the same time implying that there are no

linkages between countries. Table 22 presents the results of estimation in case of model  $M_1$ , i.e., the system (25) with non-diagonal covariance matrix. In this case we follow the Zellner (1962) estimator given by the formula (5). In both cases, namely  $M_0$  and  $M_1$  data clearly support cross country diversity in the nature of the relationship between loans (to total assets) and other variables of interest. Also, in predominant cases, the relationship, as measured by estimates of the corresponding parameter, is statistically significant. Statistical insignificance of the FE outcomes in equation (24) discussed above, has its origin in assumptions imposed within the panel regression neglecting possible heterogeneity of parameters across objects. The statistical significance as well as the direction of the sign of the relationship (positive or negative) between related variable and explanatory variables in (25) are presented in Tables 23 and 24. Such an exhibit replicates to some extent some information from Tables 21 and 22, but it permits qualitative insight into the procyclicality effects and the strength of analysed linkages. Analysing the role of economic growth in describing the LLP fluctuations, we reported statistically significant impact; see Table 20 for FE panel regression outcomes. According to the system (25) in both stochastic settings ( $M_0$  and  $M_1$ ) the analysed relationship is very diverse across countries. In general, the SURE model ( $M_1$ ) provides more precise estimates. Consequently, inference about statistical significance of parameters is much stronger than in case  $M_0$  representing independent regressions in (25). Countries with negative impact of economic growth fluctuations on LLP (to total assets) are France, Luxembourg and Netherlands, whereas Portugal, Spain and Sweden have positive impact of economic growth variations to LLP (to total assets). However, according to the model  $M_1$  the number of countries with positive impact of economic growth fluctuations increases to 5- Belgium, Italy, Portugal, Spain and Sweden, whereas the number of countries with negative

impact of economic growth to LLP increases to 4- Denmark, France, Luxembourg and Netherlands. The lack of significance between growth rate of GDP and LLP (to total assets) in case of other countries merits attention.

The impact of inflation to LLP (to total assets) was also significant, provided in the FE estimates presented in Table 20. In case of model  $M_1$  we see inflation is statistically significant for 11 countries with all having positive sign. In case of remaining 4 countries- Austria, Germany, Greece and Luxembourg, the relationship between inflation and LLP (to total assets) is insignificant.

The unemployment indicator was the third and last category in the set of macroeconomic variables used in our analyses. Just as in case of growth rate of GDP and inflation, the FE panel estimates indicate empirical significance of the relationship between unemployment and LLP (to total assets). According to Table 24, in case of SURE model ( $M_1$ ), the predominant statistically significant impacts are mixed. Positive and significant impacts are attached to France, Ireland, Netherlands and Poland. In case of Belgium, Denmark, Greece, Luxembourg and Portugal, the unemployment rate has a negative and significant impact to LLP (to total assets).

In the panel regression (24) and in the system (25) we also considered explanatory variables representing activity of the banking sector. All three variables- loans, profits and deposits (all to total assets) are significant in the FE panel regression at the 0.01 level. The results obtained for model  $M_0$  and  $M_1$  show a very interesting side of the nature of analysed relationships. The impact of loans to LLP (both to total assets) is predominantly positive and statistically significant at least at level 0.1 in case of 10 out of 15 countries. However, SURE model  $M_1$  (Table 24) indicates significant relationship for 13 out of 15 countries with the

exception of Belgium and Spain. Also, regarding the relationship between the profits and LLP (to total assets), the model  $M_1$  (Table 12) indicates a decreasing relationship for eleven out of fifteen countries. The predominant identified cases are characterised by statistically significant parameters in (25). Only for France and Ireland, there is strong data evidence in favour of positive impact of profits to LLP (both to total assets). Deposits (to total assets) has a positive significant impact according to FE panel regression estimates (Table 8). However,  $M_1$  model (SURE specification) suggests a mixed impact of deposits to LLP (both to total assets) with 11 countries having significant impact- 6 counties having positive impact and 5 counties having negative impact.

Table 13 presents the results of estimation of the elements of the covariance matrix  $\Sigma$  necessary in case of the SURE specification. We report point estimates of the variances (bold font), contemporaneous covariances (in italics, above the diagonal) and contemporaneous correlations (below the diagonal) of error terms. Analysing the estimates of correlations, it is clear, that the system regression approach, applied in case of model  $M_1$ , is empirically important. Simple analysis, based on the country independent regressions formally imposing assumption of diagonality of the covariance matrix, ignores cross country financial linkages, which seem to be substantial. The strongest correlations in the system are positive with some exceptions. The strongest positive financial linkage, as measured by the correlation of the error terms, is observed between Belgium and Finland (0.71). Also, in case of pairs Austria-Finland, Belgium-France, Belgium-Poland, Luxembourg-Netherlands, Luxembourg-Poland, the positive correlation exceeds 0.5. There are also countries with strong negative correlations (exceeding 0.5) are pairs of Austria-Denmark, France-Italy, Denmark-Portugal, France-Portugal, Greece-Spain and Poland-Italy. Poland has highest number of significant financial

linkages, as measured by correlation of the error terms, with 3 countries (2 positive and 1 negative).

Table 17: Descriptive statistics of the analysed series for Loan Loss Provisions

	$\frac{LLP_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	GDPG <sub>t,j</sub>	UNEMP <sub>t,j</sub>	INF <sub>t,j</sub>
Mean	0.0183	0.4111	0.5668	0.0044	1.2018	8.7226	1.4860
Median	0.0089	0.4058	0.5782	0.0056	1.6681	7.6750	1.4948
Maximum	0.1917	0.7340	0.8314	0.0223	25.1763	27.4700	4.8971
Minimum	0.0006	0.0850	0.2227	-0.1107	-10.8229	3.1400	-4.4781
Std. Dev.	0.0289	0.1412	0.1120	0.0099	3.5704	4.7686	1.3158
Skewness	3.9334	0.1522	-0.5895	-6.9979	0.4312	1.9018	-0.1685
Kurtosis	20.7262	2.6770	3.1629	78.2323	11.9696	6.6683	4.0632
Jarque-Bera	3761.05	1.97	14.17	58557.77	811.97	279.23	12.44
Probability	0.0000	0.3735	0.0008	0.0000	0.0000	0.0000	0.0020
Sum	4.4008	98.6632	136.0244	1.0527	288.4403	2093.4200	356.6465
Sum Sq. Dev.	0.1993	4.7661	2.9998	0.0235	3046.6350	5434.7990	413.7647
No. of observations	240	240	240	240	240	240	240

Table 18: Country-wise statistics of the analysed series for Loan Loss Provisions

Country	Avg of LLP/TA	Avg of Deposit/TA	Avg of LOANS/TA	Avg of Profit/TA	Avg of GDP	Avg of UNEMP	Avg of INF
Austria	1.0%	28.5%	37.3%	0.4%	0.64	8.93	1.22
Belgium	0.3%	39.0%	45.2%	0.5%	2.34	5.38	1.78
Denmark	0.4%	39.6%	45.3%	0.3%	1.12	6.03	1.39
Finland	0.7%	42.4%	47.9%	0.5%	1.10	7.45	1.86
France	0.3%	30.0%	52.4%	0.7%	0.87	7.93	1.37
Germany	0.5%	44.1%	53.3%	0.4%	1.16	5.14	1.60
Greece	1.2%	46.9%	55.4%	0.5%	0.99	5.14	1.85
Ireland	2.8%	37.4%	57.2%	0.1%	4.70	9.08	1.00
Italy	2.7%	41.5%	59.0%	0.4%	(0.53)	9.49	1.35
Luxembourg	1.8%	47.7%	60.3%	0.7%	0.51	17.21	1.59
Netherlands	0.7%	16.7%	63.7%	0.5%	1.14	5.88	1.43
Poland	2.6%	68.5%	65.1%	1.5%	3.61	8.38	2.08
Portugal	3.0%	55.3%	66.6%	0.3%	0.15	10.12	1.33
Spain	0.3%	23.0%	70.0%	0.7%	1.79	7.39	1.17
Sweden	9.2%	56.0%	71.3%	-0.8%	(1.56)	17.29	1.28

Table 19: Matrix of sample correlation of the analysed series for Loan Loss Provisions

	$\frac{LLP_{t,j}}{TA_{t,j}}$	$GDPG_{t,j}$	$INF_{t,j}$	$UNEMP_{t,j}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
$\frac{LLP_{t,j}}{TA_{t,j}}$	1	-0.0826	-0.2689***	0.6820***	-0.3553***	0.4209***	0.3885***
$GDPG_{t,j}$	-0.0826	1	0.1168	-0.2090***	0.4028***	-0.0596	-0.0079
$INF_{t,j}$	-0.2689***	0.1168	1	-0.2772***	0.0918	-0.0669	-0.0038
$UNEMP_{t,j}$	0.6820***	-0.2090***	-0.2772***	1	-0.3275***	0.3039***	0.2444***
$\frac{PROFIT_{t,j}}{TA_{t,j}}$	-0.3553***	0.4028***	0.0918	-0.3275***	1	-0.0621	0.0697
$\frac{LOANS_{t,j}}{TA_{t,j}}$	0.420875***	-0.05965	-0.06685	0.303896***	-0.0621	1	0.2548***
$\frac{DEP_{t,j}}{TA_{t,j}}$	0.3885***	-0.0079	-0.0038	0.2444***	0.0697	0.2548***	1

Note: \*\*\* denotes significance at 1% level

Table 20: Determinants of  $\frac{LLP_{t,j}}{TA_{t,j}}$  - the FE panel estimates of parameters in equation (24)

	Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
FE panel regression estimates							
Est.	-0.0507***	0.0012***	-0.0025***	0.0029	-0.7297***	0.0515***	0.0488***
Std. error	0.0067	0.0004	0.0003	0.0003	0.1367	0.0113	0.0089
p-value	0.0000	0.0027	0.0000	0.0000	0.0000	0.0001	0.0000

Note: \*\*\* denotes significance at 1% level

Table 21: Cross country heterogeneity of determinants of  $\frac{LLP_{t,j}}{TA_{t,j}}$  – estimates of parameters in equation (25) provided the model  $M_0$  (independent regressions)

		Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
Country	The system of independent regressions; $M_0$							
Austria	Est.	-0.0412	-0.0002	0.0013	0.0003	-0.3732	0.1564	-0.0832
	Std. error	0.0230	0.0004	0.0016	0.0014	0.4402	0.0444	0.0255
	p-value	0.0828	0.7216	0.3958	0.8583	0.4029	0.0013	0.0027
Belgium	Est.	-0.0211	0.0002	0.0021	-0.0003	-0.5098	-0.0038	0.0409
	Std. error	0.0045	0.0003	0.0007	0.0005	0.3307	0.0248	0.0253
	p-value	0.0000	0.5935	0.0071	0.5974	0.1330	0.8800	0.1155
Denmark	Est.	-0.0246	-0.0002	0.0022	-0.0003	-0.1745	0.0243	0.0303
	Std. error	0.0083	0.0001	0.0002	0.0003	0.1341	0.0111	0.0146
	p-value	0.0055	0.1023	0.0000	0.3692	0.2026	0.0364	0.0457
Finland	Est.	-0.0035	0.0000	0.0002	-0.0001	-0.3425	0.0135	0.0007
	Std. error	0.0026	0.0001	0.0002	0.0002	0.1034	0.0056	0.0032
	p-value	0.1917	0.6766	0.2845	0.3485	0.0023	0.0213	0.8165
France	Est.	-0.0151	-0.0005	0.0015	0.0009	0.3326	0.0589	-0.0469
	Std. error	0.0049	0.0001	0.0003	0.0004	0.1775	0.0150	0.0081
	p-value	0.0043	0.0027	0.0000	0.0209	0.0700	0.0004	0.0000
Germany	Est.	0.0051	0.0000	-	-0.0001	0.1674	0.0438	-0.0504
	Std. error	0.0068	0.0001	0.0002	0.0005	0.3120	0.0336	0.0324
	p-value	0.4566	0.8963	0.5285	0.8565	0.5953	0.2024	0.1294
Greece	Est.	-0.3156	0.0034	0.0020	-0.0147	-0.3411	0.4599	0.1195
	Std. error	0.1002	0.0018	0.0022	0.0057	0.2969	0.1552	0.1011
	p-value	0.0035	0.0744	0.3788	0.0138	0.2592	0.0057	0.2460
Ireland	Est.	-0.0587	0.0004	0.0089	0.0038	1.0835	-0.0815	0.1230
	Std. error	0.0240	0.0003	0.0009	0.0011	0.2876	0.0383	0.0323
	p-value	0.0200	0.2667	0.0000	0.0017	0.0007	0.0410	0.0006
Italy	Est.	-0.0470	0.0007	0.0055	-0.0025	-0.4032	0.0833	-0.0531
	Std. error	0.0380	0.0005	0.0014	0.0020	0.4816	0.0645	0.0444

	p-value	0.2258	0.2189	0.0003	0.2270	0.4087	0.2055	0.2403
Luxembourg	Est.	0.0049	-0.0001	0.0000	-0.0002	0.0588	0.0040	-0.0095
	Std. error	0.0021	0.0000	0.0003	0.0001	0.0471	0.0011	0.0048
	p-value	0.0287	0.0015	0.9362	0.2158	0.2212	0.0011	0.0572
Netherlands	Est.	-0.0094	-0.0002	0.0009	0.0006	0.0129	0.0233	-0.0077
	Std. error	0.0016	0.0001	0.0001	0.0002	0.0404	0.0040	0.0055
	p-value	0.0000	0.0003	0.0000	0.0064	0.7514	0.0000	0.1707
Poland	Est.	-0.0849	0.0000	0.0016	0.0005	-0.4221	0.0547	0.0981
	Std. error	0.0169	0.0002	0.0003	0.0003	0.1706	0.0081	0.0215
	p-value	0.0000	0.8959	0.0000	0.1009	0.0188	0.0000	0.0001
Portugal	Est.	-0.1396	0.0015	0.0015	-0.0029	-0.6661	0.1501	0.1081
	Std. error	0.1054	0.0006	0.0008	0.0013	0.5643	0.1148	0.0491
	p-value	0.1946	0.0302	0.0521	0.0270	0.2466	0.2003	0.0351
Spain	Est.	0.0280	0.0004	0.0010	-0.0002	-0.1616	-0.0300	-0.0178
	Std. error	0.0160	0.0002	0.0002	0.0006	0.2452	0.0257	0.0131
	p-value	0.0900	0.0798	0.0000	0.7611	0.5145	0.2510	0.1822
Sweden	Est.	-0.0029	0.0002	0.0002	0.0000	-0.8811	0.0124	0.0070
	Std. error	0.0024	0.0000	0.0002	0.0001	0.0851	0.0031	0.0025
	p-value	0.2377	0.0000	0.3211	0.7310	0.0000	0.0003	0.0076

Table 22: Cross country heterogeneity of determinants of  $\frac{LLP_{t,j}}{TA_{t,j}}$  – estimates of parameters in equation (25) provided the model  $M_1$  (SURE specification)

		Intercept	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
Country	The SURE Model; $M_1$							
Austria	Est.	-0.0424	0.0000	0.0010	0.0002	-0.2793	0.1596	-0.0813
	Std. error	0.0095	0.0002	0.0007	0.0005	0.1263	0.0160	0.0107
	p-value	0.0001	0.8791	0.1941	0.7407	0.0342	0.0000	0.0000
Belgium	Est.	-0.0216	0.0002	0.0022	-0.0003	-0.4709	-0.0023	0.0385
	Std. error	0.0021	0.0001	0.0002	0.0001	0.0775	0.0057	0.0066
	p-value	0.0000	0.0362	0.0000	0.0146	0.0000	0.6920	0.0000
Denmark	Est.	-0.0227	-0.0002	0.0022	-0.0006	-0.2649	0.0233	0.0291
	Std. error	0.0043	0.0001	0.0001	0.0002	0.0463	0.0051	0.0094
	p-value	0.0000	0.0246	0.0000	0.0026	0.0000	0.0001	0.0040
Finland	Est.	-0.0041	0.0000	0.0003	-0.0001	-0.3398	0.0134	0.0012
	Std. error	0.0011	0.0000	0.0001	0.0001	0.0495	0.0021	0.0014
	p-value	0.0011	0.2605	0.0090	0.2161	0.0000	0.0000	0.3746
France	Est.	-0.0146	-0.0005	0.0017	0.0008	0.3396	0.0565	-0.0483
	Std. error	0.0016	0.0001	0.0001	0.0001	0.0620	0.0046	0.0043
	p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Germany	Est.	0.0026	-0.0001	-	0.0001	0.1940	0.0448	-0.0467
	Std. error	0.0046	0.0001	0.0002	0.0003	0.1948	0.0219	0.0214
	p-value	0.5696	0.4997	0.5106	0.7261	0.3269	0.0489	0.0364
Greece	Est.	-0.3196	0.0021	0.0015	-0.0181	-0.1366	0.5225	0.0677
	Std. error	0.0576	0.0013	0.0014	0.0036	0.1507	0.0747	0.0636
	p-value	0.0000	0.1090	0.2716	0.0000	0.3713	0.0000	0.2948
Ireland	Est.	-0.0613	0.0002	0.0085	0.0037	0.9144	-0.0832	0.1451
	Std. error	0.0157	0.0002	0.0007	0.0009	0.1797	0.0257	0.0271
	p-value	0.0005	0.4144	0.0000	0.0002	0.0000	0.0028	0.0000
Italy	Est.	-0.0442	0.0007	0.0052	-0.0009	-0.6291	0.0633	-0.0290
	Std. error	0.0184	0.0003	0.0007	0.0011	0.1874	0.0289	0.0314
	p-value	0.0224	0.0548	0.0000	0.3994	0.0020	0.0359	0.3625
Luxembourg	Est.	0.0044	-0.0001	0.0001	-0.0002	0.0348	0.0039	-0.0085

	Std. error	0.0009	0.0000	0.0001	0.0001	0.0205	0.0007	0.0024
	p-value	0.0000	0.0003	0.6151	0.0248	0.0992	0.0000	0.0010
Netherlands	Est.	-0.0095	-0.0002	0.0010	0.0006	0.0271	0.0235	-0.0083
	Std. error	0.0011	0.0000	0.0001	0.0001	0.0248	0.0030	0.0037
	p-value	0.0000	0.0000	0.0000	0.0000	0.2819	0.0000	0.0346
Poland	Est.	-0.0812	0.0000	0.0015	0.0005	-0.3978	0.0530	0.0946
	Std. error	0.0105	0.0002	0.0002	0.0002	0.1071	0.0066	0.0141
	p-value	0.0000	0.9128	0.0000	0.0445	0.0008	0.0000	0.0000
Portugal	Est.	-0.1504	0.0015	0.0015	-0.0027	-0.7381	0.1630	0.1127
	Std. error	0.0546	0.0004	0.0004	0.0008	0.2695	0.0617	0.0256
	p-value	0.0096	0.0005	0.0020	0.0030	0.0100	0.0127	0.0001
Spain	Est.	0.0167	0.0004	0.0011	0.0003	-0.1565	-0.0206	-0.0086
	Std. error	0.0104	0.0002	0.0001	0.0004	0.1301	0.0154	0.0096
	p-value	0.1193	0.0110	0.0000	0.4689	0.2378	0.1910	0.3769
Sweden	Est.	-0.0032	0.0002	0.0003	0.0000	-0.8501	0.0119	0.0061
	Std. error	0.0020	0.0000	0.0001	0.0001	0.0606	0.0023	0.0020
	p-value	0.1206	0.0000	0.0418	0.9048	0.0000	0.0000	0.0052

Table 23: The sign and significance of impact in equation (25) – the model  $M_0$  (independent regressions)

	Intercept	$GDPG_{t,j}$	$INF_{t,j}$	$UNEMP_{t,j}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
Austria	-*	-	+	+	-	+***	-.***

Belgium	_-***	+	-	+***	-	-	+
Denmark	_-***	-	-	+***	-	+**	+***
Finland	-	-	-	+	_-***	+**	+
France	_-***	_-***	+**	+***	+*	+***	_-***
Germany	+	-	-	-	+	+	-
Greece	_-***	+*	_-**	+	-	+***	+
Ireland	_-**	+	+***	+***	+***	_-**	+***
Italy	-	+	-	+***	-	+	-
Luxembourg	+**	_-***	-	+	+	+***	_-*
Netherlands	_-***	_-***	+***	+***	+	+***	-
Poland	_-***	-	+	+***	_-**	+***	+***
Portugal	-	+**	_-**	+*	-	+	+**
Spain	+*	+*	-	+***	-	-	-
Sweden	-	+***	-	+	_-***	+***	+***

Note: the positive/negative impact of a particular variable is denoted by +/- respectively. We also put notation reporting the significance at level 0.01, 0.05 and 0.1 by \*\*\*, \*\* and \*.

Table 24: The sign and significance of impact in (25) – the model  $M_1$  (independent regressions)

	Intercept	$GDPG_{t,j}$	$INF_{t,j}$	$UNEMP_{t,j}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{DEP_{t,j}}{TA_{t,j}}$
Austria	_-***	+	+	+	_-**	+***	_-***
Belgium	_-***	+**	+***	_-**	_-***	-	+***
Denmark	_-***	_-**	+***	_-***	_-***	+***	+***
Finland	_-***	-	+***	-	_-***	+***	+

France	_***	_***	+***	+***	+***	+***	_***
Germany	+	-	-	+	+	+**	-**
Greece	_***	+	+	_***	-	+***	+
Ireland	_***	+	+***	+***	+***	_***	+***
Italy	-**	+*	+***	-	_***	+**	-
Luxembourg	+***	_***	+	-**	+*	+***	_***
Netherlands	_***	_***	+***	+***	+	+***	-**
Poland	_***	-	+***	+**	_***	+***	+***
Portugal	_***	+***	+***	_***	_***	+**	+***
Spain	+	+**	+***	+	-	-	-
Sweden	-	+***	+**	+	_***	+***	+***

Note: the positive/negative impact of a particular variable is denoted by +/- respectively. We also put notation reporting the significance at level 0.01, 0.05 and 0.1 by \*\*\*, \*\* and \*.

Table 25: Point estimates of the variances (**bold**), contemporaneous covariances (in italics above the diagonal) and contemporaneous correlations (shaded cells below the diagonal) of error terms in case of model  $M_1$  (SURE specification)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Poland	Portugal	Spain	Sweden
Austria	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>						
Belgium	0.3494	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Denmark	-0.5388	-0.2655	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Finland	0.6116	0.7150	-0.2560	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
France	-0.3063	0.6673	0.3192	0.3282	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Germany	0.2691	-0.2742	0.0907	-0.2599	-0.4524	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Greece	-0.0744	-0.0492	0.1008	0.3135	0.1550	-0.1622	<b>0.0006</b>	<i>-0.0001</i>	<i>0.0000</i>						
Ireland	0.1352	-0.2046	-0.3707	-0.1572	-0.4034	0.0896	-0.3231	<b>0.0001</b>	<i>0.0000</i>						
Italy	0.0758	-0.6336	0.3691	-0.2468	-0.5561	0.2911	0.0166	-0.1206	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Luxembourg	0.2132	0.3528	0.3086	0.0911	0.2609	0.2867	-0.4941	0.1507	0.1137	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Netherlands	0.1062	0.2218	-0.2327	-0.0468	-0.1148	-0.2431	-0.3544	-0.3041	0.1307	0.0528	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Poland	-0.1545	0.5363	-0.0495	0.1760	0.4719	-0.2057	0.2391	-0.0376	-0.6349	0.0555	0.0834	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>	<i>0.0000</i>
Portugal	0.2654	-0.4205	-0.5445	-0.0496	-0.7377	0.2210	0.1263	0.3492	0.3539	-0.3678	-0.0052	-0.4446	<b>0.0000</b>	<i>0.0000</i>	<i>0.0000</i>
Spain	0.0132	-0.1113	-0.4136	-0.1833	-0.3468	-0.3298	-0.6269	0.4082	-0.0242	-0.1479	0.4144	-0.1770	0.1847	<b>0.0000</b>	<i>0.0000</i>
Sweden	-0.2540	-0.1861	0.4026	0.1457	-0.0977	0.0371	0.2748	-0.1663	0.1618	-0.2577	-0.1350	-0.1121	0.0552	-0.1803	<b>0.0000</b>

## Chapter 5- Procyclicality of Capital Buffer for banks in EU Countries

In recent years, procyclicality of capital requirements has become an emerging topic for discussion from policy makers as well as regulators perspective. The basic argument regarding the procyclicality of capital requirements for the banks is well known. During a recession phase, banks incur more losses eroding bank's capital and at the same risk-based capital requirements, as regulated by Basel II and Basel III, also become higher. In such scenario, if banks are unable to raise sufficient new capital, it limits their lending capacity which could result in credit crunch further amplifying the recession (Repullo and Suarez, 2013). On the other hand, during an expansionary phase, driven by lower losses, there is extra lending capacity available with the banks due to the presence of sufficient capital leading to amplification of expansionary conditions prevailing in the credit market. However, correcting the potential contractionary effect on credit supply by relaxing capital requirements during recessions may put banks in difficult situations due to already existing high loan defaults at that time. The business cycle may also impact capital buffers. If banks fail to build up capital reserves during economic upswings, they may face inadequate capital levels in downturns. This could necessitate raising equity capital at a high cost, potentially leading them to reduce assets to meet regulatory minimum capital thresholds (Repullo and Suarez, 2013; Borio and Zhu, 2012; Valencia and Bolanos, 2018). Given the conflicting objectives at stake, there are two different schools of thought- first who think that procyclicality is a necessary evil, whereas the other group thinks that there should be explicit effort to correct the procyclicality. Basel III is a step to incorporate both views. It mandates the quality and quantity of the capital

requirements to banks but also introduces provision of a capital preservation buffer and a countercyclical buffer, which are supposed to be increased during good times and decreased during bad times.

Regulatory capital requirements are intended to ensure that banks hold sufficient capital to absorb unexpected losses arising from their operations. The concept of unexpected losses is to be distinguished from expected losses. Contrary to unexpected losses, for expected losses banks must set aside provisions, which enter into the profit and loss (P&L statement) and are recognized in the balance sheet as negative assets (Boehl et al., 2016)

The term 'capital buffer' is defined as the amount of capital, held by the banks in excess of what is mandated by the regulators (Jokipii and Milne, 2008; Atici and Gursoy, 2012).

Eichberger and Summer (2005) refer to capital buffer as a cushion against insolvency crises.

Banks may hold capital buffer for a variety of reasons based on: (a) the capital assessment models driven by bank's own risk appetite and business assumptions (Atici and Gursoy, 2012), (b) motivation to reflect the soundness of the bank also resulting in better ratings as they rely on ratings to gain access to capital markets (Jackson, 1999) and finally (c) the need to insure themselves by having capital buffers beyond what is required by the regulators to avoid any cost related to market discipline and supervisory intervention (Milne, 2004; Bikker and Metzmakers, 2005 ). The new Basel III regulations expect the banks to hold sufficiently enough capital, thereby enabling them to absorb potential future losses and also boosting confidence level in the banking sector. Regulators would also expect that banks, with a relatively risky portfolio, hold a relatively high level of capital buffer. Otherwise, these banks are more likely to fall below the capital requirement threshold set by the regulators, which could give rise to a credit crunch (Lindquist, 2004). According to Barth et al. (2006), capital

buffers are persistent both over countries and over time, and they will exceed regulatory capital requirements.

However, the bank's decision to hold capital buffer may result in trade-off as it reduces the banks' ability to lend more. Ayuso et al. (2004) suggests that bank tries to minimize its intertemporal costs while making a decision on capital as a result of trade off among different types of costs related to capital levels.

## 5.1 Determinants of Capital Buffer

The link between regulatory capital and economic cycle varies across banks and countries. However, there are certain factors which determine regulatory capital for the banks. These factors can be split generally into two groups containing bank-specific variables and macroeconomic variables.

Table 26 presents the list of variables – banking sector specific and macroeconomic related, which are considered for the procyclicality analysis of capital buffers.

Table 26: Definitions of variables used in analysis for procyclicality of capital buffers

Variable	Measure	Notation	Expected effect on Capital Buffer
<i>Dependent variable:</i>			
Capital Buffer	Capital Ratio minus capital ratio required divided by capital ratio required	<i>CAPBUF</i>	
<i>Determinants:</i>			
Banking sector specific:			
Capital Buffer Lag	Lag of Capital Buffer	<i>CAPBUF_L</i>	+
Profit	Profit before taxes divided by total assets	<i>PROFIT/TA</i>	+/-
Loan Supply	Gross loans & advances to customers divided by total assets	<i>LOANS/TA</i>	-
Non-Performing Loans (NPL)	Ratio of amount of loans non-performing by total amount of loans	<i>NPL</i>	-
Return on Equity	Return on Equity (ROE)	<i>ROE</i>	-
Macroeconomic:			
Business cycle measure	Real GDP growth	<i>GDPG</i>	+/-
Business cycle measure	Inflation (Consumer Prices Index)	<i>INF</i>	+/-
Business cycle measure	Unemployment (% of total labour force)	<i>UNEMP</i>	+/-

### 5.1.1 Macroeconomic determinants of capital buffer

Three macroeconomic determinants of capital buffer are considered denoted by GDPG, INF and UNEMP.

The GDPG is real GDP growth and measures the procyclicality of capital buffer. The relationship between business cycle and capital buffer has been an emerging topic of research

especially in the aftermath of the global financial crisis (Ayuso et al., 2004; Berger, 2006; Jokipii and Milne, 2008; Schanz et al., 2011; Atici and Gursoy, 2012; Repullo and Suarez 2013; Boehl et al., 2016; Valencia and Bolanos, 2018; Abbas et al., 2021). The business cycle indicated by GDP has a negative relation with the capital buffer as indicated by some empirical researches (Ayuso et al., 2004; Jokipii and Milne, 2008; Bikker and Metzmakers, 2007; Abbas et al., 2021). On the other hand, there are also empirical research studies suggesting procyclicality of capital buffer (Atici and Gursoy, 2012; Valencia and Bolanos, 2018).

There is limited evidence of inflation being used as a key factor in assessing its impact on capital buffers. However, if inflation (INF) is viewed as a cyclical economic variable—rising during booms and falling during downturns—it could be expected to behave similarly to GDP, potentially exerting either a procyclical or countercyclical effect on the capital buffer.

Unemployment and GDP are negatively correlated, indicating that unemployment rises during recessions and falls during economic expansions. As an economic indicator, unemployment is expected to move in the opposite direction of GDP. Therefore, if GDP has a procyclical effect on capital buffers, unemployment would be expected to have a countercyclical effect.

### 5.1.2 Banking specific determinants of capital buffer

As determinants of loan loss provisions specific to the banking sector, we use four bank related variables – Profit, Loan supply, non-performing loans and return on equity.

PROFIT is operating profit before provisions and taxes divided by total assets (PROFIT/TA) of the banks. Banks can increase their capital buffer through retained earnings, but this is an uncertain option if profits are highly volatile. Lindquist (2004) and Milne & Whalley (2001) found a significant negative relation between capital buffer and generation of profits.

However, there are research studies which indicate a positive relationship between capital

buffer and profits (Jokipii and Milne, 2008; Atici and Gursoy, 2012), suggesting the ambiguity of sign of this variable.

LOANS normalized by total assets (LOANS/TA) is introduced as a proxy for changes in credit demand and supply. An increase in loans implies an increase in capital requirements, which, in a context where adjusting capital is costly, is likely to transitorily reduce capital buffers.

The expected sign of this variable is negative as a larger number of loans with respect to total assets are likelier to reflect a riskier profile (Jokipii and Milne, 2008) and this hypothesis has been supported by previous studies on capital buffer (Ayuso et al., 2004; Atici and Gursoy, 2012; Bikker and Metzmakers, 2007).

Non-performing loans (NPL) are introduced as an independent variable as a proxy for credit risk. It is considered as gross non-performing debt as percentage of total gross debt. As it is a measurement of the risk taken by the banks, the expected sign for NPL in relation to capital buffer is negative which is also supported in previous studies (Ayuso et al., 2004; Atici and Gursoy, 2012; Abbas et al., 2021). However, if banks set their capital in line with the true riskiness of their portfolios, then a positive relation will be expected.

Return on equity (ROE) is introduced to capture the direct costs of holding the excess capital and a negative relationship between the capital buffer and ROE is expected. A negative sign indicates that the higher the cost of the capital, the bigger the negative effect on the capital buffer. Ayuso et al. (2004), Jokipii and Milne (2008), Bikker and Metzmakers (2007) and Atici and Gursoy (2012) recorded negative relation between ROE and capital buffer.

## 5.2 Estimation Equations

The basic model (based on Pipień and Anand, 2023; Ayuso et al., 2004) elaborated within a panel regression environment reads as follows:

$$\begin{aligned} \text{CAPBUF}_{t,j} = & \alpha_0 + \alpha_1 \text{CAPBUF}_{t-1,j} + \alpha_2 \text{GDPG}_{t,j} + \alpha_3 \text{INF}_{t,j} + \alpha_4 \text{UNEMP}_{t,j} + \\ & \alpha_5 \frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}} + \alpha_6 \frac{\text{LOANS}_{t,j}}{\text{TA}_{t,j}} + \alpha_7 \text{NPL} + \alpha_8 \text{ROE} + \varepsilon_{t,j}, \end{aligned} \quad (26)$$

where all variables are observed for  $j$ -th country ( $j=1,\dots,n$ ) at year  $t=1,\dots,T$ . The dependent variable is the capital buffer (CAPBUF). The independent variables can be subdivided into two groups. In the first group we collect the macroeconomic variables, like annual growth of the real Gross Domestic Product ( $\text{GDPG}_{t,j}$ ) inflation rate ( $\text{INF}_{t,j}$ ) and unemployment rate ( $\text{UNEMP}_{t,j}$ ). The second group of variables consist of various bank-specific variables, like profits before taxes ( $\frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}}$ ), non-performing loans ratio (NPL), Bank Loans ( $\frac{\text{LOANS}_{t,j}}{\text{TA}_{t,j}}$ ) and return on equity (ROE). We also include the lagged dependent variable ( $\text{CAPBUF}_{t-1,j}$ ) with one period lag in order to test whether adjusting costs are relevant.

Following Pipień and Anand (2023), we advance by relaxing the assumption in (26) regarding the cross-country homogeneity of parameters  $\alpha_i$ . To achieve this, we utilize Zellner's (1962) Seemingly Unrelated Regression Equations (SURE) system. We rewrite equation (26), allowing all regression parameters to vary across  $j$ :

$$\begin{aligned} \text{CAPBUF}_{t,j} = & \alpha_0 + \alpha_{1,j} \text{CAPBUF}_{t-1,j} + \alpha_{2,j} \text{GDPG}_{t,j} + \alpha_{3,j} \text{INF}_{t,j} + \alpha_{4,j} \text{UNEMP}_{t,j} + \\ & \alpha_{5,j} \frac{\text{PROFIT}_{t,j}}{\text{TA}_{t,j}} + \alpha_{6,j} \frac{\text{LOANS}_{t,j}}{\text{TA}_{t,j}} + \alpha_{7,j} \text{NPL} + \alpha_{8,j} \text{ROE} + \varepsilon_{t,j}, \end{aligned} \quad (27)$$

### 5.3 Results and discussion

We used annual data forming the balanced panel for 10 EU countries, namely Austria, Belgium, Denmark, France, Germany, Greece, Italy, Luxembourg, Netherlands, Spain and

Sweden covering the period from 2009 to 2020. Table 27 and table 28 present some descriptive statistics for the variables applied in this study.

Table 28 indicates that the banks hold far more capital than that required by the regulators. On average, the banking sectors in our sample have capital buffer of 118% over the entire period of 2009 – 2020, however this ratio substantially varies across countries, ranging from 74% to 161%. Luxembourg and Denmark have high average capital buffer with values 161% and 145% respectively whereas Spain and Italy have low average capital buffer with values of 74% and 83% respectively. Also, profits, loans, NPL and ROE are very diverse across countries. Similarly, the three macroeconomic determinants- growth rate of GDP, unemployment and inflation are far more diversified across countries. Average GDP growth rate combined for all countries during the analysis period is 0.57%. Italy and Spain are two countries with a negative average GDP growth rate (-0.96% and -0.34% respectively) during the analysis period. On the other hand, Luxembourg and Sweden have the highest GDP growth rate (1.76% and 1.52% respectively) during this period. The average unemployment rate is 8.2% and shows strong heterogeneity across countries, with Spain having highest average unemployment rate (19.9%) and Germany the lowest average unemployment rate (4.9%) during this period. Inflation shows relatively less heterogeneity with overall average value of 1.26%.

Table 29 presents the correlation matrix of the regression variables. The overall sample yields information about the relative weak associations between capital buffer and explanatory variables with exception of lagged dependent variable. The strongest correlation is identified in case of lagged capital buffer (one year lag) with a correlation of 0.91. All four variables (profits, loans, NPL and ROE) representing condition of the banking sector are relatively more correlated than macroeconomic determinants, with NPL having the highest correlation.

Surprisingly they are not as strongly correlated with the related variable as one may expect. Later in the section we show that reporting weak relationships between analysed variables is erroneous. The most important factor driving the nature of relationships between analysed variables is cross country heterogeneity evident within the SURE model.

Tables 30, 31 and 32 present the results of estimation of parameters in equations (26) and (27). As a point of departure, we estimated parameters in equation (26) using fixed-effect (FE) panel regression techniques. In this case, no country diversity of impact of explanatory variables to the capital buffer can be achieved. The results are collected in Table 30. Among all factors potentially influencing variability of the capital buffer, only lagged capital buffer and inflation are empirically important as we receive statistically significant estimates of parameters corresponding to lagged capital buffer and inflation. Surprisingly, none of the bank related variable is significant related to the capital buffer. GDP and Unemployment appear not to contribute significantly to the capital buffer, as point estimates of corresponding parameters are relatively small and insignificant.

The results of our empirical insight into cross country heterogeneity of analysed relationships are presented in Tables 31 and 32. In Table 31, we report estimation outcomes in case when imposing assumption of no correlations between  $\varepsilon_{t,j}$  and  $\varepsilon_{s,i}$  in the system of equations (27) (model  $M_0$ ). It means that in this setting we run OLS separately for each country in the sample according to equation (4). Such estimation treats the regression for each country separately, and ignores interactions among the equations, at the same time implying that there are no linkages between countries. Table 32 presents the results of estimation in case of model  $M_1$ , i.e., the system (27) with non-diagonal covariance matrix. In this case we follow the Zellner (1962) estimator given by the formula (5). In both cases, namely  $M_0$  and  $M_1$  data clearly

support cross country diversity in the nature of the relationship between loans (to total assets) and other variables of interest. Also, in predominant cases, the relationship, as measured by estimates of the corresponding parameter, is statistically significant. Statistical insignificance of the FE outcomes in equation (26) discussed above, has its origin in assumptions imposed within the panel regression neglecting possible heterogeneity of parameters across objects. The statistical significance as well as the direction of the sign of the relationship (positive or negative) between related variable and explanatory variables in (27) are presented in tables 33 and 34. Such an exhibit replicates to some extent some information from Tables 31 and 32, but it permits qualitative insight into the procyclicality effects and the strength of analysed linkages. Analysing the role of economic growth in describing the capital buffer variations, we reported initially a very weak, slightly negative but statistically insignificant impact; see Table 30 for FE panel regression outcomes. According to the system (27) in both stochastic settings ( $M_0$  and  $M_1$ ) the analysed relationship is very diverse across countries. In general, the SURE model ( $M_1$ ) provides more precise estimates. Consequently, inference about statistical significance of parameters is much stronger than in case  $M_0$  representing independent regressions in (27). Countries with positive impact of economic growth fluctuations on capital buffer are Austria, Belgium, Denmark, France, Netherlands, Spain and Sweden. However, according to the model  $M_1$  this impact may be treated as decisively significant only in the case of Belgium, Denmark, France, Netherlands, Spain and Sweden. The lack of significance between growth rate of GDP and capital buffer in case of other countries merits attention. Moreover, the sign of growth rate of GDP has been mixed with showing positive and negative coefficients across countries. Table 34 shows that among the set of such countries, Belgium,

Denmark, France and Sweden have negative impact of economic growth on capital buffer, whereas Netherlands and Spain have positive impact of economic growth on capital buffer.

The impact of unemployment to capital buffer was also insignificant, provided the FE estimates presented in Table 30. In case of model  $M_1$  we see some diversity. Negative and significantly supported by the data impact was obtained in case of Austria, Netherlands and Spain. Positive and statistically significant influence may be reported for Belgium and Denmark. In case of other countries, the relationship between unemployment and capital buffer is insignificant.

The inflation indicator was the third and last category in the set of macroeconomic variables used in our analyses. Contrary to the growth rate of GDP and inflation variables, the FE panel estimates indicate empirical importance of the relationship between inflation and capital buffer. According to Table 34, in case of SURE model ( $M_1$ ), the predominant statistically significant impacts are positive and are attached to Austria, Belgium, France, Italy and Netherlands. Only in case of Spain, the inflation rate has a negative and significant impact to capital buffer.

In the panel regression (26) and in the system (27) we also considered as explanatory variables some observed categories representing activity of the banking sector. Among them, only lagged capital buffer is significant in the FE panel regression at the 0.01 level. Apart from Belgium and Luxembourg, lagged capital buffer is statistically significant for all countries considered in the analysis. The predominant statistically significant impacts are mostly positive with the exception of Spain which has a negative sign.

The four variables (profits, loans, NPL and ROE) representing condition of the banking sector are statistically insignificant in the FE panel regression. The results obtained for model  $M_1$

show a very interesting side of the nature of analysed relationships. The impact of profit to capital buffer is positive and statistically significant at least at level 0.1 in case Austria, France, Italy and Netherlands. In case of Belgium and Spain, the impact is also statistically significant but negative. Regarding the relationship between the loans and capital buffer, the model  $M_1$  (Table 34) indicates a statistically significant positive relationship for Belgium and Denmark, whereas for Austria, Netherlands and Spain it indicates negative relationship. For NPL, there is strong data evidence for positive relationship with capital buffer for 2 countries (Spain and Sweden) and negative relationship for 3 countries (Belgium, Luxembourg and Netherlands). ROE also shows a similar pattern of mixed relationship with capital buffer, having statistically positive relationship with capital buffer for 2 countries (Belgium and Spain) and statistically negative relationship for 4 countries (Austria, France, Italy and Netherlands).

Table 30 shows that the FE panel regression estimates indicate statistically insignificant relationships between capital buffer and bank-related variables namely loans (to total assets), profits (to total assets), NPL and ROE. The OLS model ( $M_0$ ) and the SURE specification ( $M_1$ ) provide contrasting results compared to FE panel outcomes and result in significant linkages between capital buffer and bank-related variables. Loans (to total assets) has a mixed impact to capital buffer. Out of 10 countries, 4 countries have negative and significant linkages whereas 1 country has positive significant association. In comparison, Profits (to total assets) have strong evidence of positive relationship with capital buffer for 6 out of 10 countries with only Belgium and Spain having negative and significant relationship. NPL is also insignificant for FE model (Table 30). However, it is significant and have positive linkages with capital buffer for 2 countries whereas for 3 countries, this variable has negative association. For remaining

5 countries, NPL is not empirically significant. ROE, statistically insignificant for FE regression (Table 30), is also significant for 6 countries (4 positive linkages and 2 negative linkages).

Table 35 presents the results of estimation of the elements of the covariance matrix  $\Sigma$  necessary in case of the SURE specification. We report point estimates of the variances (bold font), contemporaneous covariances (in italics, above the diagonal) and contemporaneous correlations (below the diagonal) of error terms. Analysing the estimates of correlations, it is clear, that the system regression approach, applied in case of model  $M_1$ , is empirically important. Simple analysis, based on the country independent regressions formally imposing assumption of diagonality of the covariance matrix, ignores cross country financial linkages, which seem to be substantial. The strongest correlations in the system are positive with some exceptions. The strongest financial linkage, as measured by the correlation of the error terms, is observed between Austria and Denmark (0.86) followed by Netherlands and France (0.85). Also, in case of pairs Austria- Belgium, Austria-France, Austria-Sweden, Belgium-Denmark, Belgium-Germany, Belgium-Sweden, Denmark-France, Denmark-Spain, Denmark-Sweden and Italy-Sweden, the positive correlation exceeds 0.5. The few exceptions with strong negative correlations (exceeding 0.5) are pairs of Germany-Netherlands and Italy-Spain. It is also interesting to note that Austria has significant financial linkages, as measured by correlation of the error terms, with 4 countries (all positive).

Table 27: Descriptive statistics of the analysed series for Capital Buffers

	CAPBUF	CAPBUF_LAG	Loans/TA	Profit/TA	NPL	ROE	GDP	UNEMP	INF
Mean	1.1815	1.0966	65.6523	0.0031	3.3334	4.8496	0.5720	8.1993	1.2568
Median	1.2277	1.1036	67.0797	0.0039	2.6440	5.8218	1.4573	7.0400	1.2049
Maximum	2.3500	2.3500	78.0443	0.0076	13.6185	12.2380	5.9521	26.0900	3.5321
Minimum	0.4324	0.2929	48.8278	-0.0138	0.1456	-24.8760	-10.8229	3.1400	-0.5004
Std. Dev.	0.4421	0.4591	6.3259	0.0032	2.7483	5.1096	2.8646	4.5275	0.9378
Skewness	0.2393	0.3524	-0.4568	-2.0838	1.8869	-2.3720	-1.5456	2.1524	0.2618
Kurtosis	-0.5862	-0.4504	-0.4357	7.4254	4.0895	10.0290	2.6461	4.7941	-0.6023
Observations	120	120	120	120	120	120	120	120	120

Table 28: Country-wise statistics of the analysed series for Capital Buffers

Country	Avg of CAPBUF	Avg of CAPBUF_LAG	Avg of Loans/TA	Avg of Profit/TA	Avg of NPL	Avg of ROE	Avg of GDP	Avg of UNEMP	Avg of INF
Austria	1.03	0.94	70.09	0.00	3.67	4.89	0.41	5.20	1.71
Belgium	1.33	1.29	63.62	0.00	3.28	6.45	0.71	7.34	1.57
Denmark	1.45	1.35	70.74	0.00	3.15	4.91	0.96	6.49	1.16
France	0.97	0.88	57.59	0.00	3.53	5.73	0.29	9.27	0.98
Germany	1.17	1.11	57.33	0.00	1.80	1.69	0.79	4.91	1.18
Italy	0.83	0.74	67.78	0.00	9.51	-0.53	-0.96	10.37	1.03
Luxembourg	1.61	1.54	64.10	0.00	0.56	6.31	1.76	5.64	1.47
Netherlands	1.34	1.22	71.75	0.00	2.27	5.63	0.59	5.30	1.55
Spain	0.74	0.68	66.13	0.00	4.70	2.93	-0.34	19.85	0.98
Sweden	1.34	1.22	67.39	0.01	0.87	10.49	1.52	7.61	0.94

Table 29: Matrix of sample correlation of the analysed series for Capital Buffers

	CAPBUF	CAPBUF_L	Loans/TA	Profit/TA	NPL	ROE	GDP	UNEMP	INF
Cap Buffer	1	0.9084***	0.2308	0.4308***	-0.4906***	0.3717***	0.1815	-0.4595***	-0.0786
Cap Buffer Lag	0.9084***	1	0.2555***	0.4067***	-0.4629***	0.3387***	0.2484***	-0.4423***	0.0259
Loans/Assets	0.2308	0.2555***	1	0.2391***	0.0884	0.2012	0.1623	-0.0781	0.1365

Profit/Assets	0.4308***	0.4067***	0.2391***	1	-0.4669***	0.9672***	0.3876***	-0.2088	-0.1265
NPL	-0.4906***	-0.4629***	0.0884	-0.4669***	1	0.4829***	-0.1096	0.4657***	-0.0469
ROE	0.3717***	0.3387***	0.2012	0.9672***	-0.4829***	1	0.3973***	-0.2226	-0.1363
GDP	0.1815	0.2484***	0.1623	0.3876***	-0.1096	0.3973***	1	-0.1181	0.2276
UNEMP	-0.4594***	-0.4423	-0.0781	-0.2088	0.4657***	-0.2226	-0.1181	1	-0.1736
INF	-0.0786	0.0259	0.1365	-0.1265	-0.0469	-0.1363	0.2276	-0.1736	1

Note: \*\*\* denotes significance at 1% level

Table 30: Determinants of CAPBUF - the FE panel estimates of parameters in equation (26)

	Intercept	CAPBUF <sub>L,t,j</sub>	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	NPL <sub>t,j</sub>	ROE <sub>t,j</sub>
FE panel regression estimates									
Est.	0.3212	0.7999***	-0.0055	-0.0073	-0.0506**	0.0019	11.8115	-0.0105	-0.0040
Std. error	0.1830	0.0482	0.0067	0.0044	0.0195	0.0029	21.8403	0.0083	0.0137
p-value	0.1047	0.0000	0.4312	0.1205	0.0232	0.5166	0.5985	0.2335	0.7747

Note: \*\*\* denotes significance at 1% level, \*\* at 5% level

Table 31: Cross country heterogeneity of determinants of  $CAPBUF_{t,j}$  – estimates of parameters in equation (27) provided the model  $M_0$  (independent regressions)

		Interc ept	$CAPBUF_{L,t,j}$	$GDPG_{t,j}$	$INF_{t,j}$	$UNEM$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$NPL_{t,j}$	$ROE_{t,j}$
Country	The system of independent regressions; $M_0$									
Austria	Est.	2.0414	0.7519	0.0200	-0.0501	0.1297	-0.0301	93.8248	-0.0432	-0.0874
	Std. error	1.1449	0.1193	0.0092	0.0261	0.0398	0.0136	113.7680	0.0236	0.0877
	p- value	0.0999	0.0000	0.0503	0.0791	0.0068	0.0477	0.4256	0.0917	0.3387
Belgium	Est.	0.0256	-0.0947	-0.0519	0.0743	0.0450	0.0178	-78.0594	-0.0475	0.0597
	Std. error	0.6113	0.1158	0.0070	0.0137	0.0291	0.0071	31.0925	0.0251	0.0143
	p- value	0.9672	0.4295	0.0000	0.0002	0.1478	0.0279	0.0274	0.0821	0.0013
Denmark	Est.	1.8067	0.4982	-0.0760	0.0406	-0.0218	-0.0154	13.7738	-0.0288	0.0570
	Std. error	1.5232	0.1801	0.0273	0.0534	0.0966	0.0147	202.7063	0.0382	0.1303
	p- value	0.2585	0.0171	0.0166	0.4613	0.8254	0.3147	0.9469	0.4656	0.6695
France	Est.	0.7158	0.5302	-0.0282	0.0198	0.0359	-0.0102	365.8036	-0.0182	-0.1925
	Std. error	0.8864	0.1301	0.0092	0.0326	0.0366	0.0134	112.9072	0.0489	0.0541
	p- value	0.4351	0.0015	0.0096	0.5548	0.3459	0.4621	0.0071	0.7157	0.0040
Germany	Est.	1.9883	0.7297	0.0175	-0.0618	-0.0265	-0.0201	50.7390	-0.1319	-0.0605
	Std. error	0.6071	0.3362	0.0172	0.0505	0.0820	0.0059	109.1336	0.1281	0.0734
	p- value	0.0066	0.0508	0.3294	0.2445	0.7522	0.0050	0.6503	0.3235	0.4257
Italy	Est.	2.6176	0.5693	0.0054	0.0100	0.0492	-0.0392	413.7799	-0.0175	-0.2814
	Std. error	0.8225	0.2277	0.0121	0.0209	0.0412	0.0115	101.2604	0.0248	0.0704
	p- value	0.0079	0.0279	0.6625	0.6412	0.2553	0.0053	0.0015	0.4938	0.0018
	Est.	4.3630	-0.1167	-0.0440	-0.5769	-0.3591	0.0181	683.0292	-1.2642	-0.5085

Luxembo urg	Std. error	3.5038	0.4480	0.0335	0.3835	0.4680	0.0146	478.6231	0.3433	0.3848
	p- value	0.2368	0.7989	0.2141	0.1584	0.4577	0.2384	0.1791	0.0031	0.2110
Netherla nds	Est.	2.5210	0.5306	0.0800	-0.0335	0.1551	-0.0026	222.3378	-0.8135	-0.2304
	Std. error	0.9772	0.1600	0.0251	0.0207	0.0496	0.0099	82.0299	0.3255	0.0369
	p- value	0.0241	0.0062	0.0078	0.1311	0.0087	0.7978	0.0189	0.0279	0.0000
Spain	Est.	7.6101	-0.5255	0.0290	-0.0392	-0.1118	-0.0727	-95.6215	0.1311	0.0570
	Std. error	0.9909	0.2180	0.0062	0.0079	0.0144	0.0098	25.1170	0.0241	0.0137
	p- value	0.0000	0.0329	0.0005	0.0003	0.0000	0.0000	0.0025	0.0002	0.0013
Sweden	Est.	-3.4996	0.6010	-0.0564	-0.0044	0.1626	0.0088	-8.2722	1.5293	0.1029
	Std. error	1.6328	0.1609	0.0235	0.0578	0.1059	0.0162	203.9550	0.2098	0.1108
	p- value	0.0533	0.0028	0.0333	0.9407	0.1507	0.5960	0.9683	0.0000	0.3716

Table 32: Cross country heterogeneity of determinants of  $CAPBUF_{t,j}$  – estimates of parameters in equation (27) provided the model  $M_1$  (SURE specification)

		Intercept	$CAPBUF_{L,t,j}$	$GDPG_{t,j}$	$INF_{t,j}$	$UNEM_{t,j}$	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	$NPL_{t,j}$	$ROE_{t,j}$
Country	The system of independent regressions; $M_0$									
Austria	Est.	1.8716	0.6318	0.0092	0.1379	-0.0319	-0.0286	193.3496	-0.0265	-0.1598
	Std. error	0.7291	0.0787	0.0063	0.0277	0.0155	0.0089	73.8898	0.0176	0.0563
	p-value	0.0247	0.0000	0.1670	0.0003	0.0626	0.0074	0.0225	0.1583	0.0150
Belgium	Est.	-0.0060	-0.1190	-0.0500	0.0465	0.0745	0.0192	-87.8440	-0.0543	0.0638
	Std. error	0.4351	0.0870	0.0054	0.0196	0.0108	0.0053	21.2414	0.0161	0.0101
	p-value	0.9892	0.1966	0.0000	0.0350	0.0000	0.0033	0.0014	0.0055	0.0000
Denmark	Est.	1.6689	0.5112	-0.0838	-0.0392	0.0681	-0.0132	1.9131	-0.0125	0.0646
	Std. error	0.9808	0.1288	0.0183	0.0685	0.0382	0.0092	135.6254	0.0259	0.0868
	p-value	0.1146	0.0019	0.0006	0.5775	0.0997	0.1760	0.9890	0.6378	0.4710
France	Est.	0.6627	0.5337	-0.0286	0.0363	0.0209	-0.0097	377.2581	-0.0096	-0.2012
	Std. error	0.5356	0.0825	0.0050	0.0153	0.0182	0.0091	62.8768	0.0280	0.0275
	p-value	0.2397	0.0000	0.0001	0.0352	0.2728	0.3061	0.0001	0.7376	0.0000
Germany	Est.	2.2258	0.5917	0.0125	-0.0627	-0.0498	-0.0223	79.2478	-0.0359	-0.0538
	Std. error	0.4474	0.2533	0.0134	0.0609	0.0401	0.0038	82.3876	0.0971	0.0595
	p-value	0.0003	0.0377	0.3702	0.3230	0.2376	0.0001	0.3551	0.7181	0.3841
Italy	Est.	2.6706	0.5417	0.0049	0.0554	0.0168	-0.0406	443.4165	-0.0197	-0.3001
	Std. error	0.7208	0.1514	0.0100	0.0309	0.0190	0.0099	83.6899	0.0180	0.0587
	p-value	0.0030	0.0038	0.6316	0.0975	0.3930	0.0015	0.0002	0.2966	0.0003
Luxembourg	Est.	4.1604	-0.0522	-0.0391	-0.3296	-0.5554	0.0171	609.3119	-1.2191	-0.4651
	Std. error	3.0268	0.4127	0.0296	0.4038	0.3288	0.0133	428.7139	0.3007	0.3417

	p-value	0.1944	0.9015	0.2110	0.4303	0.1170	0.2231	0.1807	0.0016	0.1985
Netherlands	Est.	2.8766	0.4746	0.0757	0.1651	-0.0367	-0.0061	255.3803	-0.8641	-0.2422
	Std. error	0.4204	0.1033	0.0145	0.0273	0.0145	0.0065	54.1209	0.1738	0.0243
	p-value	0.0000	0.0006	0.0002	0.0001	0.0265	0.3616	0.0005	0.0003	0.0000
Spain	Est.	7.7019	-0.5563	0.0294	-0.1136	-0.0403	-0.0733	-90.1028	0.1313	0.0537
	Std. error	0.5440	0.1242	0.0035	0.0080	0.0048	0.0054	15.3578	0.0145	0.0087
	p-value	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
Sweden	Est.	-2.7441	0.4596	-0.0436	0.1349	0.0020	0.0056	127.8018	1.4520	0.0204
	Std. error	1.4772	0.1280	0.0199	0.0990	0.0461	0.0118	140.7610	0.1780	0.0818
	p-value	0.0879	0.0037	0.0488	0.1978	0.9660	0.6424	0.3818	0.0000	0.8072

Table 33: The sign and significance of impact in equation (27) – the model  $M_0$  (independent regressions)

	Intercept	CAPBUF_L <sub>t,j</sub>	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	NPL <sub>t,j</sub>	ROE <sub>t,j</sub>
Austria	+*	+***	+*	-*	+***	-**	+	-*	-
Belgium	+	-	-***	+***	+	+**	-**	-*	+***
Denmark	+	+**	-**	+	-	-	+	-	+
France	+	+***	-***	+	+	-	+***	-	-***
Germany	+***	+*	+	-	-	-***	+	-	-
Italy	+***	+**	+	+	+	-***	+***	-	-***
Luxembourg	+	-	-	-	-	+	+	-***	-
Netherlands	+**	+***	+***	-	+***	-	+**	-**	-***
Spain	+***	-**	+***	-***	-***	-***	-***	+***	+***
Sweden	-*	+***	-**	-	+	+	-	+***	+

Note: the positive/negative impact of a particular variable is denoted by +/- respectively. We also put notation reporting the significance at level 0.01, 0.05 and 0.1 by \*\*\*, \*\* and \*.

Table 34: The sign and significance of impact in (2) – the model  $M_1$  (independent regressions)

	Intercept	CAPBUF_L <sub>t,j</sub>	GDPG <sub>t,j</sub>	INF <sub>t,j</sub>	UNEMP <sub>t,j</sub>	$\frac{LOANS_{t,j}}{TA_{t,j}}$	$\frac{PROFIT_{t,j}}{TA_{t,j}}$	NPL <sub>t,j</sub>	ROE <sub>t,j</sub>
Austria	***	***	+	***	*	***	**	-	**
Belgium	-	-	***	**	***	***	***	***	***
Denmark	+	***	***	-	*	-	+	-	+
France	+	***	***	**	+	-	***	-	***
Germany	***	**	+	-	-	***	+	-	-
Italy	***	***	+	*	+	***	***	-	***
Luxembourg	+	-	-	-	-	+	+	***	-
Netherlands	***	***	***	***	**	-	***	***	***
Spain	***	***	***	***	***	***	***	***	***
Sweden	*	***	**	+	+	+	+	***	+

Note: the positive/negative impact of a particular variable is denoted by +/- respectively. We also put notation reporting the significance at level 0.01, 0.05 and 0.1 by \*\*\*, \*\* and \*.

Table 35: Point estimates of the variances (bold), contemporaneous covariances (in italics above the diagonal) and contemporaneous correlations (shaded cells below the diagonal) of error terms in case of model  $M_1$  (SURE specification)

	Austria	Belgium	Denmark	France	Germany	Italy	Luxembourg	Netherlands	Spain	Sweden
Austria	<b>0.0008</b>	<i>0.0004</i>	<i>0.0013</i>	<i>0.0007</i>	<i>0.0005</i>	<i>0.0003</i>	<i>0.0004</i>	<i>0.0004</i>	<i>0.0002</i>	<i>0.0025</i>
Belgium	0.6079	<b>0.0005</b>	<i>0.0009</i>	<i>0.0001</i>	<i>0.0008</i>	<i>0.0005</i>	<i>-0.0004</i>	<i>-0.0002</i>	<i>0.0001</i>	<i>0.0021</i>
Denmark	0.8552	0.7249	<b>0.0029</b>	<i>0.0010</i>	<i>0.0013</i>	<i>0.0005</i>	<i>0.0011</i>	<i>0.0005</i>	<i>0.0006</i>	<i>0.0036</i>
France	0.6575	0.1119	0.5162	<b>0.0013</b>	<i>-0.0007</i>	<i>-0.0003</i>	<i>-0.0010</i>	<i>0.0012</i>	<i>0.0003</i>	<i>0.0008</i>
Germany	0.3138	0.6511	0.4780	-0.3947	<b>0.0026</b>	<i>0.0000</i>	<i>0.0018</i>	<i>-0.0015</i>	<i>0.0003</i>	<i>0.0023</i>
Italy	0.1584	0.3707	0.1698	-0.1694	0.0141	<b>0.0034</b>	<i>0.0006</i>	<i>0.0000</i>	<i>-0.0007</i>	<i>0.0040</i>
Luxembourg	0.1196	-0.1808	0.1925	-0.2757	0.3245	0.1036	<b>0.0112</b>	<i>-0.0003</i>	<i>-0.0004</i>	<i>0.0007</i>
Netherlands	0.3526	-0.2620	0.2453	0.8495	-0.7125	0.0193	-0.0759	<b>0.0017</b>	<i>0.0001</i>	<i>-0.0002</i>
Spain	0.3796	0.3013	0.5521	0.4821	0.3160	-0.6595	-0.1977	0.1073	<b>0.0004</b>	<i>-0.0004</i>
Sweden	0.7324	0.7464	0.5497	0.1970	0.3690	0.5715	0.0576	-0.0310	-0.1616	<b>0.0145</b>

## Conclusions

The dissertation employed a nonstandard econometric framework, Seemingly Unrelated Regression Equations (SURE), to examine procyclicality in the banking sector for EU countries, focusing on three key areas: loan supply, loan loss provisions, and capital buffers. This study was guided by the existing literature and identified research gaps, aiming to comprehensively analyse how these factors vary with economic cycles. Various models were developed, and the diverse results indicate the heterogeneity of procyclicality. The findings align with theoretical expectations and the critical literature review, where this heterogeneity was also observed.

The first chapter of this thesis, primarily focused on the theoretical aspects, lays the groundwork for the dissertation's objectives and hypotheses. Thus, it serves as a foundation for the subsequent main empirical section.

The theoretical findings on the concept of cyclicity and the evolution of economic cycle theories can be summarized in the following points:

1. The concept of cyclicity in economics has been explored since the mid-19th century. Clément Juglar (1857) is often credited as the founding father of business cycle theory, identifying phases of prosperity, crisis, and liquidation. Money supply and banking are crucial in understanding business cycles. Initially, banks played a secondary role in economic theories, but their importance in monetary and fiscal policies has grown, especially highlighted during recent financial crises. Early classical economists like Adam Smith, Thomas Malthus, and David Ricardo did not develop systematic business cycle theories. However, Malthus's underconsumption theory noted the potential for economic crises due to insufficient demand. Juglar's work marked a shift from crisis

theories to business cycle theories, identifying cyclical phases and emphasising the importance of recurring movements in economic activity. Alfred Marshall attributed business cycles to psychological factors such as business confidence and credit availability. He also proposed the quantity theory of money to explain economic fluctuations through changes in money supply and price levels.

2. Austrian economists Ludwig von Mises and Friedrich Hayek attributed economic recessions to central bank interference in interest rates, leading to investment mismatches and inevitable recessions due to monetary disturbances. John Maynard Keynes argued for government intervention to stabilise economies, advocating countercyclical policies to manage aggregate demand and suggesting that economies could become stuck in undesirable equilibrium points without external boosts. The Keynesian model dominated until the 1970s, when external shocks and high inflation exposed its flaws. Neoclassical models, particularly those incorporating technical change and productivity shocks, gained prominence. Kydland and Prescott's real business cycle theory integrated business cycle and growth theories, using dynamic general equilibrium models to study economic fluctuations driven by technology shocks and other exogenous factors.
3. Modern theories, including Dynamic Stochastic General Equilibrium (DSGE) models, have furthered the understanding of procyclicality by analysing how economies respond to various shocks, distinguishing between classic RBC models and New-Keynesian DSGE models with price-setting frictions. The 2007-08 financial crisis highlighted the procyclicality of financial variables, prompting the Financial Stability Forum to explore mitigation strategies. Regulatory capital's procyclicality, especially

under Basel II, exacerbates credit cycles, leading to Basel III's countercyclical buffers and improved stress testing.

4. Research shows that bank lending is procyclical, increasing during economic expansions and decreasing during recessions. Goodhart and Segoviano (2004) explain that stricter regulatory scrutiny during recessions reduces loan supply, potentially worsening economic slowdowns. Kashyap and Stein (2000) found bank capital and size critical for US loan supply. Altunbas et al. (2002) observed a positive correlation between capital and loan supply in European banks. Hempell and Sorensen (2010) identified liquidity and capital as key constraints during the 2007-08 crisis. Studies like Ivashina and Scharfstein (2010) and Jimenez et al. (2011) further support the procyclicality of loan supply, impacting economic stability.
5. The procyclicality of loan loss provisioning (LLP) and its linkage with economic cycles has also gained prominence as a topic of research, especially in the post-financial crisis of 2007-08. Laeven and Majnoni (2002) found that banks delay LLP until downturns, amplifying economic impacts, and showed a negative correlation between LLP and GDP growth. Bikker and Metzmakers (2005) confirmed this but linked loan growth rate positively to LLP. Bouvatier and Lepetit (2013) concluded that backward-looking provisioning amplifies cyclicity, especially in emerging countries. Olszak and Pipień (2016) noted that financial integration increases LLP's procyclicality. Caporale et al. (2014) found that excessive loans during expansions lead to a rise in non-performing loans during recessions. Credit risk models often increase procyclicality, affecting economic stability.

6. Post-2007-08 financial crisis, policymakers and researchers have focused on the interactions between macroeconomic conditions and regulatory capital, concerned about procyclicality amplifying economic fluctuations. During upturns, decreased capital requirements encourage risk-taking and credit extension without sufficient capital buffers, while downturns see increased capital needs, leading to reduced lending and asset disposals. Basel II's risk-sensitive approach raised concerns about amplifying business cycles, prompting Basel III's introduction of countercyclical buffers. Studies (e.g., Peek and Rosengren, 1995; Kishan and Opieal, 2006) show that capital requirements significantly affect bank lending behaviour, with undercapitalised banks being more pro-cyclical. The BCBS countercyclical buffer aims to mitigate these effects.

The resurgence of the procyclicality debate following the 2008 global financial crisis and the diverse findings from the reviewed literature naturally guided the formulation of the thesis research questions, objectives, and hypotheses. There is insufficient evidence of cross-country linkages in the analysis of the procyclicality of credit growth, credit risk, and regulatory capital. The growing interconnectedness of financial institutions and markets and highly correlated financial risks have intensified cross-border spillovers through various channels (Claessens et al., 2011; Olszak and Pipień, 2016; Fernandez-Gamez et al., 2020). Much of the literature overlooks the heterogeneity among countries when conducting cross-country procyclicality analysis. However, the main objective was to use the SURE model as a verification tool, representing a novel approach. This leads the reader to the second part of the thesis.

The second chapter outlined the methodology for procyclicality testing, which relies on the Seemingly Unrelated Regression Equations (SURE) model proposed by Zellner (1962). The SURE model enhanced the Generalized Linear Regression Model (GLRM) by addressing heteroscedasticity in cross-sectional data and autocorrelation in time series. While these assumptions are valid for separate cross-sectional data or time series analyses, panel data often exhibit heteroscedasticity and autocorrelation. The SURE model allows for heterogeneity-analysed effects (like procyclicality). Consequently, the SURE model may be more suitable for panel data than the GLRM or the Classical Linear Regression Model (CLRM). Statistical significance tests in this thesis involving log-likelihood ratios showed that the SURE model consistently exhibited higher likelihood ratios than the OLS equivalents, thereby confirming the first detailed hypothesis H1.

We employed two approaches to study cross-country linkages in the procyclicality analysis of EU countries. First, we use the Fixed Effect (FE) panel regression approach to identify the procyclicality effect common to all analysed countries, leveraging data from multiple countries and assuming constant parameters. In the second step, we use the Seemingly Unrelated Regression Equations (SURE) system. This method allowed for variable parameters of interest across countries, enabling us to test for cross-country heterogeneity in the procyclicality effect. Importantly, this approach provides an econometric framework for assessing the empirical relevance of standard panel regression outcomes, which assume a uniform procyclicality effect across all analyzed countries. Our primary research hypothesis posits that the procyclicality effect is country-specific, exhibiting significant variability among different economies.

The structure of chapters 3, 4 and 5 was quite similar and had an empirical focus.

Chapters 3, 4, and 5 were structured in two parts: the first part focused on explaining the determinants of the dependent variable and formulating the hypothesis. The second part focused on the outcomes of the SURE model, provided statistical inferences and included a discussion of the findings.

In terms of empirical analysis, three models were estimated and analysed in chapters 3, 4 and 5 to test the procyclicality hypothesis for selected EU countries:

- i) FE Panel regression at aggregate level combining all countries
- ii) M0 model with independent regressions for each country without considering the correlation of the error terms
- iii) M1 model with independent regressions for each country considering the correlation of the error terms (SURE specification)

Chapter 3 deals with procyclicality of loan supply for a sample of 15 EU countries. Empirical research indicates that loan growth is typically positive during economic booms and negative during recessions, affecting credit quality. Banks may ease credit standards during booms, leading to riskier loans and potential defaults during downturns. The credit supply is influenced by bank-specific factors (like profitability, credit risk, and deposits) and macroeconomic variables (such as GDP growth, inflation, and unemployment). Research showed that loan supply generally increases with GDP growth and decreases with rising unemployment. Inflation's impact was mixed, while the relationship between bank deposits and loans has evolved with financial innovations. Understanding these dynamics is crucial for managing economic cycles

and credit risks. Macroeconomic variables like GDP growth, inflation, and unemployment vary considerably across countries, with mixed impacts on loan supply. Fixed-effect panel regression results initially showed less significant relationships between loan supply and macroeconomic variables, but System of Equations (SURE) models revealed substantial cross-country diversity. Significant financial linkages between countries were also observed, with the SURE model providing more precise estimates than simple regressions.

Chapter 4 deals with procyclicality analysis of loan loss provisions (LLP) for a sample of 15 EU countries. Loan loss provisions (LLP) are crucial for banks' risk management by building loan loss reserves (LLR) to guard against expected loan losses, thus protecting capital during credit losses. LLPs impact profitability and future capital, providing transparency in financial statements, unlike non-performing loans (NPLs). They signal credit risk to market participants, conveying information about future earnings. LLPs, alongside write-offs, indicate loan quality and influence financial standing. Determinants of LLPs include bank-specific factors (profits, loans, deposits) and macroeconomic variables (GDP growth, inflation, unemployment). GDP growth correlates negatively with LLPs, indicating procyclicality, while inflation and unemployment show positive relationships. The study found weak correlations between LLP and explanatory variables like GDP and inflation, with unemployment showing the strongest correlation. Fixed-effect (FE) panel regression and the Seemingly Unrelated Regression (SURE) models were used to estimate the parameters. The SURE model revealed significant cross-country diversity in the

relationship between LLP and economic variables. GDP growth negatively impacted LLP in France, Luxembourg, and the Netherlands, while it positively impacted Portugal, Spain, and Sweden. Inflation was significant in 11 countries, all positively related to LLP. Unemployment showed mixed impacts across countries. Bank-specific variables (loans, profits, deposits) significantly influenced LLP. The SURE model indicated a positive relationship between loans and LLP in 13 countries and a predominantly negative relationship between profits and LLP. Deposits had mixed impacts on LLP across countries. The study highlights the importance of considering cross-country heterogeneity and financial linkages in analysing LLP determinants.

Chapter 5 addresses the procyclicality of capital buffers in 15 EU countries. Recently, the procyclicality of capital requirements has gained attention from policymakers and regulators. During recessions, banks incur losses, eroding capital and raising risk-based capital requirements as per Basel II and Basel III. If banks can't raise new capital, lending capacity is limited, potentially leading to a credit crunch and worsening the recession. Conversely, banks have excess lending capacity in expansion phases due to sufficient capital, amplifying expansionary conditions. Basel III addresses these issues by introducing capital preservation and countercyclical buffers, which increase in good times and decrease in bad times, balancing the procyclicality effects while maintaining bank stability. The link between regulatory capital and the economic cycle varies across banks and countries and is influenced by bank-specific and macroeconomic variables. Bank-specific variables include profit, loan supply, non-performing loans (NPL), and return on equity (ROE). Macroeconomic determinants are real GDP growth (GDPG), inflation (INF), and unemployment (UNEMP). GDPG generally has a negative

relationship with capital buffers, indicating procyclicality. Banking sector variables (profits, loans, NPL, and ROE) correlate more with capital buffer than macroeconomic factors. The analysis reveals that reporting weak relationships for macroeconomic variables is incorrect, as cross-country heterogeneity is crucial. Fixed-effect panel regression finds only lagged capital buffer and inflation significant. The SURE model highlights diverse, significant relationships across countries, showing stronger and more precise estimates than independent regressions.

The thesis objectives were largely achieved. The SURE model was successfully applied to test procyclicality in the banking sector and cross-country heterogeneity for EU countries, meeting the primary objective. The framework of procyclicality and conceptual relationship with the banking sector was thoroughly described and introduced as planned (O1). Verifying the procyclicality hypothesis of loan supply for EU countries was completed (O2). Similarly, verification results were obtained for the procyclicality of loan loss provisions and capital buffer for EU countries (O3 and O4). The literature review highlighted mainstream trends and approaches for empirical analysis of procyclicality, and a new approach (SURE specification) was introduced to test the procyclicality in the banking sector and cross-country heterogeneity.

The main hypothesis of the thesis was confirmed. The significant variability in results across all analyzed EU countries suggests that procyclicality in the banking sector should be viewed considering the cross-country heterogeneity rather than a single approach applicable to all countries. Hypothesis H1 is validated as well; loan supply has a significant positive relation with GDP growth for 7 out of 8 countries where coefficients were found to be significant. Hypothesis H2 is confirmed for only 4 out of

9 countries with significant coefficients, indicating the hypothesis cannot be confirmed. Hypothesis H3 is supported by the procyclicality of capital buffers as it was found to have a significant positive relation for 7 out of 8 countries where coefficients were found to be significant. Hypothesis H4 is also validated; the SURE model, as derived in the second chapter, proves to generalise panel regression and functions as a significant empirical alternative.

The main contribution of this thesis lies in the results and the methods used to obtain them. The findings and the hypothesis regarding the heterogeneity of the procyclicality across EU countries offer a new perspective on the procyclicality debate, especially in the context of a regulatory framework. The focus may shift from general discussions on its existence in the banking sector to recognising it as a country-specific phenomenon. By examining individual regressors and countries separately, the research could uncover more insights and policy implications on the banking sector across EU countries. The research also provides an alternative approach to the empirical analysis of procyclicality and cross-country heterogeneity through the SURE model. The SURE model, introduced by Zellner in 1962, proves to be a suitable and empirically relevant method for panel regression tests involving cross-country analyses.

## REFERENCES

- Abbas, F., Yousaf, I., Ali, S. and Wong, W-K. (2021) Bank Capital Buffer and Economic Growth: New Insights from the US Banking Sector, *Journal of Risk and Financial Management*, 14(4):142. <https://doi.org/10.3390/jrfm14040142>
- Agénor, P.R. and Pereira Da Silva, L.A. (2012) Cyclical effects of bank capital requirements with imperfect credit markets, *Journal of Financial Stability*
- Agénor, P.R. and Zilberman, R. (2015) Loan Loss Provisioning Rules, Procyclicality, and Financial Volatility, *Journal of Banking and Finance*
- Aiyar, S., Calomiris, C and Wieladek , T. (2014) Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment, *Journal of Money, Credit and Banking*
- Akkizidis, I. and Kalyvas, L. (2018) Final basel III modelling: Implementation, impact and implications, *Palgrave Macmillan*
- Albaity, M., Noman, A.H., Mallek, R.S and Al-Shboul, M (2022) Cyclicity of bank credit growth: Conventional vs Islamic banks in the GCC, *Economic Systems*
- Albertazzi, U. and Gambacorta, L. (2009) Bank profitability and the business cycle, *Journal of Financial Stability*, Volume 5, Issue 4, Pages 393-409
- Alesina, A., Tabellini, G. and Campante, F.R. (2008) Why Is Fiscal Policy Often Procyclical?, *Journal of the European Economic Association*
- Allen, L. and Saunders, A. (2005) A Survey of Cyclical Effects in Credit Risk Measurement Models, *SSRN Electronic Journal* (126)
- Alihodzic, A., and Eksi, I. H. (2018). Credit growth and nonperforming loans: evidence from Turkey and some Balkan countries, *Eastern Journal of European Studies*, 9(2), 229-249
- Altman, E.I., Resti, A. and Sironi, A. (2002) The link between default and recovery rates: effects on the procyclicality of regulatory capital ratios, *BIS Working Paper* (113)
- Altunbas, Y., Faxylov, O. and Molyneux, P. (2002) Evidence on the bank lending channel in Europe, *Journal of Banking and Finance*
- Anastasiou, D. (2017) Is ex-post credit risk affected by the cycles? The case of Italian banks, *Research in International Business and Finance*
- Andersen, H. (2011) Procyclical implications of Basel II: Can the cyclicity of capital requirements be contained?, *Journal of Financial Stability*

- Antonakakis, N., Breitenlechner, M. and Scharler, J. (2015) Business cycle and financial cycle spillovers in the G7 countries, *Quarterly Review of Economics and Finance*
- Apostolakis, G. and Papadopoulos, A. (2019) Financial stability, monetary stability and Growth: a PVAR analysis. *Open Economies Review* 30 (1), 157–178.
- Arpa, M., Giulini, I., Ittner, A. and Pauer, F. (2001) The influence of macroeconomic developments on Austrian banks: implications for banking supervision, *BIS Paper* (1), pp. 91-116
- Athanasoglou, P., Ioannis, D. and Manthos, D. (2013) Bank procyclicality and output: Issues and policies, *Munich Personal RePEc Archive* (50830)
- Atici, G. and GURSOY, G. (2012) The Determinants of Capital Buffer in the Turkish Banking System, *International Business Research* 6(1)
- Avignone, G., Altunbas, Y., Polizzi, S. and Reghezza, A. (2021) Centralised or decentralised banking supervision? Evidence from European banks, *Journal of International Money and Finance*
- Awdeh, A. (2017) The Determinants of Credit Growth in Lebanon, *International Business Research, Canadian Center of Science and Education*, vol. 10(2), pp. 9-19
- Ayuso, J., Pérez, D. and Saurina, J. (2004) Are capital buffers pro-cyclical? Evidence from Spanish panel data, *Journal of Financial Intermediation*
- Backus, D. K., Kehoe, P.J., and Kydland, F.E. (1992) International Real Business Cycles, *Journal of Political Economy* 100, no. 4 (1992): 745–75. <http://www.jstor.org/stable/2138686>.
- Baltagi, B. (2020) *Econometric Analysis of Panel Data, Springer Texts in Business and Economics*
- Banerjee, K. (2011) Credit and Growth Cycles in India: An Empirical Assessment of the Lead and Lag Behaviour, *RBI Working Paper*
- Bang-Andersen, J., Risbjerg, L and Spange, M (2014) MONEY, CREDIT AND BANKING, *Denmark National Bank*
- Bank for International Settlements (2004) Basel II: International Convergence of Capital Measurement and Capital Standards, *BIS Framework*
- Bank for International Settlements (2012) Basel Committee on Banking Supervision. The internal audit function in banks, *Bank for International Settlements (June)*, pp. 29

Bank of England (BoE) (2009) The role of macroprudential policy, *Discussion paper*, November 2009

Baron, M. and Xiong, W. (2017) Credit Expansion and Neglected Crash Risk, *NBER Working Paper 22695*

Barth, J.R., Caprio, G.J. and Levine, R. (2001) The Regulation and Supervision of Banks Around the World, *World Bank*

Barth, J. R., Caprio, G., & Levine, R. (2008) Rethinking bank regulation: Till angels govern, *Cambridge University Press*

Basel Committee on Banking Supervision (2011) The transmission channels between the financial and real sectors: a critical survey of the literature, *BIS Working Papers (18)*, pp. 1-46

Baxter, M. and King, R.G. (1995) Approximate Band-Pass Filters for Economic Time Series, *NBER Working Paper Series*

Bcbs (2010) Consultative Document Countercyclical Capital Buffer Proposal, *Basel Committee on Banking Supervision*

Beatty A.L., Ke B., Petroni K.R. (2002) Earnings Management to Avoid Earnings Declines across Publicly and Privately Held Banks. *The Accounting Review*, Vol. 77, No. 3, pp. 547-570.

Bebczuk, R., Burdisso, T., Carrera, J. and Sangiácomo, M. (2011) A New Look into Credit Procyclicality: International Panel Evidence, *BIS CCA Conference on "Systemic risk , bank behaviour and regulation"*

Becker and Ivashina (2011) Cyclicity of Credit Supply: Firm Level Evidence, *NBER Working Paper Series*

Bedayo, M., Estrada, Á. and Saurina, J. (2020) Bank capital, lending booms, and busts: Evidence from Spain over the last 150 years, *Latin American Journal of Central Banking*

Behn, M., Haselmann, R., Wachtel, P. (2020) Procyclical Capital Regulation and Lending Source, *The Journal of Finance*

Bernanke, B.S., Gertler, M. and Gilchrist, S. (1998) The financial accelerator in a quantitative business cycle framework, *NBER Working Paper Series, Working Paper 6455*

Bernauer, T. and Koubi, V. (2002) Banking regulation in hard times: Business cycles, bank capital, and the bank failure - Credit crunch dilemma, *Journal of Public Policy*

Berndt, E.R. (1991) *The Practice of Econometrics, Classic and Contemporary*, Addison-Wesley Publishing Company, Reading

Bernstein, J., Raputsoane, L. and Schaling, E. (2016), Credit Procyclicality and Financial Regulation in South Africa, *South African Journal of Economic and Management Sciences*, SAJEMS NS 19 (2016) No 4:467-478

Bertay, A.C., Demirgüç-Kunt, A. and Huizinga, H. (2015) Bank ownership and credit over the business cycle: Is lending by state banks less procyclical?, *Journal of Banking and Finance*

Besomi, D. (2009). Clément Juglar and his contemporaries on the causes of commercial crises. *Revue Européenne Des Sciences Sociales*, XLVII–143, 17–47

Bhansali, V., Gingrich, R. and Longstaff, F.A. (2008) Systemic credit risk: What is the market telling us?, *Financial Analysts Journal*

Bikker, J.A. and Metzmakers, P.A. (2005) Bank provisioning behaviour and procyclicality, *Journal of International Financial Markets, Institutions and Money*

BIS (2001) The New Basel Capital Accord, *Consultative Document*, Basel Committee on Banking Supervision (BCBS)

BIS (2008) Addressing financial system procyclicality: a possible framework, *BIS Working Paper*

BIS (2010) Countercyclical capital buffer proposal, *Consultative Document*, Basel Committee on Banking Supervision (BCBS)

BIS (2021) The procyclicality of loan loss provisions: A literature review, BCBS Working Paper

Blasio, G.D. (2013) *Questioni di economia e finanza (Occasional papers)*, Banca D'Italia

Bliss, R. B. and Kaufman, G. G. (2003) Bank Procyclicality, Credit Crunches and Asymmetric Monetary Policy Effects: A Unifying Model, *Journal of Applied Finance; Fall 2003, ABI/Inform Global pp25-30*.

Boehl, Michael (2016) Cyclicity of Capital Requirements, *European Banking Authority*

Bofondi, M. and Ropele, T. (2011) Macroeconomic determinants of bad loans: Evidence from Italian Banks, *Questioni di Economia e Finanza*

Bologna, P. and Segura, A. (2017) Integrating stress tests within the Basel III capital framework: A macroprudentially coherent approach, *Journal of Financial Regulation*

Borio C. (2009) Implementing the macroprudential approach to financial regulations and supervision. *Financial Stability Review*, No. 13 – The future of financial regulation, Banque de France, pp. 31-41.

Borio, C. (2012) The financial cycle and macroeconomics: What have we learnt?, *Journal of Banking and Finance*

Borio, C. (2019) On money, debt, trust and central banking, *BIS Working Papers No 763, Monetary and Economic Department*

Borio, C., Drehmann, M. and Xia, D. (2018) The Financial Cycle and Recession Risk, *BIS Quarterly Review(December)*, pp. 59-71

Borio, C., Furfine, C and Lowe, P (2004) Procyclicality of the financial system and financial stability: issues and policy options, *BIS Working Paper*

Borio, C. and Zhu, H. (2012) Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?, *Journal of Financial Stability, Volume 8, Issue 4,*

Borsi, M.T. (2018) Fiscal multipliers across the credit cycle, *Journal of Macroeconomics*

Bouheni, F.B. and Hasnaoui, A. (2017), Cyclical behavior of the financial stability of eurozone commercial banks, *Economic Modelling, 67, (C), 392-408*

Bouvatier, V. and Lepetit, L. (2008) Banks' procyclical behavior: Does provisioning matter?, *Journal of International Financial Markets, Institutions and Money, 18, (5), 513-526*

Bouvatier, V. and Lepetit, L. (2013) Effects of loan loss provisions on growth in bank lending: Some international comparisons, *Economie Internationale*

Bouvatier, V., López-Villavicencio, A. and Mignon, V. (2012) Does the banking sector structure matter for credit procyclicality?, *Economic Modelling*

Bry, G. and Boschan, C. (1971) Programmed Selection of Cyclical Turning Points., *NBER*

Burns, A.F. and Mitchell, W.C. (1946) Measuring Business Cycles, *National Bureau of Economic Research*, <http://www.nber.org/books/burn46-1>

Caporale, G.M., Di Colli, S. and Lopez, J.S. (2014) Bank lending procyclicality and credit quality during financial crises, *Economic Modelling*

Carlyle, T. (1849) Occasional Discourse on the Negro Question, *Fraser's Magazine for Town and Country (London, Vol. XL., February 1849)*

Cass, D. (1965) Optimum Growth in an Aggregative Model of Capital Accumulation. *Review of Economic Studies*. 32 (3): 233-240

Catarineu-Rabell, E., Jackson, P. and Tsomocos, D.P. (2005) Procyclicality and the new Basel Accord - Banks' choice of loan rating system, *Economic Theory*

Cesaroni, T. (2015) Procyclicality of credit rating systems: How to manage it, *Journal of Economics and Business*

Chen, Y.K., Ho, A.Y.F. and Hsu, C.L., (2014) Are bank capital buffers cyclical? Evidence for developed and developing countries. *Journal of Financial Studies*, 22(3), pp.27-56.

Chevallier, C.O. and El Joueidi, S. (2019) Capital regulation and banking bubbles, *Journal of Mathematical Economics*

Chiuri, M.C., Ferri, G. and Majnoni, G. (2001) Enforcing the 1988 Basel capital requirements: Did it curtail bank credit in emerging economies?, *Economic Notes*

Christiano, L.J. and Fitzgerald, T.J. (1999) The band pass filter, *NBER*

Claessens, S., Kose, M.A. and Terrones, M.E. (2011) Financial Cycles: What? How? When?, *NBER International Seminar on Macroeconomics*

Claessens, S., Kose, M.A. and Terrones, M.E. (2014) Financial Crises: Causes, consequences and policy responses, *IMF*

Constant and Augustin (2012) The determinants of Long Term Lending Behavior in the Central African Economic and Monetary Community, *Review of Economics & Finance*

Crook, J., and Bellotti, T (2017) Time varying and dynamic models for default risk in consumer loans , *Journal of the Royal Statistical Society*

Cucinelli, D. (2016) Can speed kill? The cyclical effect of rapid credit growth: evidence from bank lending behaviour in Italy, *Journal of Risk Finance*

Cucinelli, D., Battista, M.L.D., Marchese, M. and Nieri, L. (2018) Credit risk in European banks: The bright side of the internal ratings based approach, *Journal of Banking and Finance*

Culbertson, J.M. (1962) Book Review "Federal Receipts and Expenditures During Business Cycles, 1879- 1958", *Journal of Political Economy*, vol 70, no 5, pp 509–510.

Cull, R., Martinez Peria, M.S., (2013) Bank ownership and lending patterns during the 2008-2009 financial crisis: Evidence from Latin America and Eastern Europe. *Journal of Banking & Finance* 37, 4861-4878.

Cull, Martínez Pería and Verrier, J., (2017) Bank Ownership: Trends and Implications. *IMF Working Paper, WP/17/60*

Darovskii, I. and Vymyatnina, Y.V. (2020) Russia's Macroeconomic Policy, Bank Lending and Business Cycles, *Finance and Business*

De Guevara J.F. and Maudos, J. (2011) Banking competition and economic growth: crosscountry evidence. *European Journal of Finance* 17 (8), 739–764.

Dejong, D. N., Ingram, B. F., Whiteman, C. H., Dejong, D. N., Ingrams, B. F., and Whiteman, C. H. (n.d.). Keynesian Impulses versus Solow Residuals: Identifying Sources of Business Cycle Fluctuations. *Journal of Applied Econometrics* (Vol. 15, Issue 3).

Djiogap, C.F. and Ngomsi, A. (2012) Determinants of Long Term Lending Behavior in the Central African Economic and Monetary Community, *Review of Economics and Finance*, vol. 2, 107-114

Donaldson, J., Piacentino, G and Thakor, A (2015) BANK CREDIT AND UNEMPLOYMENT, Washington University in St Louis

Drehmann, M., Borio, C. and Tsatsaronis, K. (2012) Characterising the Financial Cycle: Don't Lose Sight of the Medium Term!, *BIS Working Papers*(380), pp. 1-38

Drumond, I. (2009) Bank capital requirements, business cycle fluctuations and the basel accords: A synthesis, *Journal of Economic Surveys*

ECB Economic Bulletin (2017) Financial cycles and the macroeconomy, *Issue 1 / 2017, European Central Bank*

ECB Monthly Bulletin (2004) Developments in Banks' Loan Loss Provisions Over Recent Years, *Monetary and financial developments, ECB Monthly Bulletin, March 2004*

Eichberger, J. and Summer, M. (2005) Bank Capital, Liquidity, and Systemic Risk, *Journal of the European Economic Association*, 3(2/3), 547–555. <http://www.jstor.org/stable/40004997>

Estrella, A. (2004) The cyclical behavior of optimal bank capital, *Journal of Banking and Finance*

European Central Bank (2009) Is Basel II pro-cyclical? A selected review of the literature, *Financial Stability Review (December)*, pp. 143-150

Fama, E.F. (1986) Term premiums and default premiums in money markets, *Journal of Financial Economics*, Volume 17, Issue 1, Pages 175-196

Federal Reserve Bank of Philadelphia (2019) Cyclical and the Severity of the U.S. Supervisory Stress Test: 2014 to 2018, *FEDS Notes*,

<https://www.federalreserve.gov/econres/notes/feds-notes/cyclicality-and-the-severity-of-the-us-supervisory-stress-test-2014-to-2018-20190607.html>

Fendoğlu, S. (2017) Credit cycles and capital flows: Effectiveness of the macroprudential policy framework in emerging market economies, *Journal of Banking and Finance*

Fernandez-Gamez, M., Antonio, J., Antonio, S. and David, A. (2020) European country heterogeneity in financial distress prediction: An empirical analysis with macroeconomic and regulatory factors, *Universidade Do Algarve, Elsevier*

Fiebig, D. G. (2001) Seemingly unrelated regression, *A companion to theoretical econometrics*, edited by B. H. Baltagi, 101-121. Malden: Blackwell.

Filardo, A.J., Lombardi, M.J. and Raczko, M.A. (2019) Measuring Financial Cycle Time, *SSRN Electronic Journal* (755)

Financial Conduct Authority (2020) IFPRU 4.1 Application and purpose - FCA Handbook, *Prudential sourcebook for Investment Firms*

Fiordelisi, F., Marques-Ibanez, D. and Molyneux, P. (2011) Efficiency and risk in European banking, *Journal of Banking & Finance*, Volume 35, Issue 5, Pages 1315-1326,

Firestone, J.M. (1960) Federal receipts and expenditures during business cycles, 1879-1958, *National Bureau of Economic Research, Princeton University Press*

Floro, D. (2010) Loan Loss Provisioning and the Business Cycle: Does Capital Matter? Evidence from Philippine Banks, *Bank of International Settlements publications (March)*, pp. 1-36

Fonseca, A.R. and González, F. (2008) Cross-country determinants of bank income smoothing by managing loan-loss provisions, *Journal of Banking and Finance*, 32 (2), pp. 217-228

Fourie, J., Pretorius, T., Harvey, R., Henrico, V. and Phiri, A. (2016) Nonlinear relationship between exchange rate volatility and economic growth: A South African perspective, *Munich Personal RePEc Archive (MPRA)*

Francis, W. B., and Osborne, M. (2012) Capital requirements and bank behavior in the UK: Are there lessons for international capital standards? *Journal of Banking and Finance*, 36(3), 803–816. <https://doi.org/10.1016/j.jbankfin.2011.09.011>

Financial Stability Forum (2009) Reducing Procyclicality Arising from the Bank Capital Framework, *Joint FSF-BCBS Working Group on Bank Capital Issues, Financial Stability Forum www.bis.org(March)*, pp. 1-9

Gambacorta, L. and Marques-Ibanez, D. (2011), The bank lending channel: lessons from the crisis, *Economic Policy*, 26, (66), 135-182

Gambacorta, L and Mistrulli, P (2004) Does bank capital affect lending behavior?, *Journal of Financial Intermediation*

Gambetti, L. and Musso, A. (2012) Loan Supply Shocks and the Business Cycle, *ECB Working Paper*

Garcia, P. (2019) The Macroeconomic Consequences of Bank Capital Requirements, *Annals of Economics and Statistics*

Garcia-Arenas, J. (2020) The financial cycle: an essential tool for understanding the economy, *Monetary Policy, CaixaBank Research, March 2020*

Godlewski, C., Skąła-Wneiz, D. and Weill-Em, L. (2019) Is Lending by Polish Cooperative Banks Procyclical?, *Finance a Uver - Czech Journal of Economics and Finance*

Golodniuk, I. (2006) Evidence on the bank lending channel in Ukraine, Return to Growth in CIS Countries: *Monetary Policy and Macroeconomic Framework*

Gonzales, J E (2009) The Fundamentals of Procyclicality of the Financial System, *Phillippines Central Bank Newsletter*

Goodhart, B.C. and Segoviano, M. (2004) Basel and Procyclicality: A comparison of the Standardised and IRB Approaches to an Improved Credit Risk Method, pp. 1-25

Goodhart, C. (2012) Procyclicality and Financial Regulation, *ESTABILIDAD FINANCIERA, BANCO DE ESPAÑA*

Goodhart, C.A. (2005) Financial regulation, credit risk and financial stability, *National Institute Economic Review*

Gorton, G.B. and He, P. (2008) Bank credit cycles, *Review of Economic Studies*

Greenawalt M.B., Sinkey, J.F. (1988) Bank Loan-Loss Provisions and the Income-Smoothing Hypothesis: An Empirical Analysis, 1976-1984. *Journal of Financial Services Research* 1, pp. 301-318.

Greene W.H. (2012) *Econometric Analysis*. New York University, Prentice Hall.

Greenwood, R., Stein, J.C., Hanson, S.G. and Sunderam, A. (2017) Strengthening and streamlining bank capital regulation, *Brookings Papers on Economic Activity*

Grinin, L., and Korotayev, A. (2014). Interaction between Kondratieff Waves and Juglar Cycles. *Yearbook*. <https://hal-hprints.archives-ouvertes.fr/hprints-01863102>

Grosse, S. and Schumann, E. (2014) Cyclical behavior of German banks' capital resources and the countercyclical buffer of Basel III, *European Journal of Political Economy*

Hansen, G. D. (1985) Indivisible Labor and the Business Cycle, *Journal of Monetary Economics*, 56: 309—327, 1985

Harding, D. and Pagan, A. (2002) Dissecting the cycle: A methodological investigation, *Journal of Monetary Economics*

Harding, D. and Pagan, A. (2005) A suggested framework for classifying the modes of cycle research, *Journal of Applied Econometrics*

Hayek, F.A. (1928) Intertemporal Price Equilibrium and Movements in the Value of Money, *Money, Capital, and Fluctuations: Early Essays*, edited by Roy McCloughry, Chicago, University of Chicago Press, 1984.

Hayek, F. A. (1933) Monetary Theory and the Trade Cycle, New York, Augustus M. Kelley, 1975.

Hempell, S. and Sørensen, C.K. () The impact of supply constraints on bank lending in the euro area- crisis induced crunching?, *ECB Working Paper*

Hicks, J. (1950) A Contribution to the Theory of the Trade Cycle, *Oxford: Clarendon Press*

Hicks, J. (1965) Capital and Growth, *Oxford: Clarendon Press*

Hicks, J. (1967) Critical Essays in Monetary Theory, *Oxford: Clarendon Press*

Hiebert, P., Jaccard, I. and Schuler, Y. (2018) Contrasting financial and business cycles: Stylized facts and candidate explanations, *Journal of Financial Stability*

Hodrick, R.J., Prescott E.C. (1980) Postwar U.S. Business Cycles: An Empirical Investigation, mimeo, Carnegie-Mellon University, Pittsburgh, P.A.

Hodrick, R.J. and Prescott, E.C. (1997) Postwar U.S. Business Cycles: An Empirical Investigation, *Journal of Money, Credit and Banking*

Hofmann, B. (2016) PROCYCLICALITY: THE MACROECONOMIC IMPACT OF RISK-BASED CAPITAL REQUIREMENTS, *Vol. 19(2), pp. 179-200*

Holmstrom, B., and Tirole, J. (1997). Financial Intermediation, Loanable Funds, and the Real Sector. *The Quarterly Journal of Economics*, 112(3), 663–691.  
<http://www.jstor.org/stable/2951252>

Horváth, Katalin Mérő and Balázs Zsámboki (2002) Studies on the procyclical behaviour of banks, *NBH Working Paper*

Hsieh, M.F. and Lee, C.C. (2020) Bank Liquidity Creation, Regulations, and Credit Risk, *Asia-Pacific Journal of Financial Studies*

Huang, X. and Xiong, Q. (2015) Bank capital buffer decisions under macroeconomic fluctuations: Evidence for the banking industry of China, *International Review of Economics & Finance*, Mar 1;36:30-9.

Huizinga, H. and Laeven, L. (2019) The Procyclicality of Banking: Evidence from the Euro Area, *IMF Economic Review*

Ibrahim, M.H., (2016) Business Cycle and Bank Lending Procyclicality in a Dual Banking System, *Economic Modelling*, 55, 127–134.

Illing, M. and Paulin, G. (2005) Basel II and the cyclicity of bank capital, *Canadian Public Policy*

Imran, K and Nishat, M (2013) Determinants of bank credit in Pakistan: A supply side approach, *Economic Modelling*

International Monetary Fund (2010) Global Financial Stability Report, *World Economic and Financial Surveys*, October 2010

International Monetary Fund (2011) Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences, *IMF Working Papers*

Ivashina, B.V. and Scharfstein, D. (2010) Loan Syndication and Credit Cycles, *American Economic Review*, 100 (2): 57–61.

Iwanicz-Drozdowska, M., Witkowski, B. and Carbó Valverde, S. (2020) “When in Rome, do as Romans”. Similarities of banks performance drivers in CESEE, *Bank i Kredyt*

Jackson, P. (1999) Capital requirements and Bank Behaviour: The Impact of Basel Accord, *BCBS Working Paper*

Jacques, K.T. (2010) Procyclicality, bank lending, and the macroeconomic implications of a revised basel accord, *Financial Review*

- Jayaram, S., Patnaik, I. and Shah, A. (2009) Examining the decoupling hypothesis for India, *Economic and Political Weekly*
- Jevons, W.S. (1884) *Investigations in currency and finance*, ed. by H. S. Foxwell, London: Macmillan
- Jiang, Y. (2020) Identification of business cycles and the Great Moderation in the post-war U.S. economy, *Economics Letters*
- Jiménez, G., Ongena, S., Peydró, J.L. and Saurina, J. (2012) Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications, *American Economic Review*
- Jokipii, T., and Milne, A. (2008). The cyclical behaviour of European bank capital buffers. *Journal of Banking and Finance*, 32(8), 1440–1451.
- Jokivuolle, E., Pesola, J. and Viren, M. (2015) Why is credit-to-GDP a good measure for setting countercyclical capital buffers?, *Journal of Financial Stability*
- Jones, J. (2013) Cross-Border Banking in the Expanded European Union, *Eastern European Economics*, Vol. 51, No. 6
- Juglar, C. (1857) “Des crises commerciales et monetaires de 1800 à 1857”, *Journal des Économistes*, XIV, April and May, pp. 35–60 and 255–67
- Juglar, C. (1862) *Des Crises Commerciales et de leur retour périodique en France, an Angleterre et aux États-Unis*, Paris: Guillaumin.
- Kalirai, H. and Scheicher, M. (2002) Macroeconomic stress testing: preliminary evidence for Austria, *Financial Stability Report*, pp. 58-74
- Karni, E. (2009) A mechanism for thawing the credit markets, *Rev Econ Design* 14, 243–249 (2010). <https://doi.org/10.1007/s10058-009-0101-z>
- Kashyap, A.K. and Stein, J.C. (2000) What do a million observations on banks say about the transmission of monetary policy?, *American Economic Review*
- Kashyap, A.K. and Stein, J.C. (2004) Cyclical implications of the Basel II capital standards Introduction and summary, *Economic Perspectives*
- Kashyap, A.K., Rajan, R.G. and Stein, J.C. (2008) Rethinking capital regulation, *Federal Reserve Bank*
- Kasman, A. and Busun, K.S. (2015) A Note on Bank Capital Buffer, Portfolio Risk and Business Cycle, *Ege Akademik Bakis (Ege Academic Review)*. 15. 1-1. 10.21121/eab.2015121905.

- Keijsers, B., Diris, B. and Kole, E. (2018) Cyclicity in losses on bank loans, *Journal of Applied Econometrics*
- Kelly, R., McQuinn, K and Stuart, R (2013) Exploring the steady-state relationship between credit and GDP for a small open economy: the case of Ireland, *ECB Working Paper*
- Keynes, J.M. (1936) *The General Theory of Employment, Interest and Money, 1936, London: Macmillan*
- Kim, T. and Mangla, V. (2019) Capital Regulation with Two Banking Sectors: Cyclicity and Implementation, *Journal of Money, Credit and Banking*
- Kindleberger, C.P. (1978) *Manias, Panics, and Crashes. A History of Financial Crisis. Macmillan, London*
- King, R.G., Plosser, C. and Rebelo, S.T. (1988), Production, Growth and Business Cycles, *Journal of Monetary Economics*, 21 (1988) 195-232 North-Holland
- Kishan, R.P. and Opiela, T.P. (2006) Bank capital and loan asymmetry in the transmission of monetary policy, *Journal of Banking and Finance*
- Kishan, R.P. and Opiela, T.P. (2009) Bank Size, Bank Capital, and the Bank Lending Channel, *Journal of Money, Credit and Banking*
- Kiyotaki, N., and Moore, J. (1997) Credit Cycles, *Journal of Political Economy*, 105(2), 211–248. <https://doi.org/10.1086/262072>
- Klein, N (2013) Non-Performing Loans in CESEE: Determinants and Impact on Macroeconomic Performance, *IMF Working Papers*
- Koopman, S.J. and Lucas, A. (2005) Business and default cycles for credit risk, *Journal of Applied Econometrics*
- Koopman, S.J., Kräussl, R., Lucas, A. and Monteiro, A.B. (2009) Credit cycles and macro fundamentals, *Journal of Empirical Finance*
- Koopmans, T. C. (1965) On the Concept of Optimal Economic Growth. The Economic Approach to Development Planning. *Chicago: Rand McNally. pp. 225-287*
- Kouretas, G.P., Pawłowska, M. and Szafranski, G. (2020) Market structure and credit procyclicality: Lessons from loan markets in the European Union banking sectors, *Economic Modelling* 93, pp. 27–50
- Krüger, S., Rösch, D. and Scheule, H. (2018) The impact of loan loss provisioning on bank capital requirements, *Journal of Financial Stability*

- Kydland, F. E. and Prescott, E. C. (1982) Time to build and aggregate fluctuations, *Econometrica*, 1345–1370.
- Kyun, K. (1988) Equilibrium Business Cycle Theory in Historical Perspective. *Cambridge University Press*.
- Laidler, D. (2003). The price level, relative prices and economic stability: aspects of the interwar debate. *BIS Working Papers* [www.bis.org](http://www.bis.org)
- Laeven, L. and Majnoni, G. (2003) Loan loss provisioning and economic slowdowns: Too much, too late?, *Journal of Financial Intermediation*
- Landau, J. (2009) Procyclicality – what it means and what could be done, *Deputy Governor of the Bank of France, at the Bank of Spain's conference on Procyclicality and the Role of Financial Regulation*; Madrid, 4 May 2009
- Lane, P. R. (2003) The cyclical behaviour of fiscal policy: evidence from the OECD, *Journal of Public Economics*, vol 87, no 12, pp 2661–2675.
- Leila Fourie (2011) Credit extension in South Africa: A business cycle perspective for the period 1985 to 2009, *African Journal of Business Management*
- Lenart, L. and Pipień, M. (2015) Empirical Properties of the Credit and Equity Cycle within Almost Periodically Correlated Stochastic Processes - the Case of Poland, UK and USA, *Central European Journal of Economic Modelling and Econometrics*
- Léon, F (2020) Are public development banks counter-cyclical? A brief, *14th AFD International Research Conference on development*
- Leroy, A. and Lucotte, Y. (2019) Competition and credit procyclicality in European banking, *Journal of Banking and Finance*
- Lin, L.K. (2020) The Cyclical Patterns of Capital Buffers, *Hitotsubashi Journal of Commerce and Management*
- Lindquist, K. G. (2004). Banks' buffer capital: How important is risk? *Journal of International Money and Finance*, 23, 493-513. <http://dx.doi.org/10.1016/j.jimonfin.2004.01.006>
- Lucas, R. E. (1980). Methods and Problems in Business Cycle Theory. In *Source: Journal of Money, Credit and Banking* (Vol. 12, Issue 4). <https://about.jstor.org/terms>
- Ly, K.C and Shimizu, K (2021) Did Basel regulation cause a significant procyclicality?, *Journal of International Financial Markets, Institutions and Money*

- Malovaná, S. (2018) The Pro-Cyclicality of Risk Weights for Credit Exposures in the Czech Republic, *CNB Working Paper*
- Malthus, T.R. (1798) An Essay on the Principle of Population, *London: Oxford University Press.*
- Malthus, T.R. (1836) Principles of Political Economy, 2nd ed. *London: W. Pickering (the first edition was published in 1820).*
- Marcucci, J. and Quagliariello, M. (2008) Is bank portfolio riskiness procyclical?: Evidence from Italy using a vector autoregression, *Journal of International Financial Markets, Institutions and Money, Volume 18, Issue 1, Pages 46-63,*
- Marcucci, J. and Quagliariello, M. (2011) Credit Risk and Business Cycle Over Different Regimes, *SSRN Electronic Journal*
- Maredza, A. (2016) Do capital requirements affect cost of intermediation?: Evidence from a panel of South African banks, *The Journal of Developing Areas*
- Marshall, A. (1887) “Remedies for fluctuations of general prices”, *Contemporary Review, March (reprinted in Memorials of Alfred Marshall, London: Macmillan, 1925)*
- Mazzi, G. and Scocco, M. (2003) Business cycles analysis and related software applications, *European Commission Working Papers and Studies, pp. 1-28*
- Mcmanus, R. and Ozkan, F.G. (2015) On the consequences of pro-cyclical fiscal policy, *Fiscal Studies*
- Mendoza, E.G. and Terrones, M.E. (2012) An Anatomy of Credit Booms and Their Demise, *NBER*
- Milne, A. (2004) The inventory perspective on bank capital, *Cass Business School Research Paper*
- Milne, A., and Whalley, E. (2001) Bank capital and incentives for risk-taking, *Cass Business School Research Paper.*
- Minetti, R. (2015) Financial Cycles, Housing and the Macroeconomy, *International Finance*
- Minsky, H. P. (1982). CAN “IT” HAPPEN AGAIN? A REPRISE. *Challenge*, 25(3), 5–13.  
<http://www.jstor.org/stable/40720064>
- Minsky, H.P. (1990) Schumpeter: Finance and Evolution, *Evolving Technology and Market Structure: Studies in Schumpeterian Economics, The University of Michigan Press: 5 l–74.*
- Moon, H. and Perron, B. (2006) Seemingly Unrelated Regressions, 10.1057/978-1-349-95121-5\_2296-1.

- Mustafa, A., Ansari, R. and Younis, M. (2012) Does the Loan Loss Provision affect the Banking Profitability in case of Pakistan? *Asian Economic and Financial Review* 2(7):772-783
- Ng, T. (2011) The Predictive Content of Financial Cycle Measures for Output Fluctuations, *BIS Quarterly Review* (June), pp. 53-65
- Ohanian, L. E. (2010) The economic crisis from a neoclassical perspective. *Journal of Economic Perspectives*, 24(4), 45–66. <https://doi.org/10.1257/jep.24.4.45>
- Oliveira, V.B. and Raposo, C. (2019) How did regulation and market discipline influence, banking distress in Europe?: Lessons from the global financial crisis, *Studies in Economics and Finance*
- Olszak, M and Kowalska, I (2022) Does bank competition matter for the effects of macroprudential policy on the procyclicality of lending?, *Journal of International Financial Markets, Institutions and Money*
- Olszak, M. (2012) Procyclicality of Loan Loss Provisions – The Case of Poland, *Advances in Business-Related Scientific Research Journal*
- Olszak, M. and Pipień, M. (2016) Cross-country linkages as determinants of procyclicality of loan loss provisions, *European Journal of Finance*
- Olszak, M., Pipień, M., Kowalska, I. and Roszkowska, S. (2017) What Drives Heterogeneity of Cyclicity of Loan-Loss Provisions in the EU?, *Journal of Financial Services Research*
- Olszak, M., Pipień, M., Roszkowska, S. and Kowalska, I. (2018) The impact of capital on lending in economic downturns and investor protection - The case of large EU banks, *Central European Journal of Economic Modelling and Econometrics*
- Oppers, S.E. (2002) The Austrian Theory of Business Cycles: Old Lessons for Modern Economic Policy?, *IMF Working Paper WP/02/2*
- Osborne, M., Fuentès, A.M. and Milne, A. (2017) In good times and in bad: Bank capital ratios and lending rates, *International Review of Financial Analysis*
- Osei-Assibey, E. and Asenso, J.K. (2015) Regulatory capital and its effect on credit growth, non-performing loans and bank efficiency: Evidence from Ghana, *Journal of Financial Economic Policy*
- Pancost, A. and Robatto, R. (2019) The procyclicality of banking: evidence from the euro area, *ESRB Working Paper Series*

Panetta, F. and Angelini, P. (2009) FINANCIAL SECTOR PRO-CYCLICALITY LESSONS FROM THE CRISIS, *Bank of Italy, Questioni di Economia e Finanza (Occasional papers)*

Paquet, A., and Robidoux, B. (1997) Issues on the Measurement of the Solow Residual and the Testing of its Exogeneity: a Tale of Two Countries, *Working Paper, CREFE Université du Québec à Montréal*

Paudel, Y. (2007) Minimum Capital Requirement Basel II Credit Default Model & its Application, *BMI Paper*

Pawłowska, M. (2015) The impact of market structure and the business cycle on bank profitability: the role of foreign ownership. The case of Poland, *NBP Working Paper*

Peek, J. and Rosengren, E. (1995) Bank regulation and the credit crunch, *Journal of Banking and Finance*

Pennacchi, G.G. (2005) Risk-based capital standards, deposit insurance, and procyclicality, *Journal of Financial Intermediation*

Petersen, M.A., Rajan, R.G., 1995. The effect of credit competition on lending relationships. *Quarterly Journal of Economics* 110 (2), 406–443.

Pipień, M. and Anand, A. (2023), Cross Country Heterogeneity of Procyclicality of Bank Loans: Evidence from OECD Countries using the SURE Model” *Journal of Banking and Financial Economics* 2(20)2023, 93-110

Plosser, C.I. (1989) Understanding Real Business Cycles, *The Journal of Economic Perspectives, Summer, 1989, Vol. 3, No. 3*

Posner, E.A. (2015) How do bank regulators determine capital-adequacy requirements?, *University of Chicago Law Review*

Prast, H. (2003) Comment on ‘credit risk measurement and procyclicality’, *Banking Supervision at the Crossroads* (116), pp. 164-166

Pretorius, M. and Botha, I. (2017) The Procyclicality of African Sovereign Credit Ratings, *Advances in Applied Economic Research, Springer Proceedings in Business and Economics*, pp. 537-547

Prudential Regulatory Authority (2022) SS11/13 – Internal Ratings Based (IRB) approaches, *PRA Rulebook*

- Rebelo, S. (2005) Real business cycle models: Past, present and future. *Scandinavian Journal of Economics* (Vol. 107, Issue 2, pp. 217–238). <https://doi.org/10.1111/j.1467-9442.2005.00405.x>
- Repullo, R. (2013) Cyclical adjustment of capital requirements: A simple framework, *Journal of Financial Intermediation*
- Repullo, R. and Suarez, J. (2013) The procyclical effects of bank capital regulation, *Review of Financial Studies*
- Richter, B and Zimmermann, K. (2019) The Profit-Credit Cycle, *Financial History Workshop 2018 in Rotterdam, the EDP Jamboree 2018 in Florence, and the CESifo Workshop on Banking and Institutions 2019 in Munich*
- Rochet, J. (2008) Procyclicality of financial systems: is there a need to modify current accounting and regulatory rules?, *Financial Stability Review*(12), pp. 95-99
- Rogerson, R. (1988) Indivisible labor, lotteries and equilibrium, *Journal of Monetary Economics*, Volume 21, Issue 1, Pages 3-16,
- Rotemberg, J.J. and Woodford, M. (1997) An optimization-based econometric framework for the evaluation of monetary policy, *NBER Macroeconomics Annual*, 12:297–346
- Roulet, C. (2018) Basel III: Effects of capital and liquidity regulations on European bank lending, *Journal of Economics and Business*
- Rozite, K., Bezemer, D.J. and Jacobs, J.P. (2019) Towards a financial cycle for the U.S., 1973–2014, *North American Journal of Economics and Finance*
- Rünstler, G., Balfoussia, H., Burlon, L., Buss, G., Comunale, M., De Backer, B., Dewachter, H., Guarda, P., Haavio, M., Hindrayanto, I., Iskrev, N., Jaccard, I., Kulikov, D., Kunovac, D., Lenarcic, C., Lequien, M., Lozej, M., Mandler, M., Papageorgiou, D., Pedersen, J., Perez-Quiros, G., Rannenberg, A., Rots, E., Scharnagl, M. and Welz, P. (2018) Real and financial cycles in EU countries - Stylised facts and modelling implications, *ECB Occasional Paper*(205)
- Sahul Hamid, F. (2020) Bank lending and the business cycle: Does ownership matter in ASEAN countries?, *Journal of Asian Economics*
- Salaam, K (2015) Procyclicality Effects on Bank Lending Decisions: A Case Study of the British Banking Sector, *International Journal of Academic Research in Accounting, Finance and Management Sciences*

- Saurina, J. and Trucharte, C. (2007) An assessment of basel II procyclicality in mortgage portfolios, *Journal of Financial Services Research*
- Say, J. (1803) Of the Demand or Market for Products, *A Treatise on Political Economy, Book I, Chapter XV*
- Schafer, D. P. (2008) Revolution or Renaissance, *University of Ottawa Press, 2008*, <https://books.openedition.org/uop/1711>.
- Schularick, M. and Taylor, A. (2012) Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008, *American Economic Review*, 102 (2): 1029–61.
- Schumpeter, J.A. (1954) History of Economic Analysis, *Oxford University Press, New York*.
- Segoviano Basurto, M. and Lowe, P.W. (2011) Internal Ratings, the Business Cycle and Capital Requirements: Some Evidence from an Emerging Market Economy, *SSRN Electronic Journal (117)*
- Seremak, V. (2001) Credit Cycles- Theory and Application on the Czeck Republic, January 2001.
- Shala, A. and Toçi, V. (2021) Bank provisioning behavior, procyclicality and capital management in south-eastern Europe, *Ekonomicky casopis*
- Shim, J. (2013) Bank capital buffer and portfolio risk: The influence of business cycle and revenue diversification, *Journal of Banking & Finance, Volume 37, Issue 3, Pages 761-772*
- Shimizu, Y. (2007) Impacts of the BIS regulation on the Japanese economy, *Journal of Asian Economics*
- Sinai, A. (1976) Credit crunches: An analysis of the postwar experience, *Parameters and policies of the U.S. economy, 244-74. ed. Otto Eckstein, Amsterdam: North-Holland*.
- Sinai, A. (1992) Financial and Real Business Cycles, *Eastern Economic Journal. Presidential Address. Winter, pp. 1-54*.
- Skala, D (2021) Loan loss provisions and income smoothing – Do shareholders matter?, *International Review of Financial Analysis*
- Soedarmono, W., Pramono, S.E. and Tarazi, A. (2017) The procyclicality of loan loss provisions in Islamic banks, *Research in International Business and Finance*
- Solow, R.M. (1957) Technical Change and the Aggregate Production Function, *The Review of Economics and Statistics* Vol. 39, No. 3 (Aug., 1957), pp. 312-320

Srivastava, V., & Giles, D. (1987) *Seemingly Unrelated Regression Equations Models: Estimation and Inference*, New York: Marcel Dekker

Stolz, S. and Wedow, M. (2011), Banks' regulatory capital buffer and the business cycle: Evidence for Germany, *Journal of Financial Stability*, 7, (2), 98-110

Suarez, J. (2010) Discussion of "Procyclicality of capital requirements in a general equilibrium model of liquidity dependence", *International Journal of Central Banking*

Takats, E. and Upper, C. (2013) Credit and Growth after Financial Crises, *BIS Working Paper (416)*

Valencia, O.C. and Bolanos, A.O. (2018), Bank capital buffers around the world: Cyclical patterns and the effect of market power, *Journal of Financial Stability* 38 (2018) 119–131

Van Hoose D. (2010), *The Industrial Organization of Banking, Bank Behavior, Market Structure, and Regulation*, Springer-Verlag, Berlin Heidelberg.

Watanabe, W. (2007) Prudential regulation and the "credit crunch": Evidence from Japan, *Journal of Money, Credit and Banking*

Weinberg, J.A. (1995) Cycles in Lending Standards? *Federal Reserve Bank of Richmond Economic Quarterly* Volume 81/3 Summer 1995

Wheeler, P.B. (2019) Loan loss accounting and procyclical bank lending: The role of direct regulatory actions, *Journal of Accounting and Economics*

Wilson, T (1997) Portfolio Credit Risk (Parts I and II), *Risk Magazine*, September and October

Wray, L. R. (2011) Minsky crisis, *The Levy Economics Institute of Bard College, Working Paper, No. 659*

Xu, T. (2010) The Role of Credit in International Business Cycles, *Bank of Canada Working Paper 212-36, November 2012.*

Yan, C. and Huang, K.X. (2020) Financial cycle and business cycle: An empirical analysis based on the data from the U.S, *Economic Modelling*

Yellen, J.L. (2009) A Minsky Meltdown: Lessons for Central Bankers, *Presentation to the 18th Annual Hyman P. Minsky Conference on the State of the U.S. and World Economies—“Meeting the Challenges of the Financial Crisis”*

Zellner, A (1962) An efficient method of estimating seemingly unrelated regression equations and tests for aggregation bias, *Journal of the American Statistical Association* 57, pp. 348–368.

## LIST OF TABLES

TABLE 1: DEFINITION OF THE FINANCIAL CYCLE

TABLE 2: REGULATORS PERSPECTIVES ON PROCYCLICALITY

TABLE 3: LIST OF EU COUNTRIES BY ENTRY YEAR

TABLE 4: SHARE OF EU-27 COUNTRIES IN EU BANKING ASSETS AND LOANS (AS OF 2020, AFTER BREXIT)

TABLE 5: SHARE OF TOP 15 EU COUNTRIES IN EU BANKING ASSETS AND LOANS (AS OF 2020, AFTER BREXIT)

TABLE 6: DEFINITIONS OF VARIABLES USED IN ANALYSIS FOR PROCYCLICALITY OF CREDIT SUPPLY

TABLE 7: DESCRIPTIVE STATISTICS OF THE ANALYSED SERIES FOR CREDIT SUPPLY

TABLE 8: COUNTRY-WISE STATISTICS OF THE ANALYSED SERIES FOR CREDIT SUPPLY

TABLE 9: MATRIX OF SAMPLE CORRELATION OF THE ANALYSED SERIES FOR CREDIT SUPPLY

TABLE 10: DETERMINANTS OF  $\frac{LOANS_{t,j}}{TA_{t,j}}$  - THE FE PANEL ESTIMATES OF PARAMETERS IN EQUATION (22)

TABLE 11: CROSS COUNTRY HETEROGENEITY OF DETERMINANTS OF  $\frac{LOANS_{t,j}}{TA_{t,j}}$  – ESTIMATES OF PARAMETERS IN EQUATION (23) PROVIDED THE MODEL M0 (INDEPENDENT REGRESSIONS)

TABLE 12: CROSS COUNTRY HETEROGENEITY OF DETERMINANTS OF  $\frac{LOANS_{t,j}}{TA_{t,j}}$  – ESTIMATES OF PARAMETERS IN EQUATION (23) PROVIDED THE MODEL  $M_1$  (SURE SPECIFICATION)

TABLE 13: THE SIGN AND SIGNIFICANCE OF IMPACT IN EQUATION (23) – THE MODEL M0 (INDEPENDENT REGRESSIONS)

TABLE 14: THE SIGN AND SIGNIFICANCE OF IMPACT IN EQUATION (23) – THE MODEL M1 (INDEPENDENT REGRESSIONS)

TABLE 15: POINT ESTIMATES OF THE VARIANCES (BOLD), CONTEMPORANEOUS COVARIANCES (IN ITALICS ABOVE THE DIAGONAL) AND CONTEMPORANEOUS CORRELATIONS (SHADED CELLS BELOW THE DIAGONAL) OF ERROR TERMS IN CASE OF MODEL M1 (SURE SPECIFICATION)

TABLE 16: DEFINITIONS OF VARIABLES USED IN ANALYSIS FOR PROCYCLICALITY OF LOAN LOSS PROVISIONS

TABLE 17: DESCRIPTIVE STATISTICS OF THE ANALYSED SERIES FOR LOAN LOSS PROVISIONS

TABLE 18: COUNTRY-WISE STATISTICS OF THE ANALYSED SERIES LOAN LOSS PROVISIONS

TABLE 19: MATRIX OF SAMPLE CORRELATION OF THE ANALYSED SERIES FOR LOAN LOSS PROVISIONS

TABLE 20: DETERMINANTS OF  $\frac{LLP_{t,j}}{TA_{t,j}}$  - THE FE PANEL ESTIMATES OF PARAMETERS IN EQUATION (24)

TABLE 21: CROSS COUNTRY HETEROGENEITY OF DETERMINANTS OF  $\frac{LLP_{t,j}}{TA_{t,j}}$  – ESTIMATES OF PARAMETERS IN EQUATION (25) PROVIDED THE MODEL  $M_0$  (INDEPENDENT REGRESSIONS)

TABLE 22: CROSS COUNTRY HETEROGENEITY OF DETERMINANTS OF  $\frac{LLP_{t,j}}{TA_{t,j}}$  – ESTIMATES OF PARAMETERS IN EQUATION (25) PROVIDED THE MODEL  $M_1$  (SURE SPECIFICATION)

TABLE 23: THE SIGN AND SIGNIFICANCE OF IMPACT IN EQUATION (25) – THE MODEL  $M_0$  (INDEPENDENT REGRESSIONS)

TABLE 24: THE SIGN AND SIGNIFICANCE OF IMPACT IN (25) – THE MODEL  $M_1$  (INDEPENDENT REGRESSIONS)

TABLE 25: POINT ESTIMATES OF THE VARIANCES (BOLD), CONTEMPORANEOUS COVARIANCES (IN ITALICS ABOVE THE DIAGONAL) AND CONTEMPORANEOUS CORRELATIONS (SHADED CELLS BELOW THE DIAGONAL) OF ERROR TERMS IN CASE OF MODEL  $M_1$  (SURE SPECIFICATION)

TABLE 26: DEFINITIONS OF VARIABLES USED IN ANALYSIS FOR PROCYCLICALITY OF CAPITAL BUFFERS

TABLE 27: DESCRIPTIVE STATISTICS OF THE ANALYSED SERIES FOR CAPITAL BUFFERS

TABLE 28: COUNTRY-WISE STATISTICS OF THE ANALYSED SERIES FOR CAPITAL BUFFERS

TABLE 29: MATRIX OF SAMPLE CORRELATION OF THE ANALYSED SERIES FOR CAPITAL BUFFERS

TABLE 30: DETERMINANTS OF  $CAPBUF$  - THE FE PANEL ESTIMATES OF PARAMETERS IN EQUATION (26)

TABLE 31: CROSS COUNTRY HETEROGENEITY OF DETERMINANTS OF  $CAPBUF_{t,j}$  – ESTIMATES OF PARAMETERS IN EQUATION (27) PROVIDED THE MODEL  $M_0$  (INDEPENDENT REGRESSIONS)

TABLE 32: CROSS COUNTRY HETEROGENEITY OF DETERMINANTS OF  $CAPBUF_{t,j}$  – ESTIMATES OF PARAMETERS IN EQUATION (27) PROVIDED THE MODEL  $M_1$  (SURE SPECIFICATION)

TABLE 33: THE SIGN AND SIGNIFICANCE OF IMPACT IN EQUATION (25) – THE MODEL  $M_0$  (INDEPENDENT REGRESSIONS)

TABLE 34: THE SIGN AND SIGNIFICANCE OF IMPACT IN (25) – THE MODEL  $M_1$  (INDEPENDENT REGRESSIONS)

TABLE 35: POINT ESTIMATES OF THE VARIANCES (BOLD), CONTEMPORANEOUS COVARIANCES (IN ITALICS ABOVE THE DIAGONAL) AND CONTEMPORANEOUS CORRELATIONS (SHADED CELLS BELOW THE DIAGONAL) OF ERROR TERMS IN CASE OF MODEL  $M_1$  (SURE SPECIFICATION)

## LIST OF FIGURES

FIGURE 1: DIFFERENT PHASES OF BUSINESS CYCLE

FIGURE 2: THE MODEL OF A JUGLAR CYCLE

FIGURE 3: DOMESTIC CREDIT GROWTH AND GDP GROWTH IN SELECTED EU COUNTRIES (2002- 2020)

FIGURE 4: NON-PERFORMING LOANS RATIO AND GDP GROWTH IN SELECTED EU COUNTRIES (2008-2020)

FIGURE 5: DECOMPOSITION OF CAPITAL REQUIREMENT FUNCTION INTO VARIOUS RISK COMPONENTS

FIGURE 6: MECHANISM OF PROCYCLICAL EFFECTS OF REGULATORY CAPITAL

FIGURE 7: BANK CAPITAL RATIO AND GDP GROWTH IN SELECTED EU COUNTRIES (2008- 2020)

## Abstract (Polish)

W niniejszej rozprawie podjęto próbę analizy występowania efektu procykliczności sektora bankowego w krajach UE, koncentrując się na trzech kluczowych obszarach: podaży kredytów, odpisach na straty kredytowe (LLP) oraz buforach kapitałowych. Bazując na przeprowadzonym przeglądzie literatury, w badaniu postawiono hipotezę, że siła występowania efektu procykliczności nie jest jednakowa we wszystkich krajach, lecz wykazuje znaczną heterogeniczność, która może wynikać z czynników gospodarczych i instytucjonalnych, specyficznych dla poszczególnych państw. W celu weryfikacji tak postawionej hipotezy w badaniach wykorzystano niestandardowe podejście ekonometryczne – systemy regresji pozornie niezależnych (ang. Seemingly Unrelated Regression Equations; SURE).

Rozprawę otwiera wprowadzenie w tematykę procykliczności. Skupiono się na omówieniu ewolucji teorii cykli koniunkturalnych i powiązania aktywności gospodarczej z dynamiką sektora bankowego. Z perspektywy historycznej, od wczesnych teorii klasycznych i austriackich po nowoczesne modele, takie jak modele dynamicznego równowagi ogólnej (DSGE), obserwuje się rosnące znaczenie systemu finansowego w kształtowaniu wahań koniunkturalnych nowoczesnej gospodarki. Przegląd literatury uwypukla kluczową rolę ram regulacyjnych, szczególnie tych zawartych w Bazylei II i Bazylei III, w wzmacnianiu lub łagodzeniu efektu procykliczności. Kluczowe wnioski z przeglądu literatury wskazują na współzależność systemów finansowych oraz konieczność uwzględniania w analizach empirycznych heterogeniczności między krajami przy analizie efektu procykliczności. Istniejące badania często pomijają te aspekty, co stanowi silne uzasadnienie dla przeprowadzenia badań omówionych w rozprawie.

Przeprowadzona analiza empiryczna bazuje na trzech modelach: regresji panelowej z efektami stałymi (FE) dla danych zagregowanych, niezależnych regresjach nieuwzględniających korelacji błędów oraz modelu SURE, który uwzględnia korelacje błędów i heterogeniczność między krajami. Model SURE, kluczowa innowacja metodologiczna, konsekwentnie przewyższa mocą wyjaśniającą tradycyjne podejścia, dostarczając bardziej precyzyjnych szacunków efektów procykliczności.

Wyniki przeprowadzonych badań wskazują na istotne zróżnicowanie siły efektu procykliczności między krajami UE. W zakresie podaży kredytów wyniki pokazują, że zazwyczaj rośnie ona wraz ze wzrostem PKB i maleje wraz z wyższym bezrobociem, podczas gdy wpływ inflacji pozostaje niezdeterminowany. Regresje panelowe z efektami stałymi wykazały słabsze powiązania między zmiennymi makroekonomicznymi a podażą kredytów, podczas gdy model SURE ujawnił znaczną różnorodność między krajami i dostarczył bardziej precyzyjnych szacunków, wskazując jednocześnie na istnienie silnych powiązań finansowych między krajami. Analiza LLP wykazała, że wzrost PKB generalnie koreluje negatywnie z LLP, wskazując na procykliczność, podczas gdy inflacja i bezrobocie mają pozytywny, lecz zróżnicowany wpływ w różnych krajach. Model SURE ujawnił znaczną heterogeniczność badanego efektu między krajami, a także wpływ czynników specyficznych dla banków, takich jak kredyty, zyski i depozyty, co ponownie wskazuje na znaczenie powiązań finansowych i różnorodności regionalnej w analizach. Relacja między kapitałem regulacyjnym a wahaniami koniunkturalnymi różni się w zależności od banków i krajów i jest napędzana zarówno czynnikami makroekonomicznymi (wzrost PKB, inflacja, bezrobocie), jak i specyficznymi dla banków (zyski, kredyty, NPL, ROE). Chociaż wzrost PKB zazwyczaj wykazuje negatywny wpływ na bufory kapitałowe, model SURE ujawnia znaczną heterogeniczność między krajami i

silniejsze korelacje z czynnikami specyficznymi dla banków. Wskazuje to po raz kolejny na duże znaczenie uwzględniania zróżnicowanej dynamiki regionalnej w badaniach. Wyniki potwierdzają główną hipotezę, że procykliczność jest zjawiskiem specyficznym dla danego kraju, a nie efektem jednolitym, możliwym do precyzyjnej identyfikacji na podstawie grupy podobnych krajów.

W rozprawie uzyskano dwa zasadnicze rezultaty, ważne dla przedmiotowych analiz i praktyki gospodarczej. Po pierwsze, dostarczono empirycznych dowodów na to, że procykliczność zmiennych, opisujących aktywność sektora bankowego, znacznie różni się między krajami, podważając założenie o jednolitości, przyjmowane w ramach regulacyjnych i politycznych. Umożliwia to przesunięcie akcentów debaty na temat regulacji sektora bankowego w kierunku uznania heterogeniczności. Przedstawione w rozprawie wyniki wskazują bowiem na konieczność dostosowania podejść regulacyjnych do specyfiki poszczególnych krajów. Po drugie, badanie potwierdza zasadność stosowania modelu SURE jako solidnego narzędzia do analizy procykliczności i heterogeniczności między krajami, demonstrując jego znaczenie empiryczne i wyższość nad powszechnie stosowanymi metodami regresji panelowej.

Niniejsze badanie pogłębia zatem wiedzę na temat procykliczności w sektorze bankowym, oferując cenne wnioski dla decydentów i regulatorów. Uwzględniając heterogeniczność między krajami dostarczono podstaw do projektowania ram regulacyjnych, które równoważą stabilność finansową z wzrostem gospodarczym, szczególnie w kontekście wzajemnie powiązanych i zróżnicowanych gospodarek, takich jak UE.

## Abstract (English)

This dissertation investigates procyclicality in the banking sector across EU countries, focusing on three key areas: loan supply, loan loss provisions (LLP), and capital buffers. Based on theoretical insights and gaps in the literature, the study hypothesises that procyclicality is not uniform across countries but exhibits significant heterogeneity driven by country-specific economic and institutional factors. Aiming to validate this hypothesis, the research employs a nonstandard econometric framework, the Seemingly Unrelated Regression Equations (SURE) model, to analyse cross-country variability in the procyclicality of banking sector variables, representing a novel approach to empirical testing in this domain.

The study begins with a comprehensive theoretical review, tracing the evolution of economic cycle theories and their intersection with banking sector dynamics. Historical perspectives, from early classical and Austrian theories to modern frameworks like Dynamic Stochastic General Equilibrium (DSGE) models, highlight the growing recognition of procyclicality in financial systems. The review underscores the critical role of regulatory frameworks, particularly Basel II and Basel III, in amplifying or mitigating procyclicality. Key findings from the literature emphasise the interconnectedness of financial systems and the importance of accounting for cross-country heterogeneity when analysing procyclicality. However, existing studies often overlook these aspects, providing a solid rationale for this research.

The empirical analysis is structured around three models: a fixed-effects (FE) panel regression for aggregate data, independent regressions without accounting for error correlation, and the SURE model, which accounts for error correlations and heterogeneity

across countries. The SURE model, a key methodological innovation, consistently outperformed traditional approaches, providing more precise and nuanced estimates of procyclicality effects.

The results reveal significant variability in procyclicality across EU countries. For loan supply, Research indicates that loan supply typically rises with GDP growth and falls with higher unemployment, while inflation's impact remains inconsistent. Fixed-effect panel regressions showed weaker links between macroeconomic variables and loan supply. In contrast, the SURE model uncovered significant cross-country diversity and provided more accurate estimates, highlighting substantial financial linkages among countries. The analysis of LLP found that GDP growth generally correlates negatively with LLPs, indicating procyclicality, while inflation and unemployment have positive but variable impacts across countries. Using the SURE model, significant cross-country heterogeneity was revealed, with bank-specific factors like loans, profits, and deposits also influencing LLPs, underscoring the importance of considering financial linkages and regional diversity in such analyses. The relationship between regulatory capital and the economic cycle varies across banks and countries, driven by both macroeconomic factors (GDP growth, inflation, and unemployment) and bank-specific variables (profits, loans, NPLs, and ROE). While GDP growth generally shows a negative, procyclical impact on capital buffers, the SURE model reveals significant cross-country heterogeneity and stronger correlations with bank-specific factors, highlighting the importance of considering diverse regional dynamics in such analyses. These findings confirm the primary hypothesis that procyclicality is a country-specific phenomenon rather than a uniform effect.

The dissertation's contributions are twofold. First, it provides empirical evidence that the procyclicality of banking sector variables varies significantly across countries, challenging the assumption of uniformity in regulatory and policy frameworks. This perspective shifts the debate from general discussions on procyclicality to recognising its heterogeneity and tailoring regulatory approaches to individual country contexts. Second, the research introduces the SURE model as a robust tool for analysing procyclicality and cross-country heterogeneity, demonstrating its empirical relevance and superiority over traditional panel regression methods.

Overall, this research advances the understanding of procyclicality in the banking sector, offering valuable insights for policymakers and regulators. Emphasising cross-country heterogeneity provides a foundation for designing targeted policy frameworks that balance financial stability with economic growth, particularly in the context of interconnected and diverse economies like the EU.