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The Determinants of the Price-to-Book Value Gap Between European and US Banks

Diogo Ricardo dos Santos Gomes

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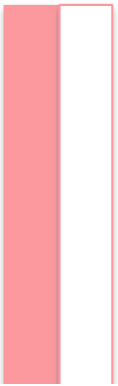

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FEP FACULDADE DE ECONOMIA
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Abstract

While European banks have exhibited, on average, below-one price-to-book values (PBVs) in the aftermath of the global financial crisis (GFC), US banks' PBVs have recuperated much more swiftly and become vastly superior to those of European banks. It is an enigma why European banks have a market-to-book ratio below one and substantially lower than US banks. Several panel data models are used in this dissertation to address this issue, namely by looking at possible determinants of US and European banks' PBVs and assessing which ones could explain the existing PBV gap in the post-GFC period between the banks of the two regions. Regressions are run for the 2008-2021 period based on a full sample comprised of 216 banks, which is subsequently divided into European and US subsamples.

Results show that (1) the factors which affect bank PBV are not the same in Europe and the US; (2) the effects of some of the PBV gap determinants are not consistent throughout the period analyzed in both regions; (3) while other factors do explain the PBV gap, profitability related metrics (such as return on equity and cost efficiency) and the amount of banks' non-performing loans (NPLs) seem to be the factors which most consistently the existence of the gap.

Finally, findings over the disparity of the long-term effects of banks' NPLs on PBV in the European and US samples suggest that investors do not trust European banks' reporting, particularly when it comes to asset quality metrics, which justifies the average below-one PBV observable in the European banking industry in the post-GFC period.

JEL Codes: G12, G21

Keywords: European and US banks; PBV Determinants; PBV Gap; Global Financial Crisis; Panel Data; Bank Misreporting

Resumo

Na sequência da crise financeira mundial de 2007-2008 (denominada de GFC), os bancos europeus têm apresentado, em média, um rácio entre a cotação em bolsa de uma das suas ações e o seu valor contabilístico (rácio esse comummente conhecido como PBV) inferior a um. Contrariamente, os PBV dos bancos americanos recuperaram rapidamente após uma queda inicial e tornaram-se, em média, muito superiores aos dos bancos europeus. É, por isso, um enigma saber por que razão os bancos europeus apresentam um PBV abaixo de um e substancialmente mais baixo que os bancos norte-americanos. Para descortinar a razão por detrás deste fenómeno, são utilizados vários modelos de dados em painel que permitem identificar quais os possíveis determinantes dos PBV dos bancos europeus e americanos e avaliar quais deles conseguem explicar a diferença entre PBV no período pós-GFC entre os bancos das duas regiões. Assim sendo, é analisado o período de 2008 a 2021 tendo como base uma amostra composta por 216 bancos, que é posteriormente dividida nas subamostras europeia e norte-americana.

As principais conclusões que derivam da interpretação dos modelos são que: (1) os fatores que afetam o PBV não são os mesmos para bancos europeus e norte-americanos; (2) os efeitos de alguns dos determinantes que explicam a diferença de PBV entre bancos Europeus e norte-americanos não são consistentes ao longo do período analisado em ambas as regiões; (3) embora outros fatores expliquem a diferença de PBV, métricas relacionadas com a lucratividade (como retorno sobre o património líquido e eficiência de custos) e o montante de empréstimos não produtivos concedidos pelos bancos (os chamados NPL) parecem ser os fatores que mais consistentemente explicam a existência dessa diferença.

Por fim, os resultados quanto à disparidade dos efeitos de longo prazo dos NPL no PBV dos bancos nas amostras europeia e americana sugerem que os investidores não confiam nos relatórios financeiros dos bancos europeus, especialmente no que diz respeito a métricas relacionadas com a qualidade de ativos. Esta descoberta ajuda a justificar o porquê do valor médio de PBV se situar abaixo de um no setor bancário europeu no período do pós-GFC.

Classificação JEL: G12, G21

Palavras-chave: Bancos Europeus e Americanos; Determinantes do PBV; Disparidade entre PBVs; Crise Financeira Mundial; Dados em Painel; Relato Financeiro Bancário

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List of Abbreviations

ECB – European Central Bank

EU – European Union

FE – Fixed Effects

GAAP - Generally Accepted Accounting Principles

GDP – Gross Domestic Product

GFC – Global Financial Crisis

IFRS - International Financing Reporting Standards

II - Interest Income

IMF – International Monetary Fund

LLP – Loan Loss Provision(s)

NII – Non-Interest Income

NPL – Non-performing Loan(s)

OLS – Ordinary Least Squares

PBV – Price-to-book Value(s)

RE – Random Effects

ROA – Return on Assets

ROE – Return on Equity

RQ – Research Question(s)

SE – Standard Errors

SEC – Securities Exchange Commission

UK – United Kingdom

US - United States

1. Introduction

The global financial crisis (GFC) marked a new era regarding the banking industry's price-to-book value (PBV). That crisis caused profound changes in the average PBV of European and US banks that can still be seen today. Prior to the GFC of 2007-2008, both US and European banks presented an average long-term PBV in excess of one, with those values being 2.4 and 2.0, respectively (ECB, 2019). However, during and after the financial crisis, this ratio dipped to values below one in both regions. In 2008, the average banking industry's PBV was 0.75 in both the US and Europe (Simoens & Vennet, 2021), and therefore below the 1.0 threshold where the market value of equity is superior to its book value.

Unsurprisingly, the financial industry was the sector which registered the highest proportion of companies with a PBV below one in the 2007-2010 period, both in Europe and in the USA (Bini & Penman, 2013). In 2010, 8 out of 10 financial companies in Europe had a lower market value than their equity book value, while that proportion was even larger in the US, where 9 out of 10 financial institutions had a PBV lower than one (Bini & Penman, 2013). These statistics were symptomatic of the financial industry's struggles to reach the average PBV of other sectors, a discrepancy still observable today. When comparing the average PBV of all other industries with the banking sector during the 2005-2022 period, it is notable that those values have gradually become more distanced (Dietz et al., 2022).

However, despite the overall banking industry still being plagued by subpar PBVs, differences in valuations of European and US banks gradually started to arise over time. By 2017, the average US bank's PBV had already recuperated to 1.5, while that of European banks was still situated at 0.9 at the time (Simoens & Vennet, 2021). Although the average PBV of European banks has, in rare moments, been superior to one since the GFC, it has been unable to sustain such a level consistently (ECB, 2019; Simoens & Vennet, 2021). Most recently, and according to the November 2022 ECB Financial Stability Review, three out of a sample of 30 European banks had a PBV higher than one, with the sector's average PBV decreasing from February to September of that same year. Also, in 2021, only 25 out of the 300 most profitable European banks had a market equity value over their book value, while the PBV of North American banks was generally described as being "very strong" during that period (Dietz et al., 2022). As such, geography has been described as having a strong relationship with a bank's PBV, with its headquarters' location explaining 68% of its valuation, a trend continuously increasing ever since 2014 (Dietz et al., 2022).

Hence, this dissertation's primary goal is to expand the literature on the PBV gap between US and European banks. The major contribution in this field has been the work of Simoens & Vennet (2021), which is continuously taken as a reference point throughout this dissertation. After conducting a literature review on the subject of the determinants of the PBV of all companies and of banks in particular - where the contributions of Calomiris & Nissim (2014) and Bogdanova et al. (2018) stand out -, the impact of some newly introduced explanatory variables as potential PBV determinants of either US or European banks is studied. Subsequently, those same factors are analyzed as potential determinants of the PBV gap between the banks of the two regions by implementing two fixed effects models.

In addition, the impact of each factor deemed as a PBV determinant for banks of either region on bank valuation is divided into short- and long-term effects through the combined usage of a random effects model and the Mundlak estimator (Mundlak, 1978). While such an analysis has been widely implemented in existing literature (Afonso et al., 2011; Alves et al., 2023), its application to this topic is groundbreaking and thus constitutes a novelty relative to the existing literature.

Lastly, an expanding-windows approach is used during the robustness checks to assess what PBV determinants justified the existence of the PBV gap in each year during the 2010-2020 period. The analysis of the determinants of the PBV gap during the entirety of the post-GFC also constitutes a novelty when compared to Simoens & Vennet (2021), who only estimated the factors responsible for continuing the PBV gap in 2017.

This dissertation is divided into seven chapters. As seen, Chapter 1 introduces the PBV gap between European and US banks in the post-GFC. Chapter 2 covers the literature review on PBV, the PBV determinants (in general and in the banking industry), and the differences between accounting standards in Europe and the US. The research questions and the methodology employed to address each of them are presented in Chapter 3. Chapter 4 provides an insight into the sample used, the variables included in this analysis and the descriptive statistics. The research questions' results are shown and discussed in Chapter 5, while the robustness checks are conducted in Chapter 6. Lastly, this study's conclusions, limitations, and potential future research are presented in Chapter 7.

2. Literature Review

2.1. The Price-to-Book Value (PBV)

The price-to-book value (PBV) - also commonly known as the price-to-book ratio (P/B ratio) - is the ratio between the market value of equity and the book value of equity of a company (or the ratio between the price per share and the book value of equity per share). This ratio is subject to large variations across time and differs significantly between sectors and firms of the same sector at any point in time (McNichols et al., 2014). Hence, the PBV is a suitable metric for evaluating firm performance, especially since it combines financial market information with accounting information. Lindenberg & Ross (1981) support this view, as they argue that while financial market data allows a better understanding of a company (namely through the observation of a security's price changes throughout time), accounting information provides information on the assets a company has at its disposition to engage in its business activities. As such, the authors defend that comparing them is a valuable means of assessing firm performance. Additionally, the PBV is commonly used as a proxy for Tobin's *Q* (Nezlobin et al., 2016), which consists of the ratio between "the value of capital relative to its replacement cost" (Tobin, 1969) and which is positively related to a company's willingness to engage in investment expenditures (Tobin, 1969; Nezlobin et al., 2016).

The PBV is seen as a reliable and intuitive way of assessing the value of a company and as an alternative security pricing method to discount cash flow models, allowing investors to perform a more straightforward analysis (Damodaran, 2012). Companies with a lower PBV tend to produce excess returns over large timeframes (Fama & French, 1993), which can indicate unbalanced security pricing by investors (Bodie et al., 2011). Therefore, the PBV allows market participants to compare different companies and to look for evidence that they are under or overvalued, as long as their accounting standards are similar (Damodaran, 2012). Also, this ratio is tightly connected to a company's franchise value (Simoens & Vennet, 2021), which consists of the present value of all future profits a company is expected to generate (Demsetz et al., 1996).

The PBV is widely regarded as a suitable market-based indicator of bank performance (ECB, 2010). It is particularly useful in situations of economic turmoil as this ratio allows analysts to study how a bank's intangible assets are affected in scenarios of uncertainty (ECB, 2010). Consequently, it trumps the price-to-earnings ratio as the most commonly used indicator of bank-performance during crises (ECB, 2010). PBV is considered a good proxy

for value as it expresses both a good proxy for value as it expresses a bank's capacity to earn future excess returns given its base level of funding and available opportunities for further growth (Jordan et al., 2011). There is an expectation that a bank can generate market value above that of its tangible assets when the PBV exceeds one. At the same time, a ratio below one indicates that investors are concerned with a bank's ability to generate value for its investors (ECB, 2019). Hence, the PBV is often looked at as a measure of a bank's health and as evidence that it should consider changes in its business model to increase profitability (Bogdanova et al., 2018). Bogdanova et al. (2018) also argue that a PBV above (below) one is indicative of a premium (discount) the market is willing to pay for the value of the intangibles the bank possesses. Furthermore, Balasubramnian et al. (2019) find that the PBV can predict future earnings and default risk in advance, making it an important indicator for regulators when monitoring these financial institutions. Lastly, a PBV lower than one can be interpreted as a reflection of the market's distrust over a financial institution's capacity to manage the looming losses a bank may undertake, given their current exposures (IMF, 2008).

2.2. General determinants of the PBV

The PBV is dependent on both the market value and the book value of a firm. Therefore, any factor affecting either of the two components of the PBV should induce changes in its value. Starting from Gordon's Model and its assumptions - stable dividend growth, perpetual cash-flows, and a constant value of return on equity - the PBV can also be written as follows (Fernandes et al., 2014):

$$\frac{P}{BV} = PBV = \frac{Payout\ ratio * ROE(1+g)}{R-g} \qquad (2.2.1)$$

As proven by equation 2.2.1, a company's PBV is positively impacted when its payout ratio, return on equity or growth rate (g) increase and negatively impacted whenever there is an increment in its risk (R) (Fernandes et al., 2014). The rationale for why and the extent to which these (and other) factors affect the PBV is discussed below.

The positive impact of profitability on firms' PBV has been widely documented. The PBV is dependent on both current (Penman, 1991; Bernard, 1994) and persistent future ROE (Penman, 1991) and profits (Fama & French, 1995). However, Bernard (1994) advocates that unlike what would be predictable, the PBV is only very slightly affected by future returns on equity.

Fama & French (1992) and Bernard (1994) defend that the PBV depends on a company's distress risk, specifically through the changes it causes in the discount rates investors use when pricing securities. Fama & French (1993) also argue that assuming the capital markets are rational, the higher returns generated by low PBV firms are an indication that these companies are exposed to a higher risk than high PBV companies and, consequently, that the PBV can even be interpreted as a proxy for common risk factors that affect a company's stock returns. Hence, *ceteris paribus*, the higher the risk associated with a firm, the lower its PBV.

The leverage a company is exposed to is also a determinant factor of a company's PBV. Some authors find empirical evidence that leverage has a negative relationship with the PBV (such as Rajan & Zingales, 1995), while Braouezec (2009) theoretically corroborates those findings. However, Chen & Zhao (2006) argue that the vastly documented negative impact of leverage on PBV is actually a reflex of those studies being conducted with samples solely comprised of high PBV firms and that the relationship between this ratio and leverage is non-monotonic depending on whether companies have small, medium, or large PBVs. Contrary to most existing literature, the authors even argue that leverage positively impacts PBV for most companies.

Ohlson (1995) argues that the dividend payment reduces a firm's book value, does not influence its current earnings, and does negatively affect the company's expected future returns. Ohlson also mentions dividend payments should cause the market value of firms to decrease on a "dollar for dollar" basis, which should cause the PBV to decrease if the book value is higher than the firm's market value or increase if the market value is higher than the book value. Furthermore, Feltham & Ohlson (1995) attribute differences between market and book equity values to the discrepancies in accounting and market valuation of operating assets, which results in goodwill creation.

Bodie et al. (2011) state that the expected future cash flows resulting from ongoing activities, the growth those activities are expected to have, and the possible implementation of future projects determine a firm's market value. The authors argue that firms with high PBV will exhibit large growth opportunities compared to low PBV companies[1]. In addition, Bernard (1994) argues that differences in PBV between companies can be attributed to gains and losses resulting from takeovers, mergers, and liquidations.

[1] The observed relationship between growth opportunities and PBV has led some authors (such as Rajan & Zingales, 1995) to use PBV as a proxy for companies' growth opportunities.

Another factor affecting the PBV, causing it to be persistently lower than one, is firms' unwillingness to recognize impairment losses, which is only exacerbated when models are used to determine the recoverable assets (Bini & Penman, 2013). Likewise, when the return on equity of a company is smaller than its cost of equity, the book value of equity per share will exceed the share price, and thus the PBV will be situated below one (Damodaran, 2012). In 2017, when more than half of the Euro area banks exhibited a PBV below one, a cost of equity in excess of the expected return on equity was pointed out as the reason behind those depressed PBVs (ECB, 2017).

This section highlights that a firm's PBV is mostly defined by present and future profitability, existing growth opportunities, risk, and dividend policy, while leverage produces an ambiguous effect. Furthermore, below-one PBVs are particularly dependent on a delayed impairment loss recognition and a cost of equity exceeding the expected return on equity.

2.3. The determinants of the PBV in the banking industry

While the previous section mentions the determinants of the PBV of any industry in general, the following focuses on the determinants of the PBV in the banking industry.

2.3.1. Bank-specific factors

Coleman & Stebunovs (2019) argue that bank-specific and banking-specific factors account for the bulk of the difference between the higher profitability of US banks when compared to their European counterparts, which, *ceteris paribus*, should cause the PBV of US banks to be larger than that of European ones. The effects of these bank-specific factors are discussed next.

Profitability is perhaps the factor most often referred to when trying to determine the drivers of PBV in banks, as higher profitability tends to be associated with higher PBV (ECB, 2019; Simoens & Vennet, 2021). Simoens & Vennet (2021) mention that the return on assets (ROA) in the USA increased soon after the financial crisis, while it remained at a low level in Europe, thus partially explaining the PBV gap observable between banks of the two regions. The authors also argue that cost efficiency played an important role in determining banks' profitability, as a larger amount of interest expenses pressured European banks' net interest margin compared to US banks (Simoens & Vennet, 2021). Thus, a higher cost efficiency typically leads to a higher PBV (Jordan et al., 2011; Simoens & Vennet, 2021). Furthermore, Calomiris & Nissim (2014) suggest that decreases in the value of intangible

assets such as bank-client relationships and negative changes in the investors' perception of the value of sources of non-interest income cause profitability to decrease, therefore contributing to the reduction of the PBV.

Although alterations to the existing regulation conducted in the post-crisis in the US and Europe were instituted to promote a healthier banking industry, they ended up producing the opposite result (Sarin & Summers, 2016; Chousakos & Gorton, 2017). Recent regulation directives such as increased regulatory capital and decreased leverage ratios are accused of being constrictive and having turned banks into weak institutions no longer discernible from one another (Chousakos & Gorton, 2017). Compared to the pre-crisis period, banks have become riskier and have suffered a decrease in their franchise value, partly explained by the new restrictive regulations (Sarin & Summers, 2016). However, Bogdanova et al. (2018) defend that regulation is unable to explain the low PBV of the banking industry and that post-crisis policies' impact on PBV has been incorrectly enhanced.

On the other hand, banks' business model choices are known to influence their PBV. Streeter (2006) argues that banks whose core activities consist of fee-collecting services tend to outperform financial institutions focusing on credit-granting activities. Jordan et al. (2011) find evidence of this, as the ratio between non-interest income and interest income is positively related to a bank's PBV in the US. Additionally, Streeter advocates that the low quality and increased risk inherent to conceding loans harm banks' profitability, consequently negatively impacting PBV. Furthermore, Simoens & Vennet (2021) argue that a larger proportion of deposits to assets leads to a lower PBV, partly explaining the existing gap between US and European banks.

Capital requirements are generally found to produce an inconsistent or ambiguous effect on bank valuation. Weigand (2016) argues that American and European banks exhibited a higher amount of Tier 1 Capital in 2016 compared to the pre-crisis period and that such an increase was causing their profitability to decrease. Conversely, Jordan et al. (2011) demonstrate that Tier 1 Capital positively impacts banks' valuation in the US. In addition, the proportion of reserves that banks hold at central banks compared to their assets is negatively related to their insolvency risk (Hugonnier & Morellec, 2017). However, reserves are also negatively related to the amount of lending banks can provide when frictions exist (Martin et al., 2011), which should cause profitability to decrease. As such, the effect of holding larger proportions of reserves at central banks is ambiguous and needs to be studied further.

Similarly, the existing literature is conflicting on whether bank size influences bank valuation. While larger balance sheets are associated with a lower PBV in the pre-crisis period, they do not seem to influence PBV post-GFC (Bogdanova et al., 2018). Simoens & Vennet (2021) contradict the latter argument, claiming that size has also negatively impacted bank PBV in Europe and the US following the GFC. On the other hand, a lack of consolidation in the banking sector is often indicated as one of the reasons which justify lower profitability in Europe, with larger banks presumably able to attain better cost efficiency and benefit from economies of scale (ECB, 2017).

Bogdanova et al. (2018) argue that investors severely punish banks for their poor asset quality, with the market value of equity decreasing more significantly than what increases in the book value of NPLs would suggest (whenever such information is made public). Likewise, several authors find evidence that the higher the proportion of NPLs to the number of overall loans, the more bank valuation tends to decrease (Jordan et al. 2011; ECB, 2019; Simoens & Vennet, 2021). Also, investors seem to value banks' proactive attempts to tackle asset quality problems by increasing financial institutions' market value of equity when banks establish higher provisioning levels to tackle NPL (Bogdanova et al., 2018; Simoens & Vennet, 2021).

Other factors, such as poor management and operational efficiency, have a negative impact on bank valuation, especially in US banks, where their impact on PBV is felt more strongly (ECB, 2019). Also, although leverage was widely regarded as a profit-increasing tool by shareholders in the pre-GFC period, investors have changed their perception of the value debt brings to financial institutions, as banks with higher leverage ratios have been penalized with lower PBVs since then (Calomiris & Nissim, 2014). Lastly, Calomiris & Nissim (2014) also argue that mismatches in the maturity of assets and liabilities – namely, the predominance of short-term financing and the granting of longer-term loans – negatively affect bank PBV.

2.3.2. Market variables

Despite their remarks on bank-specific effects, Coleman & Stebunovs (2019) also argue that macroeconomic factors may explain up to one-third of the profitability gap between the banks of the two regions, thus highlighting their importance as possible determinants of the PBV gap between European and US banks. Also, Weigand (2016) argues that, as of 2016, the European banking industry was still operating under adverse macroeconomic conditions,

which indicated the persistence of the effects of the financial crisis in the sector, while American banks seemed to be on a continuous trajectory of recovery. This situation caused banks' performance to be negatively affected in Europe compared to the US (Weigand 2016), which is expected to have caused a decrease in the PBV of European banks relative to US banks.

Firstly, some literature (ECB, 2005; Martinho et al., 2017) finds a positive relationship between banks' profitability and a country's gross domestic product (GDP) growth. Higher GDP growth has been found to reduce asset impairments (Martinho et al., 2017), while Borio et al. (2017) argue that economic growth does not influence bank performance whatsoever. Generally, a bank's market value of equity is positively associated with high expected GDP growth, causing its PBV to increase whenever the economy is believed to perform well in the future (Bogdanova et al., 2018; ECB, 2019).

According to some asset pricing models, such as the Single Index Model (Sharpe, 1963), stock market movements are the main cause of security price changes, which, *ceteris paribus,* should cause firms' PBV to be positively related to market bull runs. Simoens & Vennet (2021) confirm this hypothesis in the banking industry, as they find that European and US banks' PBVs are positively related to the evolution of the European and American stock markets, respectively.

Furthermore, each country's stance on monetary policy influences the financial institutions' PBV. Two of the mechanisms that capture the effects of monetary policy and have been found to affect banks' PBV are the Central Bank Policy Rate (CBPR) and the government bond yield spread.

The CBPR is the rate a country's Central Bank sets to execute or indicate its position on monetary policy (IMF, n.d.). Once the policy rate is defined, banks' borrowing and lending interest rates are subjected to adjustments, ultimately becoming closer to the CBPR (Norges Bank, n.d.). Hence, the CBPR has a crucial impact on an economy's deposit and lending rates. While a vast strand of literature finds evidence of a positive relationship between profitability and interest rates (such as Borio et al. 2017; Hancock, 1985), other authors, such as Altavilla et al. (2017), find that low-interest rates do not cause lower profitability, as decreases in the net interest margin are compensated by a higher non-interest income and lower loan loss provisioning levels. Simoens & Vennet (2021) find evidence that a country's policy rate is positively related to the performance level of banks, with increases in the CBPR leading to higher PBV in Europe but not in the US.

On the other hand, government bond spreads tend to increase when a tightening monetary policy is employed, as bond investors' risk aversion is enhanced due to the expected consequences of the rising interest rates in the economy (Manganelli & Wolswijk, 2009). As such, wider government bond spreads are associated with a higher issuer credit risk when compared to the benchmark country (ECB, 2008), which the overwhelming literature defines as Germany. Accordingly, Simoens & Vennet (2021) find that larger government bond spreads are negatively related to European banks' PBV.

A bank's PBV is thus positively affected by increases in profitability, cost efficiency, the percentage of fee-collecting services, asset quality, management quality, GDP, and favourable evolutions of the stock market, while also being negatively impacted by increases in leverage, asset and liability mismatches and government yield spreads. A bank's size, the amount of reserves held at the Central Bank, Tier 1 Capital, and interest rates produce effects that are not consensual among the literature and require further study. Additionally, the PBV is, as seen throughout this literature review, determined by many factors, including profitability, risk, leverage, and efficiency, which are the most crucial determinants of a bank's performance (ECB, 2010). Thus, PBV is further strengthened as an adequate market-based measure of bank performance.

2.4. US GAAP vs IFRS

One key aspect of the PBV analysis between US and European banks is the different accounting frameworks used in each region. While the IFRS (International Financing Reporting Standards) is the most widely used accounting framework in the world, publicly listed US companies still use the GAAP (Generally Accepted Accounting Principles) framework at the SEC's (Securities Exchange Commission) request (PwC, 2022). As the book value of equity consists of the difference between the book value of assets and the book value of liabilities, the usage of different accounting standards can cause the book value of equity to be impacted differently in each of the two frameworks, which consequently affects banks' PBV in a dissimilar fashion.

The GAAP and the IFRS differ regarding balance sheet composition rules. For example, employee awards may be considered a liability or equity depending on the awards' characteristics and framework, impacting earnings volatility and certain company key ratios (PwC, 2022). As for assets, there is a disparity between the GAAP and the IFRS regarding the classification rules applied to both held debt securities and loans, resulting in a divergence

in their measurement (PwC, 2022). Additionally, impairment loss reversals are strictly prohibited in the GAAP, while the IFRS dictates such a reversal is possible in certain conditions (PwC, 2022). In addition, impairment losses were calculated by taking a backwards-looking approach in the GAAP framework until 2020. In contrast, in the IFRS, historical and current data and a certain degree of plausible forecasting are incorporated in impairment loss calculation (PwC, 2022). In terms of financial liabilities, the GAAP allows more of the financial instruments issued by a company to be classified as equity instead of being considered liabilities when compared to the IFRS (PwC, 2022).

Despite these differences, it is worth noting that the convergence between GAAP and IFRS in recent years has reduced the differences between the two accounting standards. Changes in revenue recognition, for example, were introduced in 2014 and put into practice in 2018, eliminating most of the existing differences in revenue accounting (PwC, 2022). Therefore, while disparities in the accounting standards of US and European companies are still visible, the convergence between them can only lead to a more reliable comparison between the PBV of US and European banks in the future. In the meantime, PBV comparisons remain subject to accounting standards inconsistencies.

3. Research Questions and Methodology

3.1. Research Questions

This section will present this dissertation's research questions after the literature review conducted above. Before delving deeper into the PBV determinant analysis, it is important to firstly test whether the PBV gap between US and European banks documented in the existing literature is indeed observable in this dissertation. Therefore, the first research question this dissertation will address is:

RQ1: Is there a PBV Gap between US and European banks in the post-global financial crisis?

If this hypothesis is confirmed, it becomes necessary to determine how and if some of the factors mentioned during the literature review affect the PBV differently for US and European banks. Thus, the second research question is:

RQ2: What are the PBV determinants for European and US banks?

However, analyzing the determinants of the PBV in both regions is not indicative that any of them explains the gap, as this analysis simply provides information as to what influences the ratio in each location (Simoens & Vennet, 2021). Hence, the third research question will address the causes of the PBV gap:

RQ3: What determinants explain the PBV gap between European and US banks following the GFC?

Finally, the effects of the independent variables on the PBV of both European and US banks can be further divided into short- and long-term effects. In fact, existing literature points to the possibility that PBV may be differently affected by its short and long-term determinants. For example, Regehr & Sengupta (2016) argue that bank size is a crucial determinant of long-term profitability, which*, ceteris paribus* (and according to the literature review presented before), should also cause banks' PBV to be affected by their size mainly in the long run. On the other hand, Kaparakis et al. (1994) claim that, for instance, a bank's short-term cost efficiency is affected by its aggressiveness, which, *ceteris paribus*, could consequently negatively affect the PBV in the short run. This approach has been adopted by other authors, such as Alves et al. (2023), who studied how the "Pilar 2 Capital Requirements" (P2R) are affected by the independent variables in the short and long- term.

Therefore, as a means to complement RQ2, RQ4 will attempt to capture the short and long-term effects of the factors previously defined as PBV determinants:

RQ4: Are short-term and long-term PBV determinants for US and European banks the same?

The focus of this research question, however, lies solely on the bank-specific variables since managers banks only have control over them.

3.2. Methodology

This section addresses the methodology employed to answer each of the research questions presented above.

3.2.1. Research Question 1 – Two-sample t-tests

In order to determine if a PBV gap between European and US banks exists in the post-crisis period, several tests for the equality of means are employed. As such, before implementing them, the PBV of all the banks in the sample was first simultaneously grouped by year and region, creating an average PBV for each of those subsets.

Initially, a two-sample t-test is employed to verify if the average US banks' PBV was superior to that of European banks for 2008-2021[2]. Afterwards, the same test is used to determine if the average PBV of US and European banks were similar for each year in analysis. Hence, one can assess if the gap between the banks of the two regions could be observed throughout the entirety of the 2008-2021 period.

3.2.2. Research Question 2 - Panel Data

To address RQ2, a few panel data regressions are employed since both cross-sectional (multiple banks) and time series (multiple years) data is included in the analysis. Using panel data allows heterogeneity of the individuals to be incorporated into the regressions by controlling for the omitted variables of the model, while neither cross-sectional nor time-series data can (Baltagi, 2005). Furthermore, panel data models are better at dealing with "the dynamics of change" (Gujarati & Porter, 2008) than cross-section or time series models, which is particularly relevant in the case of this dissertation, given the matter at hand. Other

[2] In this case, since the number of PBV observations for each of the subsets is larger than the commonly used threshold of n=30, the Central Limit Theorem is valid and the two-sample t-test can thus be used.

benefits over the above-mentioned models include lesser collinearity, more efficiency, more informative data, more degrees of freedom and lesser biases arising from aggregating entities into broader groups (Gujarati & Porter, 2008).

When estimating panel data models, concerns over heteroskedasticity (the non-constancy of the errors across variables, often due to them being related to the independent variables) and serial correlation often arise. To address these concerns, a Modified Wald test for groupwise heteroskedasticity and a Wooldridge test for autocorrelation in panel data were conducted in this dissertation. The rejection of the null hypotheses in both tests indicates the presence of both of these issues (see **Annex A**). Consequently, all regressions estimated in this research use cluster robust standard errors, as they effectively mitigate heteroskedasticity and serial correlation concerns[3] (Hoechle, 2007).

Pooled OLS, fixed effects (FE) and random effects (RE) models are the most used when conducting panel data regressions. The in-depth econometric discussions of all models can be consulted in **Appendix 1**. Although the pooled OLS model is a viable option when dealing with panel data, it typically produces estimators with higher root mean squared errors than either the FE or the RE models (Clark and Linzer, 2015); hence, the option of using it is immediately discarded[4]. To assess which of the other two models is most suitable to answer RQ2, most literature suggests using the Hausman test to choose between the FE or the RE models. The Hausman test compares whether the sets of coefficients for the FE and RE models are correlated with the independent variables, where rejecting the null hypothesis leads to choosing the FE model over the RE model (Baltagi, 2014). The reasoning behind this conclusion is that despite the result of the Hausman test, FE estimators will always be consistent[5] even if the correlation between the coefficients and the independent variables exists, whereas RE estimators will not (Baltagi, 2014). If after conducting the Hausman test the null hypothesis cannot be rejected, the RE estimators are considered to be not only consistent but also efficient (have minimum variance) and should thus be preferred over the FE estimators (Baltagi, 2014). In this dissertation, however, cluster robust standard errors are utilized to eliminate autocorrelation and heteroskedasticity concerns, precluding the

[3] As suggested by Schmidheiny (2022), the standard errors (SE) were estimated by considering each bank as an individual cluster, which is advisable whenever the number of clusters exceeds 50 (Schmidheiny, 2022). This SE clustering criteria was applied to all models in this dissertation.

[4] Despite the immediate discarding of the pooled model, an undisclosed Wald test was still conducted to test if the set of introduced dummy variables in the FE model were equal to 0, in which case the pooled model would be preferable over the FE model. As the null hypothesis was rejected, the dummy variables were deemed as significant. Therefore, the choosing of the FE model over the pooled model is supported by the Wald test.

[5] Increases in sample size will lead to an approximation of the estimators to their true parameters.

Hausman test from being used. Instead, the Hansen-Sargan test for overidentifying restrictions is employed, yielding identical results and identical interpretation to the Hausman test under conditional homoskedasticity (Schaffer & Stillman, 2010).

Since results from the Hansen-Sargan test support the usage of the FE model (see **Table 6**), a model similar to that of Simoens & Vennet (2021) is defined as the baseline model for RQ2:

$$Y_{it} = \sum_{j=1}^{J} \beta_j B_{j,i,v} + \sum_{k=1}^{K} \gamma_k M_{k,i,t} + \alpha_i + \varepsilon_{i,t} \quad (3.2.2.1)$$

where Y_{it} corresponds to the PBV of bank i for year t. β_j and γ_k represent the set of bank-specific and market parameters, respectively, whereas $B_{j,i,v}$ and $M_{k,i,t}$ are matrixes of the bank-specific and market variables, respectively. α_i represents the bank fixed effects, while $\varepsilon_{i,t}$ is the error. Initially, a regression is run for the full sample, which is then divided into subsamples of European and US banks. By doing so, the impact of the independent variables on PBVs of the banks of the two regions can be studied separately[6].

A slight natural adaptation to the baseline model is the removal of the macroeconomic variables and the addition of country dummies. This change captures the effects of the common factors that affect banks simultaneously based on their location (both the macro variables presented above and other unobserved ones), resulting in clusters of a larger number of entities. Since macroeconomic variables are dropped from the model, including time dummies that capture time-varying country effects becomes necessary to obtain more robust results[7]. The additional model is the following:

$$Y_{it} = \sum_{j=1}^{J} \beta_j B_{j,i,v} + \varphi_j + \delta_t + \varepsilon_{i,t} \quad (3.2.2.2)$$

[6] Correlation coefficients between predictor variables were determined in order to assess whether collinearity concerns existed. A threshold of 0.6 was set as the maximum allowed correlation value between independent variables, as up to that level the predictor variables are conventionally considered to have a moderate linear relationship (Campbell, 2006). Results indicated that no pair of variables crossed the threshold of 0.6 (**see appendix B**) and so all of them were simultaneously incorporated in the regression. The only exceptions are *ROE* and *Growth* since even though their correlation does not exceed 0.6, both are calculated using Net Income, which becomes partly controlled for when estimating the impact of *Growth* on PBV.

[7] While this procedure would normally be conducted in the robustness checks, the subsequent research question (RQ3) is dependent on the results of RQ2. Since solely the variables that prove to be significant across both models will be considered as PBV determinants, the results from this model will thus be presented Results section.

where φ_j and δ_t denote country and time-fixed effects, respectively.

3.2.3. Research Question 3 – Two-sample t-tests

As mentioned earlier, the second research question only verifies which factors affect the bank PBV in each region. To analyze which factors explain the PBV gap, the approach taken by Simoens & Vennet (2021) is replicated in this dissertation. In their paper, the authors complement the regressions they had computed previously (those computed during RQ2 in this dissertation) with a Welch-Satterthwaite test (i.e., an equality of means test). In this dissertation, and as in RQ1, a two-sample t-test is used instead, yielding similar results to the Welch-Satterthwaite test.

The rationale behind implementing either test is to compare the determinants' mean values between a base case scenario where the average PBV of US and European banks is virtually identical and the last year in the analysis. Suppose a PBV determinant's mean values are shown to differ over that timeframe significantly. In that case, such a change is interpreted as evidence that the bank PBV of a certain region was influenced by a change in that determinant's mean value, ergo justifying the creation of the PBV gap. Otherwise, the variables are still considered PBV determinants in either region, not as variables that can explain the PBV gap between European and US banks.

3.2.4. Research Question 4 - Within and Between effects

Lastly, an approach similar to that adopted by Afonso et al. (2011) and Alves et al. (2023) is used to determine European and US banks' short- and long-term PBV determinants. In their articles, the authors consider the between variation (the differences between banks) of the determinants of the P2R as an indication of the effects caused in the long run. On the other hand, the within variation (changes within the same bank over time) is considered representative of the short-term effects of the independent variables. These interpretations are supported by Kuh (1959), who defends that cross-sectional data indicate long-run adjustments and that time-series data typically denotes short-term effects.

Econometrical arguments support using the RE model to analyze these short- and long-term determinants (Alves et al., 2023). Hence, the baseline model devised by Afonso et al. (2011) is applied in this dissertation as a starting point:

$$Y_{it} = \beta X_{it} + \lambda Z_i + \alpha_i \quad (3.2.4.1)$$

where Y_{it} corresponds to the PBV of bank i for year t, X_{it} and Z_i are matrixes of the time-varying and time-invariant independent variables and α_i corresponds to the bank-specific error. However, the assumption of uncorrelation between country-specific effects and independent variables (that is, $E(\alpha_i|X_{it}, Z_i) = 0$) must be maintained for the RE model's implementation to remain viable (Afonso, 2011; Alves et al., 2023). Given the results of the previous Hansen-Sargan test, that assumption is not verified, so the model's coefficient estimates are misleading. To solve this issue, the Mundlak estimator (Mundlak, 1978) is employed. The bank-specific error is modelled through it as the linear combination of the independent variables' mean value over the analyzed period (Afonso, 2011; Alves et al., 2023), ensuring that the correlation concerns are mitigated. Therefore, the following model is utilized to answer RQ4[8]:

$$Y_{it} = \gamma \bar{X}_i + \beta(X_{it} - \bar{X}_i) + \varphi_j + \delta_t + \varepsilon_{it} \quad (3.2.4.2)$$

where Y_{it} corresponds to the PBV of bank i for year t, $\bar{X}i$ is a matrix of the mean values of the independent variables previously considered to be PBV determinants for either US or European banks and $(X_{it} - \bar{X}i)$ represents the same demeaned independent variables. φ_j and δ_t represent controls for country and time effects, respectively (where j denotes the country of each bank's headquarters). γ and β are the coefficients for the between and within parameters, respectively (and thus for the long and short-term determinants, respectively). Two separate equations are computed, one for the PBV determinants of European banks and another for the PBV determinants of US banks. Additionally, a test for the joint significance of the γ estimators is conducted to guarantee that the between estimators included in the model are significant, which is crucial when employing the Mundlak approach (Alves et al., 2023).

[8] See **Appendix 2** for details on how the final model is derived from the initial model and **Appendix 3** for a brief discussion on the data treatment process specifically employed to fit the model's specifications.

4. Data

4.1. Sample and Sample Selection Criteria

In order to answer the research questions mentioned previously, data from a sample of 216 publicly listed banks (116 from Europe[9] and 100 from the US) was collected across the 2008-2021 period. All variables are winsorized at the 1% and 99% percentiles, which means that, for each variable, values beyond those percentiles are replaced by the extreme values of the 1%-99% range (Dixon & Yuen, 1974)[10].

Year-end data from banks' consolidated accounts were gathered from Moody's Bank Focus, Refinitiv Workspace and Bankscope. Market data relative to the countries where the banks' headquarters are located was collected either from Refinitiv Workspace, the Bank for International Settlements (BIS), or the World Bank. The following criteria were used to define the sample:

- Headquarters location either in Europe or the US.
- Publicly listed banks (excluding bank branches).
- Specialization: commercial, savings, cooperative, real estate & mortgage, investment, or bank holding companies.
- Total assets larger than $ 10 billion as of 2021.
- Total customer deposits and gross loans larger than 20% of total assets (to select banks with a fairly reasonable role in financial intermediation).

Bank data were primarily collected from Bank Focus and only manually complemented with data from Bankscope and Refinitiv Workspace whenever compatibility between the databases was observed (see **Annex D**).

4.2. Variable Specification

The independent variables used in this dissertation include those used by the existing literature regarding the different determinants of the PBV in US and European banks (Simoens & Vennet, 2021), the determinants of the PBV in the banking industry (Jordan, 2011; Calomiris & Nissim, 2014; Bogdanova et al., 2018) but not introduced in the PBV gap

[9] See **Annex C** for the geographical distribution of European banks.

[10] Dixon and Yuen (1974) argue that the arithmetic mean is not a robust estimate of location since it is largely affected by the sample's extreme values. In addition, a regressions' slope and intercept have been shown to be more efficiently estimated when there is evidence of sample contamination and winsorization is employed, while the resulting loss in efficiency in case the sample has a normal distribution is very limited whenever the number of observations is larger than 15 (Yale, 1970, as cited in Dixon & Yuen, 1974).

analysis, and, presumably, newly introduced variables as possible determinants of banks' PBV (namely bank growth and the reserves to assets ratio).

The dependent variable, *PBV*, corresponds to the ratio between a bank's market capitalization and its book value of equity. *Total Assets* are measured as the natural logarithm of total assets and are included to analyze the impact of a bank's *size*. *Profitability* is measured through *ROE* and the *Net Interest Margin*. The effect of *leverage* on PBV is included in the ratio between the book value of equity and total assets (*Equity to Assets*). *Cost to Income* is measured as the ratio between total cost and total income, which denotes *cost efficiency*. The ratio between reserves held at the central bank and total assets (*Reserves to Assets*) and the ratio between Tier 1 Capital and Risk Weighted Assets (*Tier 1 Ratio*) are included to capture the effects of *capital requirements*. The ratios between non-performing loans and gross loans (*NPL to Gross Loans)* and between loan loss provisions and non-performing loans (*LLP to NPL*) reflect banks' *asset quality*. The impact of a bank's *business model* is included through the ratios between total deposits and total assets (*Deposits to Assets*), total loans and total assets (*Loans to Assets*) and interest income and non-interest income (*II to NII*). *Growth* is the ratio between the absolute yearly net income variation and total assets. The *Dividend Payout Ratio* is the only ratio computed by primarily taking data from two different sources: dividends paid data was gathered from Refinitiv Workspace and total equity from Bank Focus. The *Distance to Default* variable is indicative of a financial institution's *risk* (where a lower value indicates higher default risk) and was computed using the same Z-score as that used by Marques & Alves (2021):

$$Z_{i,t} = \left(\frac{TE_{i,t}}{\left[TA_{i,t} + \frac{TA_{i,t-1}}{2} \right]} + ROA_{i,t} \right) / SDROA_i \qquad (4.2.1)$$

where $Z_{i,t}$ represents the Z-score of bank i in year t, $TE_{i,t}$ is bank i's total equity in year t, $\left[TA_{i,t} + TA_{i,t-1}/2\right]$ is the average value of total assets of bank i between years t and t_{-1}, $ROA_{i,t}$ is bank i's return on assets in year t and $SDROA_i$ corresponds to the standard deviation of the return on assets of bank i of the entire period of analysis.

Regarding market-related variables, the value attributed to each bank for each variable is dictated by the location of the bank's headquarters. *GDP* corresponds to each country's year-on-year GDP growth (at constant 2015 prices), and *Policy Rate* consists of each country's (or economic region in the case of the Eurozone) primary monetary policy rate (see **Annex E**).

The *Yield Spread* captures the effects of sovereign credit risk. It is measured as the difference between each country's 10 Year government bond and the 10 Year German government bond (see **Annex F** for a variable specification summary).

4.3. Descriptive Statistics

Table 1 shows the descriptive statistics of the different variables for the full sample. The number of observations is unequal across most variables, meaning the panel data is unbalanced. The major conclusion from the full sample statistics is that the average bank's PBV seems to be highly depressed, barely reaching the threshold of one for the 2008-2021 period.

Table 1 - Descriptive Statistics (Full Sample)

Variable	Obs.	Mean	Std. Dev.	Min	Max
PBV	2685	1.037	.678	.027	3.977
Total Assets	2853	10.508	1.701	7.648	14.745
ROE	2853	.07	.08	-.344	.278
NIM	2853	.027	.013	.006	.073
Equity to Assets	2853	.1	.033	.031	.2
Cost to Income	2853	.614	.125	.336	1.085
Reserves to Assets	2854	04	.051	0	.267
Tier 1 Ratio	2731	.14	.037	.074	.269
NPL to Gross Loans	2822	.038	.06	.001	.386
LLP to NPL	2829	1.233	1.318	.179	8.458
Deposits to Assets	2852	.635	.19	.177	.878
Loans to Assets	2853	.644	.153	.201	.897
II to NII	2853	4.122	4.654	-1.101	31.14
Growth	2853	.001	.006	-.026	.027
Dividend Payout Ratio	2295	.37	.435	-1.142	2.514
Distance to Default	2791	45.322	38.607	1.851	213.419
GDP	3024	.014	.029	-.09	.082
Policy Rate	3020	.006	.01	-.007	.05
Yield Spread	3014	.012	.013	-.011	.067

Notes: Sample based on unbalanced panel data (2008-2021). Variables are windsorized at 1 and 99 percentiles.

Perhaps more insightful to this study are the descriptive statistics of the different variables for the European and US samples during the 2008-2021 period (see **Table 2** and **Table 3**, respectively). European banks' average size was superior to that of US financial institutions, while *Cost to Income* was identical in both regions. European banks exhibited higher values in capital adequacy-related ratios, while US banks seem to have had higher quality assets and better provisioning levels. Business model metrics also differed, as US banks engaged in more intermediation activities than European banks. While the proportion

of loans to assets was practically identical, US banks secured more deposit funding than European ones.

Table 2 - Descriptive Statistics (Europe)

Variable	Obs.	Mean	Std. Dev.	Min	Max
PBV	1399	.823	.712	.027	3.977
Total Assets	1513	11.005	1.662	7.648	14.745
ROE	1513	.062	.089	-.344	.278
NIM	1513	.019	.011	.006	.073
Equity to Assets	1513	.088	.035	.031	.2
Cost to Income	1513	.618	.136	.336	1.085
Reserves to Assets	1513	.06	.061	0	.267
Tier 1 Ratio	1396	.149	.041	.074	.269
NPL to Gross Loans	1482	.058	.075	.001	.386
LLP to NPL	1489	.708	.387	.179	8.458
Deposits to Assets	1513	.529	.188	.177	.878
Loans to Assets	1513	.635	.169	.201	.897
II to NII	1513	3.289	3.75	-1.101	31.14
Growth	1513	0	.006	-.026	.027
Dividend Payout Ratio	1078	.406	.505	-1.142	2.514
Distance to Default	1477	45.509	42.831	1.851	213.419
GDP	1624	.011	.033	-.09	.082
Policy Rate	1620	.007	.012	-.007	.05
Yield Spread	1614	.012	.016	-.011	.067

Table 3 - Descriptive Statistics (US)

Variable	Obs.	Mean	Std. Dev.	Min	Max
PBV	1286	1.27	.551	.027	3.977
Total Assets	1340	9.948	1.567	7.648	14.745
ROE	1340	.079	.067	-.344	.278
NIM	1340	.035	.009	.006	.073
Equity to Assets	1340	.114	.024	.061	.2
Cost to Income	1340	.61	.112	.336	1.085
Reserves to Assets	1341	.017	.016	0	.211
Tier 1 Ratio	1335	.132	.031	.074	.269
NPL to Gross Loans	1340	.015	.016	.001	.141
LLP to NPL	1340	1.816	1.69	.179	8.458
Deposits to Assets	1339	.755	.102	.177	.878
Loans to Assets	1340	.653	.132	.201	.897
II to NII	1340	5.064	5.347	-1.101	31.14
Growth	1322	1340	.001	.006	-.026
Dividend Payout Ratio	1217	.337	.359	-1.142	2.514
Distance to Default	1314	45.113	33.239	1.851	213.419
GDP	1400	.017	.021	-.028	.059
Policy Rate	1400	.005	.007	.001	.024
Yield Spread	1400	.012	.009	-.007	.024

Given that the ratio of interest income to non-interest income was substantially higher for US banks even though the proportion of loans to assets was the same, either the amount of non-interest income was considerably superior in European banks, or US banks benefited from higher interest rates in the post-GFC period. Despite lower profitability, European banks' dividend payout ratio was superior to the value registered in its American counterparts. In addition, the risk of default banks were subjected to was virtually the same in the post-GFC era. *Policy Rate* and *Yield Spread* appear to have been very similar in the two regions, while the US has exhibited a larger *GDP* when compared to the average GDP value for the European sample.

The descriptive statistics of the dependent variable PBV after being simultaneously grouped by year and by region are of note as well (see **Table 4**).

At first glance, a clear dichotomy between the average yearly PBV can be observed between US and European banks. While the PBV of US banks exceeded one in 12 of the 14 years analyzed, European banks were never able to cross that threshold at any moment in time, contradicting the results of Simoens & Vennet (2021) and strongly hinting towards the existence of a PBV gap. One main takeaway from this analysis is that while 2011 was the year the full sample PBV was lowest (0.82), 2020 was a close second in that respect with a PBV of 0.86. This seems to indicate that the consequences of the covid-19 pandemic on the PBV of financial institutions were as serious as those which arose in the aftermath of the GFC. Considering the European sample, 2020 was indeed the year in which the average PBV was lowest. Also, 2011 being the year when PBV was most depressed attests to the fact that unlike what had happened in previous recessions, the economic recovery after the GFC was much slower, and its effects were much more long-lasting (Reserve Bank of Australia, n.d.). Another interesting fact is that in 2016, US banks' PBV was nearly double that of European banks, and the PBV gap between US and European banks was the highest recorded in the sample. This remark aligns with Weigand (2016), who, as previously mentioned, argued that the US was exhibiting a much better recovery trajectory than European banks at that time.

All variables' evolution over the 2008-2009 period is portrayed in **Annex G**.

Table 4 - PBV Statistics across time and region

	Full Sample			Europe			US		
Year	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
2008	161	.92	.638	86	.734	.602	75	1.134	.613
2009	165	.949	.631	88	.945	.733	77	.954	.493
2010	168	1.004	.628	88	.892	.74	80	1.127	.45
2011	171	.82	.57	88	.672	.657	83	.977	.408
2012	183	.899	.569	92	.75	.677	91	1.051	.38
2013	185	1.212	.723	93	.948	.738	92	1.479	.602
2014	189	1.151	.652	94	.931	.721	95	1.368	.488
2015	193	1.108	.666	97	.885	.736	96	1.334	.497
2016	200	1.256	.773	102	.859	.737	98	1.669	.567
2017	211	.975	.631	112	.77	.683	99	1.207	.472
2018	214	1.247	.745	114	.963	.777	100	1.571	.553
2019	215	1.01	.672	115	.768	.704	100	1.289	.507
2020	215	.849	.616	115	.63	.641	100	1.102	.477
2021	215	1.058	.724	115	.802	.731	100	1.352	.596

5. Results and Discussion

Results from the above-mentioned research questions are presented and discussed in this section.

5.1. Research Question 1

Table 5 shows the results of the two-sample t-tests between European and US banks' PBV (solely for the full sample and years 2008 and 2009, the table with the full results can be consulted in **Annex H**). As expected from the descriptive statistics analysis, the t-tests' null hypothesis that European and US banks' PBV mean values were the same in the period 2008-2021 was rejected at the 1% significance level. These results align with the ECB (2019) and the work of Simoens & Vennet (2021), who defended and tested the existence of the PBV gap. A PBV gap between US and European banks could be found every year in the analysis except for 2009. This result slightly differs from Simoens & Vennet (2021), who claimed that the PBV of the banks of the two regions was identical not in 2009 but in 2008[11]. The inexistence of a PBV gap in one of the earliest years of study is of major importance for this dissertation since 2009 becomes the starting point for comparing how the PBV of banks from both regions deviated following the GFC in RQ3. As PBV values did not differ between the two regions in 2009, all significant changes to the mean values of the PBV determinants from that year onwards reflect a deviation from the PBV equality scenario, hence explaining the origination and perpetuation of the gap.

Table 5 – Equality of in means test between European and US banks' PBV

Year	Difference in means (European-US Banks PBV)	Obs.
Full Period	-0.448***	2685
2008	-0.400***	161
2009	-0.00950	165

Note: ***, ** and * indicate significance at 1%, 5% and 10%, respectively.

5.2. Research Question 2

Table 6 shows the results of the impact of the possible PBV determinants on bank PBV across the full, European and US samples. Combined results from the FE effects and the country and time FE models indicate that *Distance to Default* and *II to NII* cannot be classified as PBV determinants for Europe nor the US (despite the impact of *Distance to Default* being

[11] However, the authors used equity values registered on the 31st of March of the subsequent year when calculating the PBV variable, which can possibly explain this minor difference.

significant for the full sample in Model II). *Loans to Assets* and *Dividend Payout Ratio* are considered PBV determinants in both the full and the European sample, but solely on Model II. *Deposits to Assets* positively and significantly affect bank PBV in the full and European samples and negatively impact it in the US sample. However, none of these results are robust across both models. The proportion of *Reserves to Assets* negatively impacts PBV in the European sample but solely in Model II. Oppositely, *Growth* positively impacts bank PBV in the European sample but only in the Baseline Model. *Tier 1 Ratio* positively impacted bank valuation in the European and US samples but only in Model II. Since the impact of these factors on PBV was not robust across both models, subsequent research questions will not hover around these variables. Nevertheless, all the results of the factors deemed as significant fall in line with their expected impact on PBV based on the literature review except for *Reserves to Assets*, whose predicted effect was ambiguous.

All the remaining variables produce a robust and significant impact on banks' PBV of at least one of the two regions. While the effect of bank size was ambiguous in the literature, results indicate that *Total Assets* negatively and significantly affect bank PBV across Europe (at least at the 5% significance level). Minton et al. (2019) attribute this negative impact on bank valuation to the larger amount of trading assets larger banks typically own since investors seem to apply a valuation discount to banks which engage in trading activities more frequently. In the US, the negative impact is only significant (at the 5% level) in the Baseline Model.

As expected, *ROE* and *NIM* produce a positive and significant impact on PBV (at the 1% significance level for the full and US samples in terms of *ROE*, at the 5% level for the full sample and at least at the 10% level for the US sample in terms of *NIM*), despite that impact not being significant for the European sample in the Baseline Model.

Equity to assets is a PBV determinant for both the full sample (at least at the 10% significance level) and the US one (at the 1% significance level) while only producing a statistically significant effect for the European sample in Model II. Nevertheless, leverage negatively impacts bank valuation in all three samples. Therefore, this dissertation contradicts the findings of Calomiris & Nissim (2014) and Bogdanova et al. (2018) but somewhat falls in line with the results of Simoens & Vennet (2021)[12]. Hence, an argument can be made that

[12] Who find Equity to Assets to be a PBV determinant but with the major contribution of the European sample as opposed to this dissertation, where significant effects on PBV are observed in the US sample.

Table 6– RQ2 Regression Results (PBV Determinants)

	Baseline Model			Model II		
	Full Sample (1)	Europe (2)	US (3)	Full Sample (4)	Europe (5)	US (6)
Total Assets	-0.118**	-0.221**	-0.202**	-0.078***	-0.134***	-0.026
ROE	1.029***	0.365	1.031***	1.836***	1.053**	1.646***
NIM	6.466**	6.455	14.764***	9.374**	11.642**	10.292*
Equity to Assets	-1.956*	-0.730	-7.521***	-5.548***	-5.966***	-8.203***
Cost to Income	-0.723***	-0.885***	-0.635**	-1.048***	-1.205***	-1.130***
Reserves to Assets	-0.292	-0.395	1.944	-0.617	-1.209**	2.832
Tier 1 Ratio	-0.108	0.534	1.073	1.712	3.549**	4.157*
NPL to Gross Loans	-1.471***	-0.969**	-6.749***	-2.009***	-1.464***	-7.335***
LLP to NPL	0.025	-0.141***	0.012	0.021	-0.105**	0.005
Deposits to Assets	0.363	-0.196	-0.712*	0.703**	1.166**	0.401
Loans to Assets	0.258	0.019	0.322	-0.978***	-1.782***	-0.054
II to NII	-0.005	-0.000	-0.004	-0.000	-0.001	-0.005
Growth	1.601	3.151*	-0.190	2.077	1.982	0.716
Dividend Payout Ratio	-0.012	0.011	-0.041	0.061**	0.095***	0.025
Distance to Default	-0.002*	-0.001	0.000	0.000	-0.001	0.001
GDP	1.855***	1.228***	2.010***			
Policy Rate	-2.475	-6.396**	-4.231**			
Yield Spread	9.949***	-1.672	20.986***			
N	2132	949	1183	2144	961	1183
adj. R^2	0.781	0.859	0.718	0.586	0.708	0.479
Hansen-Sargan	67.837*** (0.000)	66.152*** (0.000)	58.320*** (0.000)	58.747*** (0.000)	55.084*** (0.000)	31.681*** (0.004)
Bank-FE	Yes	Yes	Yes	No	No	No
Country FE	No	No	No	Yes	Yes	Yes
Time FE	No	No	No	Yes	Yes	Yes

Notes: The Baseline Model corresponds to the bank fixed effects model for the full, European and US samples, respectively, while Model II corresponds to the country and time fixed effects model for the full, European and US samples, respectively. ***, ** and * indicate significance at 1%, 5% and 10%, respectively. Variables are windsorized at 1 and 99 percentiles. The impact of *Growth* is calculated in a second set of regressions at the expense of *ROE* (not disclosed for brevity reasons). No notable changes in the other variables' significance or the adj. R^2 take place when compared to the regressions, including *ROE*. The null hypothesis of the Hansen-Sargan test is that the RE estimation is consistent, therefore, preferable to fixed effects (the p-value is reported in brackets).

even in the post-GFC era, investors are not weary of the negative consequences of increased debt, or at least that prospects of increased profitability outweigh the worrisome problems that arise with increased leverage.

Unsurprisingly, increased *Cost to Equity* impacts bank PBV negatively (at the 1% level for the full and European samples and at least at the 5% significance level for the US sample). As predicted, *NPL to Gross Loans* is found to affect bank PBV negatively. The significant impact at the 1% level of significance for all samples in all models (apart from column (2)) attests to how critical this ratio is in determining a bank's valuation and constitutes a differentiating point relative to Simoens & Vennet (2021), who had only found a significant impact for the full sample and the European one.

Unlike what is argued by these authors, *LLP to NPL* is found to have a negative impact on the PBV at the 1% level of significance for European banks. This result could be related to the fact that, in the past, most banks would typically solely incur in the creation of additional provisions whenever a credit event had already occurred (ECB, 2014). As such, increased NPL coverage levels may have warned investors that a credit event had likely already occurred. To circumvent this and other issues related to high levels of NPLs, a package of measures, including setting a minimum value for the *LLP to NPL* ratio[13] was devised by a commission created by the European Banking Authority (Stamegna, 2021). However, this regulation only became effective in 2019, which does not cover most years of this analysis. Even with this imposition, other issues when setting aside provisions remain. Banks that do not set adequate provisioning levels will need to draw the necessary amount from their capital whenever their NPL coverage ratio drops below the minimum level (ECB, 2020), possibly causing concerns over banks' ability to meet their capital requirements[14].

In terms of market variables, all of the included factors were deemed as PBV determinants in at least one of the regions. As predicted, PBV is strongly positively related (at the 1% significance level) to *GDP* in all three samples. Since better economic performance indicates the state of a country's economic health (Callen, n.d.), investors seem to respond favorably to GDP increases, leading to higher bank PBV. Also, as seen in the literature review, GDP is associated with higher bank profitability (which is only partly controlled for

[13] This value differs depending on the number of years that went by since an expose became non-performing and whether the exposure is secured or unsecured (Stamegna, 2021).
[14] Although loan loss reserves do constitute Tier 2 capital and thus constitute regulatory capital, they only do so whenever they are set as a precautionary measure and not as a response to identified value deterioration (Basel Committee on Banking Supervision, 2019).

in this dissertation through *ROE, NIM* and arguably *II to NII* and *Cost to Income*[15]) leading to higher bank PBV.

Unlike what is argued by Simoens & Vennet (2021), a positive relationship between PBV and CBPR could not be found in this dissertation. Instead, results indicate that a country's policy rate significantly negatively impacts PBV across Europe and the US, both at the 5% significance level. This finding is explained by the fact that while increased interest rates will result in banks setting more significant lending rates, the increased rates will incentivize investors to withdraw their deposits from financial institutions and seek better investment opportunities (White, 2022). In that case, returns from interest-bearing assets would increase in a slower proportion to interest bearing-liabilities, leading to added pressure which can ultimately end in a bank's collapse[16]. Since it is typical for banks to primarily obtain short-term financing and, at the same time, provide long-term borrowing (Wheelock, 2016), investors may be weary of these asset-liability mismatches whenever the CBPR increases.

Also, contrary to Simoens & Vennet (2021), no significant impact of *Yield Spread* on PBV could be found for the European sample. Instead, a positive and significant effect (at the 1% significance level) was registered in the full and the US samples. In Europe, while government bond yield spreads tend to widen when a tight monetary policy is employed, they are also bound to increase as a country's credit risk and liquidity premium increase (Barbosa & Costa, 2010). However, the bond spread between the US and Germany reflects a different scenario altogether. During this dissertation's analysis period, this spread has been continuously increasing, as De Vijlder (2021) also notes. The author claims that the yield spread increase is explained by a widening of the real rates on the government bonds since inflation expectations have not differed significantly between the US and Germany in the post-GFC. Real bond rates, on the other hand, consist of the expected real interest rates plus a real rate risk premium (Vlieghe, 2018, as cited in De Vijlder, 2021). Hence, De Vijlder (2021) claims that an increase in the US-German bond spread expresses the investors' view that Germany, and consequently the entire Eurozone, may be in route to lesser growth in following years compared to the US (thus requiring an expansionary policy, resulting in lower bond yields). De Vijlder (2021) also hypothesizes that lower real rates may be a consequence of the ECB's asset purchasing programs, resulting in lower risk premiums in Europe. If that is the case, the author claims that investors would feel anxious over the consequences of the ECB halting

[15] See Robustness Checks for RQ2
[16] As it did in 2023 with SVB, for example (Fernand, 2023).

the asset purchasing programs. Either way, the two explanations are plausible under the observed positive and significant impact of the bond yield spread on bank PBV.

RQ2 results reveal that profitability measures (*ROE* for the European sample and *ROE* and *NIM* for the US one), asset quality, cost efficiency, GDP and the CBPR are common PBV determinants for the European and US banks. Additionally, bank size and the NPL coverage ratio are found to affect bank PBV in Europe, whereas a bank's exposure to leverage will negatively affect its PBV in the US.

5.3. Research Question 3

Table 7 presents the results of the PBV determinants' mean values variation between 2009 and 2021. Firstly, while *Total Assets*, *Equity to Assets* and *LLP to NPL* were previously considered as PBV determinants for banks of one of the regions, a significant change in their mean value was not observed between 2009 and 2021 for that region, and hence these variables cannot explain the appearance of the PBV gap.

In terms of profitability, *ROE* changed massively from 2009 to 2021 in the US sample. Thus, given *ROE*'s positive impact on PBV, this evident increase is expected to have largely contributed to driving the PBV gap apart. Oppositely, *NIM*'s decrease is significant at the 1% level and is expected to have produced the inverse outcome on US banks' PBV. Such a decrease is explained by banks having suffered from continuously decreasing returns on assets in the post-GFC, which benefits in terms of low funding costs could not offset (Wheelock, 2016). Even so, the magnitude of the changes seems to point out that, overall, profitability has contributed to an increase in bank PBV in the US, especially since *ROE* is a direct determinant of the PBV (as seen in Equation 2.2.1)

Cost to Income was considered a negative PBV determinant for both European and US banks, and thus its negative swing in the US (significant at the 1% level) and positive swing in Europe (significant at the 10% level) are clear signals that cost efficiency has contributed to widening the PBV gap between the US and European banks. These results support the argument that investors would value improved cost efficiency in Europe especially (Committee on the Global Financial System, 2018) mainly since pre-GFC levels could not yet be attained.

Table 7 - PBV determinants' mean values variation between 2009 and 2021

		Europe			US		
	Year	Mean	Std. Dev.	% Change	Mean	Std. Dev.	% Change
Total Assets	2009	10.945	1.777	2.90	9.56	1.71	11.20***
	2021	11.262	1.528		10.63	1.32	
ROE	2009	.065	.079	8.29	.009	.118	1292.02***
	2021	.07	.097		.119	.04	
NIM	2009	.02	.012	-18.82***	.035	.007	-16.37***
	2021	.017	.009		.029	.009	
Equity to Assets	2009	.083	.035	0.04	.106	.024	4.59
	2021	.083	.033		.111	.022	
Cost to Income	2009	.593	.122	5.36*	.626	.127	-7.67***
	2021	.625	.148		.578	.097	
NPL to Gross Loans	2009	.05	.055	-36.63***	.034	.022	-81.48***
	2021	.032	.033		.006	.006	
LLP to NPL	2009	.719	.34	7.31	.93	.727	260.25***
	2021	.771	.367		3.352	2.327	
GDP	2009	-.034	.024	272.68***	-.026	NA	328.68
	2021	.059	.016		.059	NA	
Policy Rate	2009	.013	.011	-79.90***	.001	NA	0.00
	2021	.003	.008		.001	NA	
Yield Spread	2009	.008	.013	45.98**	.004	NA	273.50
	2021	.012	.013		.017	NA	

Notes: ***, ** and * indicate significance at 1%, 5% and 10%, respectively, based on underlying two-sample t-tests Variables for which there is a single observation per sub-sample for all banks in a given year (all macroeconomic factors for US banks) have no standard deviation for that year, leading to the inability of testing the significance of the *% Change*. *GDP* in the European and US samples is presented as a positive value as the absolute method is used in the percentage change calculation.

NPL to Gross Loans has decreased significantly (at the 1% significance level) in Europe and the US. In Europe, successive measures to address NPL have been implemented in the past years, particularly in the EU. These include the directives proposed in the European Council of 11 July 2017 and the European Commission's strategy to prevent NPL escalation due to the covid-19 pandemic in December 2020[17]. On the other hand, previously existing

[17] The European Council of 11 July 2017 suggested the fostering of the secondary NPL market, the changing of insolvency regulation, the strengthening of bank supervision and the revamping of the banking industry (Council of the EU, 2017), while the December 2020 strategy included the first two points of the European Council of July 2017, defended an increased cooperation between of national asset management companies and incentivized the taking of precautionary measures by national public entities (European Commission, 2020).

legislation, creditor practices, and more developed market structures in the US enabled a much more rapid resolution of the rising NPL problem[18]. Therefore, although in 2021 both regions registered lower NPL levels than in 2009, the US' remarkable turnaround, denoted by the difference in *% Change*, indicates that a much faster NPL tackling has led to the widening of the PBV gap.

Regarding macro variables, *GDP* is found to have substantially increased both in Europe (significant at the 1% level) and in the US. *GDP* undoubtedly contributed to improving European banks' PBV, given the combined results of RQ2 and RQ3. While no exact confirmation can be given, the combined results in the US sample suggest the same (given the sheer variation in *% Change*). Consequently, the claim that *GDP* contributed to shrinking the gap will not be made even though its variation is only significant in Europe banks. *Policy Rate* on the other hand can be claimed to have contributed to shrinking the PBV gap, given the combined results of RQ2 and RQ3[19].

The decrease in *Policy Rate* (significant at the 1% level) results from accommodative monetary policies employed in European countries, which sought to stimulate economic risk-taking and activity in response to the GFC[20] (ECB, 2015). Hence, the negative effects of an increased policy rate appear to have been mitigated through a sharp decrease in interest rates.

Although the significance of the change in *Yield Spread* in the US sample cannot be determined, the extreme variation registered is once again a strong hint that the PBV gap may have suffered adjustments due to macro-economic factors in the US (which, in this case, may have contributed to the widening of the PBV gap).

The PBV gap between 2009 and 2021 appears to have been driven by superior profitability, cost efficiency and asset quality in the US, whereas the setting of a favorable CBPR in Europe prevented that gap from being even larger. Although untested, results also point to investors' favorable sentiment towards the US economy when compared to Europe as a possible cause for the emergence of the PBV gap between 2009 and 2021.

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[18] For example, previously existing laws facilitated SME insolvency, leading to a faster NPL resolution (Baudino & Yun, 2018); US banks will usually bring a restructured debt plan to court in order to speed up the insolvency process and eliminate the court's time expenditure with designing such a plan (Baudino & Yun, 2018); NPL transactions amounted to 40% of all loan portfolio sales from 2009 to 2014, totaling 75.2 billion US dollars (Baudino & Yun, 2018).

[19] Since 2009 and 2021 values for the US sample are the same, no change between those periods took place.

[20] Examples of accommodative monetary policy measures during this time include the cutting of policy rates implemented by the ECB's Governing Council in June 2014 (ECB, 2015) or the Base Rate cuts in the UK in 2016 following the Brexit vote (Harari, 2017).

5.4. Research Question 4

Table 8 shows the results of the estimation of the short- and long-term effects of each PBV determinant on bank PBV[21]. In the short-term, all of the variables are found to impact PBV except for *ROE* in the European sample. In the long run, *ROE* is found to positively influence bank PBV of both regions (at the 1% level), which attests to PBV as an indicator of franchise value, that is, of banks' ability to generate profits in the future (Demsetz et al., 1996). Also, *NPL to Gross Loans* negatively influences PBV in the long-term but solely in the US. Hence, investors appear to be generally more attentive to short-term changes in each PBV determinant (i.e., alterations within each specific bank) than to long-term changes (i.e., in the banking industry as a whole).

The finding that *NPL to Gross Loans* tends to negatively impact banks' PBV in the long run in the US but not in Europe is particularly puzzling. A higher proportion of NPL in Europe would be expected to cause decreases in future profitability and worsen bank risk in the long run, thus negatively affecting its PBV (as is found to happen in the US). Moreover, given the vast literature advocating that high proportions of NPL are detrimental to the banking industry's stability and recovery in Europe (Bogdanova et al., 2018; Simoens & Vennet, 2021), it would be expected to see investors penalizing banks with lower long-term asset quality with lower valuations. As such, investors ignoring banks' long-term asset quality metrics (*NPL to Gross Loans*) suggests they do not entirely trust the quality of bank reporting in Europe post-GFC.

Huizinga & Laeven (2012) argue that in the aftermath of the GFC, bank managers knowingly undervalued earnings losses and the magnitude of bank assets' deterioration while overstating banks' book value and the amount of existing regulatory capital. Huizinga & Laeven (2012) attribute this event to existing incentives for banks and managers to misreport results, which could only occur due to the regulatory forbearance and the accounting discretion observable at the time. Since then, European regulators have strived for more efficient and clear data reporting to increase the quality of banks' public information (European Banking Federation, n.d.). Some already implemented and future measures to ensure reliable financial reporting include the tackling of weak banking corporate governance (ECB, 2023) and the introduction of changes in bank reporting (Moody's Analytics, 2023) in EU countries, as well as revisions to prudential banking reporting in the UK (Moody's

[21] ROE is included as a PBV determinant for the European sample, see explanation in **Chapter 6** - Robustness Checks for RQ2, last paragraph.

Analytics, 2022). However, despite those efforts, Cos (2022) argues that bank conduct following the onset of the GFC has led to a generalized lack of trust in European banking institutions and subsequent difficulty restoring that trust. Cos (2022) also argues that in the absence of society's trust in the banking industry, all confidence has to be placed in codes and models, which have already been flawed in the past. Additionally, Roth & Jonung (2022) advocate that European citizens' confidence in the regulators themselves (i.e., the ECB) is still considerably below the confidence levels registered before the GFC, mainly due to the poor macroeconomic performance registered in the Euro Area in the post-GFC (Brouwer & Haan, 2022).

These arguments align with other authors who find that a consistently average below-one PBV observed in Europe after the GFC (see **Annex I**) indicates that investors do not completely trust the quality of bank reporting in Europe. Bini & Penman (2013) attribute long periods of lower-than-one PBVs to firms' unwillingness to recognize impairment losses, especially when models determine an asset's recoverable value. Additionally, Acharya et al. (2016) argue that European banks' average below-one PBVs indicate that investors apply large discounts when valuing bank assets, thus questioning the reliability of banks' reported asset quality values. Acharya et al. (2016) also advocate that one of the reasons why European banks' PBVs are so depressed is that these financial institutions have been known to classify assets with a considerable degree of risk as risk-free assets. Hence, investors believe the consequences of a hypothetical adverse economic event are larger than those suggested by routinely conducted stress tests (Acharya et al., 2016).

As such, a vast strand of literature recognizes that European banks' past practices have led to investor distrust over bank reporting, specifically in terms of asset quality. Since the long-term effects of *NPL to Gross Loans* on PBV in Europe are not in conformity with economic reasoning, particularly given that such a phenom is undoubtedly not replicated in the US, this research's results further corroborate that hypothesis. Hence, the dichotomy between the relevance attributed by investors to the amount of NPLs a bank holds in Europe and the US observed in this dissertation is evidence that trust in the European banking industry has not recovered its pre-GFC levels. At the same time, no such problem is posed in the U.S. anymore.

Ultimately, results from **Table 8** strongly support the view that investors do trust (at least partly) in banks' reporting of asset quality variations in the short-term but not on the overall reported level of asset quality metrics (here denoted by *NPL to Gross Loans*), which can

explain why long-term asset quality has no impact on bank PBV in Europe.

Table 8 – PBV determinants' short and long-term impacts on bank PBV

	Baseline Model - Europe		Baseline Model - US	
	Between	Within	Between	Within
	(1)	(2)	(3)	(4)
Total Assets	-0.011	-0.158**		
ROE	6.038***	0.314	4.846***	1.246***
NIM			5.114	17.100***
Equity to Assets			-3.051	-6.588***
Cost to income	-0.070	-0.854***	-0.598	-0.495**
NPL to Gross Loans	-2.324	-1.315***	-7.518***	-5.204***
LLP to NPL	0.200	-0.128***		
Observations	949		1183	
R2 (overall)	0.6806		0.4551	
R2 (between)	0.7134		0.3871	
R2 (within)	0.2839		0.4892	
Between effects	23.99***		46.22***	

Notes: ***, ** and * indicate significance at 1%, 5% and 10%, respectively. Between and within parameters denote long and short-term effects on bank PBV, respectively. Columns (1) and (2) correspond to the European sample whereas (3) and (4) correspond to the US one. Results from the joint significance test support the inclusion of the Between parameters in the model.

6. Robustness Checks

The following section focuses on documenting a series of complementary analyses supporting the previous findings.

6.1. Research Question 2 – Sensitivity Analysis and Profitability Measures' Disentanglement

Firstly, a sensitivity analysis is conducted, where interaction terms (dummy variables, denoted as Z) are introduced in the baseline model, separating the factors' impacts in European and US samples on bank PBV. Secondly, the Simoens & Vennet (2021) approach is utilized, where *ROE* is disentangled from the other profitability measures (*NIM, II to NII* and *Cost to Income*). Hence, the baseline regression is calculated twice, once with *ROE* and no other profitability measures and once with the opposite scenario. **Table 9** shows the results of these robustness checks.

Results from column (2) broadly support the findings from RQ2 once the sample is divided into European and US banks. Bank size is found to negatively impact both European and US banks' PBV[22]. At the same time, the effect of *ROE* in the US sample positively and significantly differs (at the 10% level) from its effect in the European one[23]. The most surprising result of this sensitivity analysis is *NIM*, whose effect on PBV is not significantly different between the samples. As expected from RQ2, results indicate that the negative effect of decreased leverage is non-significant in the European sample, which largely differs (at the 1% level) from the penalization that US banks´ PBV suffers from when their debt ratios decrease. Provisioning levels are confirmed to impact the PBV of European banks but not of US ones since they produce a nearly opposite effect to that registered in Europe (effects are significant at the 1% level in either case). *Growth* is confirmed to produce a positive impact on the PBVs of European banks[22], and even though that effect is nearly opposite in the US, *Growth* is found not to differ from the effect registered in Europe significantly. *GDP*'s and *Policy Rate*'s additional impact on PBV in the US sample is found not to significantly differ from that in the European sample, confirming that *GDP* and *Policy Rate* significantly (positively and negatively, respectively) affect bank PBV across both regions. Also, although the impact of *Yield Spread* is proved not to be significant in Europe,

[22] Although this factor is not a PBV determinant for the US/European sample across both models employed in RQ2, it was deemed as such by the bank-fixed effects model which this sensitivity analysis relies upon.
[23] Which is consistent with the models where profitability components are non-disentangled.

its effect in the US positively and significantly (at the 1% level) differs from those seen in the European sample, confirming the findings of RQ2.

Table 9- Sensitivity Analysis and profitability measures' disentanglement

			Europe	
	Baseline Model (1)	Sensitivity Analysis (2)	ROE, no profitability measures (3)	Profitability measures, no ROE (4)
Total Assets	-0.118**	-0.221**	-0.241**	-0.220**
Total Assets *Z		0.019		
ROE	1.029***	0.365	0.862***	
ROE*Z		0.666*		
NIM	6.466**	6.455		6.803
NIM*Z		8.309		
Equity to Assets	-1.956*	-0.730	0.203	-0.671
Equity to Assets*Z		-6.791***		
Cost to Income	-0.723***	-0.885***		-0.955***
Cost to Income*Z		0.250		
Reserves to Assets	-0.292	-0.395	-0.483	-0.379
Reserves to Assets*Z		2.339		
Tier 1 ratio	-0.108	0.534	0.612	0.532
Tier 1 ratio*Z		0.539		
NPL to Gross Loans	-1.471***	-0.969***	-0.876**	-1.145***
NPL to Gross Loans*Z		-5.780***		
LLP to NPL	0.025	-0.141***	-0.150***	-0.147***
LLP to NPL*Z		0.152***		
Deposits to Assets	0.363	-0.196	-0.446	-0.172
Deposits to Assets*Z		-0.516		
Loans to Assets	0.258	0.019	0.312	0.017
Loans to Assets*Z		0.303		
II to NII	-0.005	-0.000		-0.001
II to NII*Z		-0.004		
Growth	1.601	3.151*		3.151*
Growth*Z		-3.341		
Dividend Payout Ratio	-0.012	0.011	0.007	0.017
Dividend Payout Ratio*Z		-0.051		
Distance to Default	-0.002*	-0.001	-0.001	-0.001
Distance to Default*Z		0.002		
GDP	1.855***	1.228***	0.985***	1.247***
GDP *Z		0.781		
Policy Rate	-2.475	-6.396**	-6.222**	-5.926**
Policy Rate*Z		2.165		
Yield Spread	9.949***	-1.672	-2.264	-1.856
Yield Spread*Z		22.658***		
N		2132	949	949
adj. R^2		0.812	0.851	0.859

Notes: ***, ** and * indicate significance at 1%, 5% and 10%, respectively. Column (1) shows the Baseline Model of RQ2 for the full sample. A sensitivity analysis is presented in column (2), where interaction terms (Z, representative of dummy variables with value 1 if the bank's headquarters is in the US) are introduced in the Baseline Model. The same procedure as employed in the Baseline Model of RQ2 in terms of *Growth* and *ROE* is adopted in column (2). The disentanglement of *ROE* from the other profitability measures is shown in (3) and (4) for the European sample.

Lastly, the amount of NPL is established to negatively affect European banks' PBV and even more so in the US (with both effects being significant at the 1% level). This result is of major importance as it helps to clarify the impact of NPL on the PBV gap between European and US banks. As seen in RQ3, the magnitude of the (negative) NPL *% Change* from 2009 to 2021 was larger in the US, yet results were significant at the 1% level in both regions. Thus, although results indicated the possibility of better NPL tackling in the US leading to the widening of the PBV gap, that hypothesis could not be confirmed. However, as seen in the sensitivity analysis, bank valuation is more dependent on asset quality in the US than in Europe. This result is unsurprising given that *NPL to Gross Loans* produced short- and long-term effects on bank PBV in the U.S. and solely a short-term impact on European banks' PBVs in RQ4. As such, and since those short and long-term effects are not analyzed separately in this model, the global impact of *NPL to Gross Loans* on bank valuation is felt more strongly in the US. Hence, even if the NPL *% Change* was the same in the two regions, reducing NPL would have produced a larger impact on bank PBV in the US than in Europe. Therefore, NPL contributed to widening the PBV gap between European and US banks between 2009 and 2021.

Columns (3) and (4) show the profitability components disentanglement in the European sample. As seen in column (3) and similarly to Simoens & Vennet (2021), *ROE* is found to positively affect European banks' PBV (at the 1% level) once other profitability components are not controlled for and will thus be considered as a PBV determinant in the European sample in subsequent analyses[24]. However, *NIM* and *II to NII* remain non-determinants of bank PBV even when *ROE* is not controlled for, while *Cost to Income* is deemed significant in both models (see column (4)).

6.2. Research Question 3 - Expanding-Windows Approach

In RQ3, the determinants of the PBV gap were determined based on the 2009-2021 period. While some factors were considered as gap determinants for that period, an interesting addition to this study is to analyze if and how each factor affected bank PBV in different years using an expanding window-like approach[25]. The line representing the

[24] Given that *ROE* was significant at the 11% level in the entangled baseline scenario and at least significant at the 10% level in all other models, evidence seems to support this decision.

[25] The expanding-windows method is preferred to the rolling-windows approach in this instance since 2009 has to remain part of the analysis as the year in which banks' average PBV did not differ between European and US entities.

European subsample in the *NPL to Gross Loans* graph (see **Annex J**) clearly elucidates the rationale behind this idea. While the proportion of NPLs decreased consistently from 2015 onwards (with the ratio even becoming lower than that of 2009 in 2021), it kept steadily increasing before that year. Hence, an increased *NPL to Gross Loans* ratio in the European sample might have enhanced the PBV gap even further in previous years.

Table 10 and **Table 11** show the *% Change* of each variable between 2009 and the year indicated in the column header for Europe and the US, respectively[26]. Results indicate that, similarly to what had been established during RQ3, the *Total Assets'* mean value in 2009 did not differ significantly from its mean value in any other year of the sample in Europe. Hence, while a bank's size seems to influence its PBV, it cannot explain the PBV gap in any of the years.

In the US, after hitting century lows during the recession of 2008-2009, *ROE* immediately started to recuperate its pre-GFC levels in the following years (FRED, n.d.). Thus, as expected, *ROE*'s *% Change* is positive and significant at the 1% level from 2010 to 2020. In Europe, *ROE* (found to be a PBV determinant after disentangling it from other profitability indicators) has significantly (at the 1% level) contributed to widening the gap in 2020, hinting towards a profitability decrease as the major factor in explaining why the lowest PBV figure in the European sample was registered in 2020. In the US, the *NIM* increased at the 5% significance level in the early years of the sample. This is because interest rates have been found to have a negative relationship with the *NIM* over intervals of one or two years in the US (Wheelock, 2016), as they had during the 2008-2009 recession (Wheelock, 2016). However, in 2020, the *NIM* had become significantly lower (at the 5% significance level) than its 2009 mean value due to the covid-19 pandemic, which is argued to have negatively affected banks' *NIM* (Shabir, 2023).

Unlike what was seen in RQ3, the behavior of the *Equity to Assets* ratio seems to contribute to the reduction of the PBV gap ever since 2011, and more prominently in most recent years (when considering its negative impact on US banks' PBV and the ratio's growth when compared to the base case scenario of 2009). The rapid shift in banks' debt levels may be attributed to the new regulations introduced following the GFC. The Dodd-Frank Act Regulatory Guide was implemented in 2010 in the US and encouraged banks to decrease their leverage (Barr, 2012) by setting minimum leverage ratios of 4% for financial institutions

[26] t-tests could not be conducted for GDP, Policy Rate and Yield Spread in the US sample once again.

(Moody's Analytics, n.d.). This meant these financial institutions were forced to hold a higher proportion of regulatory capital to total assets than before[27]. As seen in the results table, the introduction of the Act coincides with a decrease in bank leverage and is thus a plausible explanation for this event. Also, differences between these results and those from RQ3 suggest that banks had to increase their leverage levels as a response to the pandemic.

The evolution of *Cost to Income* between European and US banks is somewhat similar in the sense that its variation only becomes significant from 2017 onwards (initially at the 10% significance level in both regions and later at the 5% level in Europe and 1% level in the US). However, *Cost to Income* increased in Europe and decreased in the US from 2017 onwards compared to 2009's values. Results confirm that cost efficiency has been continuously decreasing in Europe since 2010 (ECB, 2018). Thus, cost efficiency has steadily deteriorated in Europe over the years while also constantly improving in the US (apart from 2020), driving the PBV gap further apart.

As expected, and unlike the results from RQ3, the *NPL to Gross Loans* ratio varied positively and significantly (at the 5% level, with the base year being 2009) from 2012 to 2015 in Europe. This ratio continuously increased from 2010 until 2014, and only then did it gradually decrease. Even so, in no year other than 2021 did the NPL to Gross Loans ratio decrease compared to its 2009 mean value. This result somewhat falls in line with Simoens & Vennet (2021), who argued that this ratio's impact had actually contributed to widening the gap and called for regulators to act on the matter. In the US, the impact of *NPL to Gross Loans* remained consistent during the years in analysis. This ratio started to decrease in 2011, and its negative difference in means[28] became significant at the 1% level from 2012 onwards. Therefore, while *NPL to Gross Loans* negatively affected European banks' PBV from 2012 to 2015, its consistent decrease in the US contributed to enhancing the PBV of US banks across the period, thus widening the PBV gap to European banks. In any case, the decrease in NPL cannot be dissociated from the measures implemented by the policymakers of the two regions, as described in RQ3.

In Europe, *LLP to NPL* revealed itself as a PBV gap determinant in 2012 since its variation in that year, compared to 2009, was significant at the 10% level. Given the negative impact on PBV described in RQ2, the *LLP to NPL* decrease in 2012 is expected to have contributed to reducing the gap that year. This is most likely because, during the financial

[27] Which, *ceteris paribus*, should contribute to a decrease in the proportion of debt to assets.
[28] Difference in means calculated as: 2009's variable mean value – other year's variable mean value.

Table 10 - PBV determinants' % Change in Europe from 2010-2020

	% Change - Europe										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Assets	0,09	-0,36	0,04	0,52	-0,17	-0,87	-0,74	0,96	0,95	1,34	2,79
ROE	16,53	-27,51	-28,41	-23,98	-13,34	-2,76	-8,79	7,40	21,28	11,53	-49,86***
Cost to Income	-1,08	3,08	4,04	2,95	1,39	3,89	4,01	4,69*	5,25*	7,57**	8,91**
NPL to Gross Loans	13,35	20,72	39,64**	49,99**	53,77**	44,42**	35,35	32,30	11,82	-2,12	-14,11
LLP to NPL	0,34	-6,17	-10,39*	-7,62	-6,32	-3,87	-3,62	-6,26	-4,33	-7,77	4,65
GDP	1,86***	3,43***	3,29***	3,68***	5,83***	9,03***	11,25***	14,74***	18,04***	20,62***	14,46***
Policy Rate	1,44	5,83	-11,36	-48,93***	-69,92***	-83,48***	-87,18***	-87,06***	-83,39***	-80,66***	-101,00***

Table 11 - PBV determinants' % Change in the US from 2010-2020

	% Change - US										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ROE	507,50***	779,74***	919,03***	973,30***	910,87***	942,97***	938,40***	887,36***	1 189,08***	1117,91***	762,58***
NIM	7,44**	7,73**	5,46	1,87	0,81	-2,12	-2,14	-0,10	3,50	1,41	- 8,11**
Equity to Assets	2,29	5,80*	7,22**	7,17**	8,44**	8,98***	8,81***	13,12***	16,26***	19,09***	8,07***
Cost to Income	-1,36	0,17	1,01	1,44	0,53	-0,27	-3,40	-4,80*	-7,97***	-7,83***	-8,25***
NPL to Gross Loans	0,12	-13,58	-35,45***	-54,59***	-67,50***	-72,87***	-74,31***	-76,35***	-80,04***	-80,11***	-76,22***
GDP	2,71	4,30	6,68	8,64	11,13	14,14	16,04	18,64	22,14	21,48	28,70
Policy Rate	0	0	0	0	0	200,00	400,00	1000,00	1 800,00	1200,00	0
Yield Spread	-24,50	-86,64	0,67	137,19	263,70	265,48	395,55	342,54	444,54	367,04	231,18

Notes: ***, ** and * indicate significance at 1%, 5% and 10%, respectively, based on underlying two-sample t-tests. The tables show the *% Change* of each variable between 2009 and the year indicated in the column header for the PBV determinants of each region.

crisis, pressure from regulators and the market led banks to strengthen their provisioning levels abruptly (ECB, 2014), returning to lower NPL coverage ratios in the GFC aftermath. Although only significant in 2012, the *LLP to NPL* ratio was below 2009's value in all years apart from 2010 and 2020.

In terms of the macro variables, results from **Table 11** strongly indicate that these factors contribute to explaining the PBV gap, as those factors' mean variability is very considerable in most years. However, as in RQ3, they cannot be undoubtedly labelled as such. In the European subsample, *GDP*'s positive *% Change* is significant at the 1% level for all years in analysis, which is unsurprising given that the GFC sparked the worst recession in 2008-2009 in the EU since the Great Depression (Piroli, 2015). The *Policy Rate* decreased significantly (at the 1% level) from 2013 onwards due to European countries' accommodative monetary policies, which sought to incentivize economic risk-taking[29] as a response to the GFC (ECB, 2015).

Hence, the PBV gap has been determined by different factors in different years and apart from the macroeconomic variables in the US sample (whose impact on US banks' PBV could not be tested), only bank size is found not to have interfered in the expansion or shrinking of the gap in any year in the analysis. *ROE*'s decrease in Europe and constant increase in the US compared to 2009 values highlights profitability's role in the origination of the PBV gap, as does the evolution of cost efficiency across the two regions. Decreased leverage in the US has prevented the PBV gap from increasing further in most years analyzed, as has decreased provisioning in Europe in 2012. The NIM and NPLs are found to have contributed to widening the PBV gap early on in the period (in the US and Europe, respectively), only to gradually decrease over time and to contribute to its reduction when compared to those initial years. Conclusions over the effects of macroeconomic variables remain shrouded in uncertainty due to the inability to test the significance of US variables' evolution over time. Nevertheless, results suggest that a more favorable economic outlook in the US has contributed to pulling the PBV further apart in most years of the 2010-2021.

6.3. Research Question 4 – Separate Within and Between Estimations

Table 12 shows the robustness checks for RQ4. In the European sample, *ROE* is found

[29] Examples of accommodative monetary policy measures during this time include the cutting of policy rates implemented by the ECB's Governing Council in June 2014 (ECB, 2015) or the Base Rate cuts in the UK in 2016 following the Brexit vote (Harari, 2017).

to be a short-term determinant of bank PBV at the 10% significance level. Other than that, despite a few changes in the significance levels of *NPL to Gross Loans* and *Total Assets*, results remain robust. In the US sample, *Cost to Income* is found to affect bank PBV in the long run at the 5% significance level, and its short-term impact only becomes significant at the 10% level. In general, these robustness checks confirm the overall results obtained previously. Also, the higher R^2 of the baseline models compared to those used in the robustness checks confirm them as the superior models.

Table 12 - Separate Within and Between Estimations

	Europe		US	
	Between estimator (1)	Within estimator (2)	Between estimator (3)	Within estimator (4)
Total Assets	-0.008	-0.217***		
ROE	6.377***	0.449*	5.186***	1.623***
NIM			5.108	-0.362*
Equity to Assets			-2.816	-9.606***
Cost to income	0.104	-0.950***	-0.581	15.696***
NPL to Gross Loans	0.079	-0.697**	-8.096***	-5.285***
LLP to NPL	0.209	-0.143***		
Observations	949	949	1183	1183
R2 (overall)	0.2691	0.0243	0.2551	0.1189
R2 (between)	0.3062	0.0288	0.4008	0.0027
R2 (within)	0.0000	0.1567	0.0000	0.2791

Notes: Standard errors are in parentheses. ***, ** and * indicate significance at 1%, 5% and 10%, respectively. In columns (1) and (3), the RQ4 Baseline Model is re-estimated using the between estimators for the European and US samples, respectively. In columns (2) and (4), the RQ4 Baseline Model is re-estimated using the within estimators for the European and US samples, respectively.

7. Conclusions and Limitations & Future Research

The main conclusions, study limitations and future research suggestions are presented in this section.

7.1. Conclusions

This dissertation focuses on studying the PBV gap, particularly the factors that justify its appearance in the post-GFC. To do so, the effects of several factors on European and US banks' PBV are first analyzed and then untwined into short and long-term effects. To perform this research, a sample comprised of 216 listed banks (including 116 European banks and 100 US ones) and several panel data models were employed.

A PBV gap between US and European banks is found for both the 2008-2021 period as a whole and in all separate years in analysis apart from 2009. Results thus align with a vast literature (ECB, 2019; Simoens & Vennet, 2021) which documents that the average US bank's PBV has been superior to that of European banks during and after the GFC.

Results from the implementation of several fixed effects models on the European sample suggest that increases in numerous bank-specific and macroeconomic factors such as profitability, cost efficiency and economic growth positively affect bank PBV. In contrast, increases in size, the amount of NPLs, provisioning levels and a country's policy rate are found to impact bank PBV negatively. In the US, evidence is found that increases in profitability, cost efficiency, economic growth and the government bond yield spread between the US and Germany positively affect bank PBV, whereas increases in bank equity, the quantity of NPLs and US' policy rate negatively impact bank PBV. As such, each of these factors is found to be a PBV determinant in the post-GFC for either European banks, US banks or both.

From these, only size is found not to contribute to explaining the difference between European and US banks' PBV in any of the years of the period analysed. Due to methodology limitations, the impact of US macroeconomic variables on US banks' PBV could not be determined with certainty. Yet, results from the baseline model and robustness checks in RQ3 strongly hint towards the government bond yield spread between the US and Germany (and, therefore, towards differences in investors' perspectives of the future economic outlook of the US and Europe) being a PBV gap determinant. Decreased leverage in the US and decreased provisioning in Europe have prevented PBV differences across banks of the two regions from becoming even larger in at least one of the years in the post-

GFC. Results also demonstrate that profitability, cost efficiency and the amount of NPLs are the crucial factors which justify the emergence of a PBV gap. In the US, a strong positive variation in ROE in most years analysed appears to have more than offset a few years where the NIM variation was negative (although it exhibited a positive variation in a few years analysed as well). From 2017 onwards, cost efficiency steadily decreased in Europe and improved in the US. Opposite variation in the amount of NPLs was registered almost throughout the entirety of the 2010-2021 period, with positive variations in Europe and negative variations in the US strongly cementing the proportion of NPLs to gross loans as the key factor when explaining the PBV gap. However, the continuous addressing of this issue in Europe led to the first significant decrease in this ratio compared to 2009 levels in 2021.

Furthermore, the amount of NPLs is the only PBV determinant which, despite producing common effects on PBVs of US and European banks (as PBVs of banks from both regions are impacted negatively with increased NPLs), has a stronger influence in one of the regions (namely in the US). This stronger overall impact is symptomatic of the lack of interest investors attribute to increased asset quality in the long run in Europe, as opposed to what happens in the US. This result does not follow economic reasoning and is interpreted as evidence that investors find European banks reporting devoid of meaning, particularly regarding asset quality information. Existing literature (Bini & Penman, 2013; Acharya et al., 2016) supports this argument and names it as the main cause for the average below-one bank PBV in Europe. Additionally, investors are found to generically attribute more importance to short-term changes in PBV determinants' values than to their long-term variations.

This dissertation is the first to study the determinants of the PBV gap on a year-to-year basis and to analyze the short and long-term effects of PBV determinants on bank valuation. As such, it offers both regulators and bank managers evidence of what key metrics need to be closely monitored and addressed to reduce the existing PBV gap between European and US banks. Additionally, it provides conclusive evidence that investors' trust in the European banking sector has degraded following the GFC, particularly in terms of bank reporting and bank asset quality. This study thus stresses the need to restore trust to reinstate above-one bank PBVs in Europe.

7.2. Limitations & Future Research

The sample used in this dissertation was comprised of US and European banks, which follow different accounting standards - the GAAP and the IFRS, respectively. This causes discrepancies in the book value of equity measurement to arise, which most likely produces an unbalanced impact on the PBV of the banks of the two regions. The contents of this study could be revisited at a future moment if there is a convergence in the accounting standards used in both regions.

While the response to RQ1 does assert that there was a PBV gap in the 2008-2021 period, the existence of a gap before that period could not be tested in this dissertation since data on some of the variables (and particularly on the dependent variable, PBV) was only available from 2008 onwards in Bank Focus. Consequently, the premise that the PBV gap was developed or at least widened from 2008 onwards is solely supported by the existing literature and not tested out in this dissertation.

Also, this dissertation could not study the impact of stock market movements since banks' information publication dates vary from firm to firm. Simoens & Vennet (2021) mitigate this problem by modelling each company's PBV as the market value of equity as of 31st March to match them with Stock Market data gathered at the end of each year's first quarter. However, this could lead to errors when measuring the impact of the other bank-specific variables on PBV since market noise may affect the PBV between the moment information becomes public and 31st March. Hence, the impact of the stock market was scrapped from this dissertation altogether.

When conducting the equality of means tests for the PBV determinants in RQ3, the sample was divided into US and European banks to perceive how each factor evolved. However, in the US sample, macroeconomic factors were common to all companies in any given year. Consequently, the standard deviations required to conduct a two-sample t-test could not be generated for either year, making the test unfeasible. Therefore, while the contribution of the macroeconomic factors on the PBV gap in the European sample could be studied statistically, that of the US sample could not. Future research may center on developing a different approach to test out the impact of the US macroeconomic variables on the PBV gap.

Future research may also focus on assessing whether some of the variables regarded as inconclusive when estimating their impact on PBV can be classified as determinants of the PBV gap between European and US banks. For is dissertation, only independent variables

whose impact on PBV remained robust across both models in RQ2 were considered PBV determinants. However, different authors have used various models to assess the validity of several PBV determinants: Jordan et al. (2011) and Calomiris & Nissim (2014) compute their regressions with time-fixed effects, Simoens & Vennet (2021) employ bank-fixed effects, and Bogdanova et al. (2018) opt for using no fixed effects whatsoever on their baseline model, solely adding them as robustness checks (namely time FE, country FE and country and time FE). Consequently, according to each researcher's objective and interpretation of the models, different options can be employed. Researchers who deem the country and time FE model as an adequate one when the sample is comprised of banks from different countries across a multitude of years may attempt to determine whether *Deposits to Assets*, *Loans to Assets*, *Reserves to Assets*, *Tier 1 Ratio* and *Dividend Payout Ratio* are indeed partly responsible for explaining the PBV gap[30].

[30] And, additionally, if *NIM* and *Equity to Assets* have contributed to expand or shrink the gap in the European sample. Oppositely, it could also be tested whether *Total Assets* and *Growth* help to explain the gap based on their impact on the US and European samples, respectively, if the bank fixed effect model is preferred.

8. Appendices

8.1. Appendix 1 – Pooled OLS, FE and RE models

The Pooled OLS, FE and RE models derive from the following baseline equation (Clark & Linzer, 2015):

$$y_i = \alpha_{j[i]} + \beta x_i + \varepsilon_i; \quad \varepsilon_i \sim N(0, \sigma_y^2) \tag{8.1.1}$$

where i corresponds to each entity, the impact of x_i on y_i is captured by the β, which is the same within each j unit (where a unit consists of the grouping of the entities). Even by clustering the entities into units, some variation of y can be left unexplained, and so a unit effect α_j is added to allow adjustments to y to be made (Clark & Linzer, 2015).

The pooled model can be represented through the following expression:

$$y_i = \alpha + \beta x_i + \varepsilon_i; \quad \varepsilon_i \sim N(0, \sigma_y^2) \tag{8.1.2}$$

The notable difference from the baseline model is that a unit effect is no longer included. This causes the estimated β to be biased whenever α_j is correlated with x (Clark & Linzer, 2015). As that tends to happen in most instances, the pooled OLS model will often lead to incorrect statistical inferences (Clark & Linzer, 2015). While the pooled OLS definition is straightforward, Gelman (2005) finds that the FE and RE models' definitions vary from author to author and are often conflicting. Clark & Linzer (2015) find the same issue and offer a reconciling approach by discussing each model as they are most commonly used in literature. According to the authors, the FE model can be expressed as follows:

$$y_i = \sum_{j=1}^{J} \alpha_j z_{j[i]} + \beta x_i + \varepsilon_i; \quad \varepsilon_i \sim N(0, \sigma_y^2) \tag{8.1.3}$$

In this case, and unlike what happens in the pooled OLS model, the unit effect $\alpha_j$is introduced in the model. However, a new set of variables z_j are also introduced for each unit, with $z_{j[i]} = 1$ if entity i belongs to group j and $z_{j[i]} = 0$ otherwise. Essentially, these $z_{j[i]}$ variables correspond to dummy variables, whose inclusion allows for a certain subgroup to be represented within the equation. In the RE model, however, the intercepts α_j no longer consist of the dummy variables attributed to each group and instead follow a probability distribution function, which is usually a normal distribution function (with mean μ_α and

variance σ_α^2) that expresses how much the intercepts α_j vary around their mean (Clark & Linzer, 2015). The following expression characterizes a RE model:

$$y_i = \alpha_{j[i]} + \beta x_i + \varepsilon_i; \quad \alpha_j \sim N(\mu_\alpha, \sigma_\alpha^2); \quad \varepsilon_i \sim N(0, \sigma_y^2) \tag{8.1.4}$$

The RE model is, in a sense, a combined version of the FE and the pooled models since it allows for partial pooling in units to take place while at the same time retaining a specific intercept for each group (Clark & Linzer, 2015). Its resemblance to the pooled model makes it that, in some instances, group intercepts will be closer to the distribution's mean, μ_α, then they would be otherwise (Clark & Linzer, 2015). This leads to one of the most striking differences between the FE and the RE models: the usual caveats of the estimators they provide. In fact, the FE model will typically provide less unbiased estimators than the RE model. Still, its standard errors tend to be larger than the RE model's, leading to lesser efficiency and stability (Clark & Linzer, 2015). Another difference between the two models is the assumption of correlation between individual-specific effects and the independent variables. While the RE model assumes uncorrelation between them, the FE model does not (Baltagi, 2014).

8.2. Appendix 2 – Model Derivation in Research Question 4

This section follows the procedure adopted by Afonso et al. (2011). Taking their initial model as a starting point:

$$Y_{it} = \beta X_{it} + \lambda Z_i + \alpha_i \tag{8.2.1}$$

where Y_{it} corresponds to the PBV of bank i for year t, X_{it} and Z_i are matrixes of the time-varying and time-invariant independent variables and α_i corresponds to the bank-specific error. To mitigate correlation concerns, the bank-specific error is modelled as the linear combination of the independent variables' mean value over the analyzed period through the Mundlak estimator (Mundlak, 1978):

$$E(\alpha_i | X_{it}, Z_i) = \eta \bar{X}_i \tag{8.2.2}$$

Since now $\alpha_i = \eta \bar{X}_i + \varepsilon_i$ (where the new error-term ε_i is now uncorrelated with the independent variables), the initial model can be written as:

$$Y_{it} = \beta X_{it} + \lambda Z_i + \eta \bar{X}_i + \varepsilon_i \quad (8.2.3)$$

Which, in turn, can be rearranged to form the following equation:

$$Y_{it} = \beta(X_{it} - \bar{X}_i) + (\eta + \beta)\bar{X}_i + \lambda Z_i + \varepsilon_{it} \quad (8.2.4)$$

$(\eta + \beta)$ can be replaced by a single coefficient, γ, which is representative of the effects of the independent variables on PBV in the long run. In the model employed in this dissertation, the only time-invariant variables are the dummy variables introduced to control for macro variables at the country level, and so λZ_i is replaced by φ_j. Time-fixed effects (δ_t) are also included to control for those same macro variables, as their variation from year to year would otherwise affect the results. Therefore, the final model is as follows:

$$Y_{it} = \gamma \bar{X}_i + \beta(X_{it} - \bar{X}_i) + \varphi_j + \delta_t + \varepsilon_{it} \quad (8.2.5)$$

8.3. Appendix 3 – Data Treatment Process Required for Research Question 4

It is important to note that to implement the model used in RQ4, data on banks with missing values in at least one variable for a given year had to be previously wiped out from the sample in that year (Schunck, 2013). Otherwise the demeaned variables would be generated taking into consideration observations that would not be incorporated into the regressions (as rows of data with missing values are not included in the model estimation). Hence, even though the panel was initially unbalanced, this procedure turns it into a balanced panel.

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Annexes

Annex A - Wooldridge test for autocorrelation in panel data and Modified Wald test for groupwise heteroskedasticity in fixed effect regression model, respectively

Null Hypothesis	H0: no first-order autocorrelation	H0: no groupwise heteroskedasticity
Test statistic	36.953	3.0e+30
p-value	0.0000	0.0000

Annex B – Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) PBV	1.00																		
(2) Total Assets	-0.2	1.00																	
(3) ROE	0.42	-0.1	1.00																
(4) NIM	0.29	-0.4	0.13	1.00															
(5) Equity to Assets	0.20	-0.4	0.12	0.59	1.00														
(6) Cost to Income	-0.2	0.15	-0.4	-0.2	-0.1	1.00													
(7) Reserves to assets	-0.0	0.18	-0.0	-0.2	-0.2	0.18	1.00												
(8) Tier 1 Ratio	0.11	-0.0	0.11	-0.2	0.07	-0.0	0.35	1.00											
(9) NPL to Gross Loans	-0.2	0.14	-0.2	-0.0	-0.1	0.06	0.21	-0.0	1.00										
(10) LLP to NPL	0.23	-0.1	0.14	0.26	0.28	-0.1	-0.1	-0.0	-0.2	1.00									
(11) Deposits to Assets	0.36	-0.5	0.13	0.55	0.48	-0.1	-0.1	-0.1	-0.2	0.33	1.00								
(12) Loans to Assets	-0.0	-0.4	-0.0	0.32	0.18	-0.3	-0.2	-0.2	-0.0	0.01	0.29	1.00							
(13) II to NII	0.01	-0.1	-0.0	0.20	0.05	-0.2	-0.2	-0.1	-0.0	0.16	0.06	0.32	1.00						
(14) Growth	0.09	-0.0	0.42	0.05	0.09	-0.1	-0.0	0.05	-0.0	0.06	0.09	-0.0	-0.0	1.00					
(15) Dividend Payout Ratio	0.11	-0.0	0.15	-0.0	0.00	-0.0	0.03	0.04	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	1.00				
(16) Distance to Default	0.09	-0.1	0.13	-0.1	0.15	-0.1	0.05	0.22	-0.2	0.16	0.14	0.09	-0.0	0.03	0.09	1.00			
(17) GDP	0.15	-0.0	0.22	0.06	0.16	-0.0	0.02	0.09	-0.1	0.09	0.18	-0.0	-0.0	0.22	0.03	0.11	1.00		
(18) Policy Rate	0.10	-0.0	0.16	0.26	0.19	-0.1	-0.1	-0.2	0.01	0.05	0.02	0.11	0.12	-0.0	-0.0	-0.1	0.08	1.00	
(20) Yield Spread	0.17	-0.0	0.13	0.26	0.22	-0.1	-0.1	-0.1	0.28	0.14	0.13	0.11	0.07	0.05	-0.0	-0.1	0.03	0.54	1.00

Annex C – Geographical bank distribution in Europe

Country	# Banks	Country	# Banks	Country	# Banks
Austria	6	Greece	4	Portugal	1
Belgium	1	Hungary	1	Romania	2
Croatia	1	Iceland	1	Slovakia	1
Cyprus	1	Ireland	4	Slovenia	1
Czech Republic	2	Italy	13	Spain	6
Denmark	3	Malta	1	Sweden	3
Finland	2	Netherlands	3	Switzerland	13
France	17	Norway	6	UK	9
Germany	4	Poland	10	**Total**	**116**

Annex D - Expected variable impact and data source

Variable Name	Expected Impact	Source
PBV		BankFocus and Refinitiv Workspace
Total Assets	-/+	BankFocus
ROE	+	BankFocus
NIM	+	BankFocus
Equity to Assets	-/+	BankFocus
Cost to Income	-	BankFocus
Reserves to Assets	-/+	BankFocus
Tier 1 Ratio	+	BankFocus and Bankscope
NPL to Gross Loans	-	BankFocus and Bankscope
LLP to NPL	+	BankFocus and Bankscope
Deposits to Assets	-	BankFocus
Loans to Assets	-	BankFocus
II to NII	-	BankFocus
Growth	+	BankFocus
Dividend Payout Ratio	+	BankFocus and Refinitiv Workspace
Distance to Default	+	Own Calculations*
GDP	+	World Bank
Policy Rate	+	BIS
Yield Spread	-	Refinitiv Workspace

Note: * Based on data collected from BankFocus.

Annex E - Policy Rates as determined by BIS for the 2008-2021 period[31].

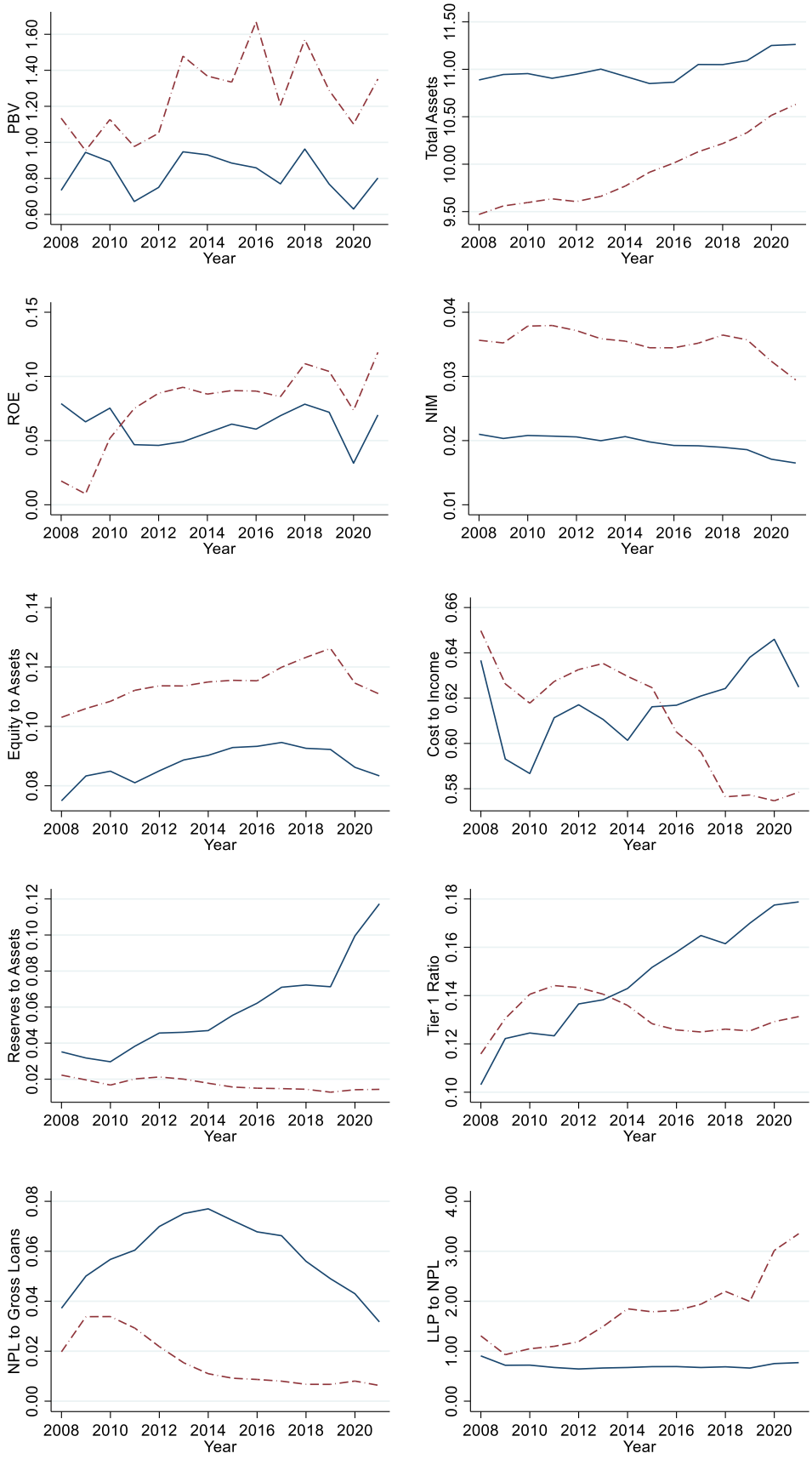
Croatia	Interest rate on money market interbank deposits
Czech Republic	Official 2-week repo rate
Denmark	Certificates of deposits interest rate
Euro Area	Official central bank liquidity providing, main refinancing operations, fixed rate
Hungary	Official base rate
Iceland	7-day collateralized lending rate (2008); average of the current account rate and the maximum rate on 28-day certificates of deposit (2009-2013); central bank term deposit rate (2014-2021);
Norway	Official deposit facility rate
Poland	Official 7-day central bank bill yield
Romania	Official policy rate
Sweden	Central bank fixed repo/reversed repo rate
Switzerland	Mid-point of the SNB target range (2008-2018); SNB policy rate (2019-2021)
UK	Official bank rate
US	Mid-point of the Federal Reserve target rate

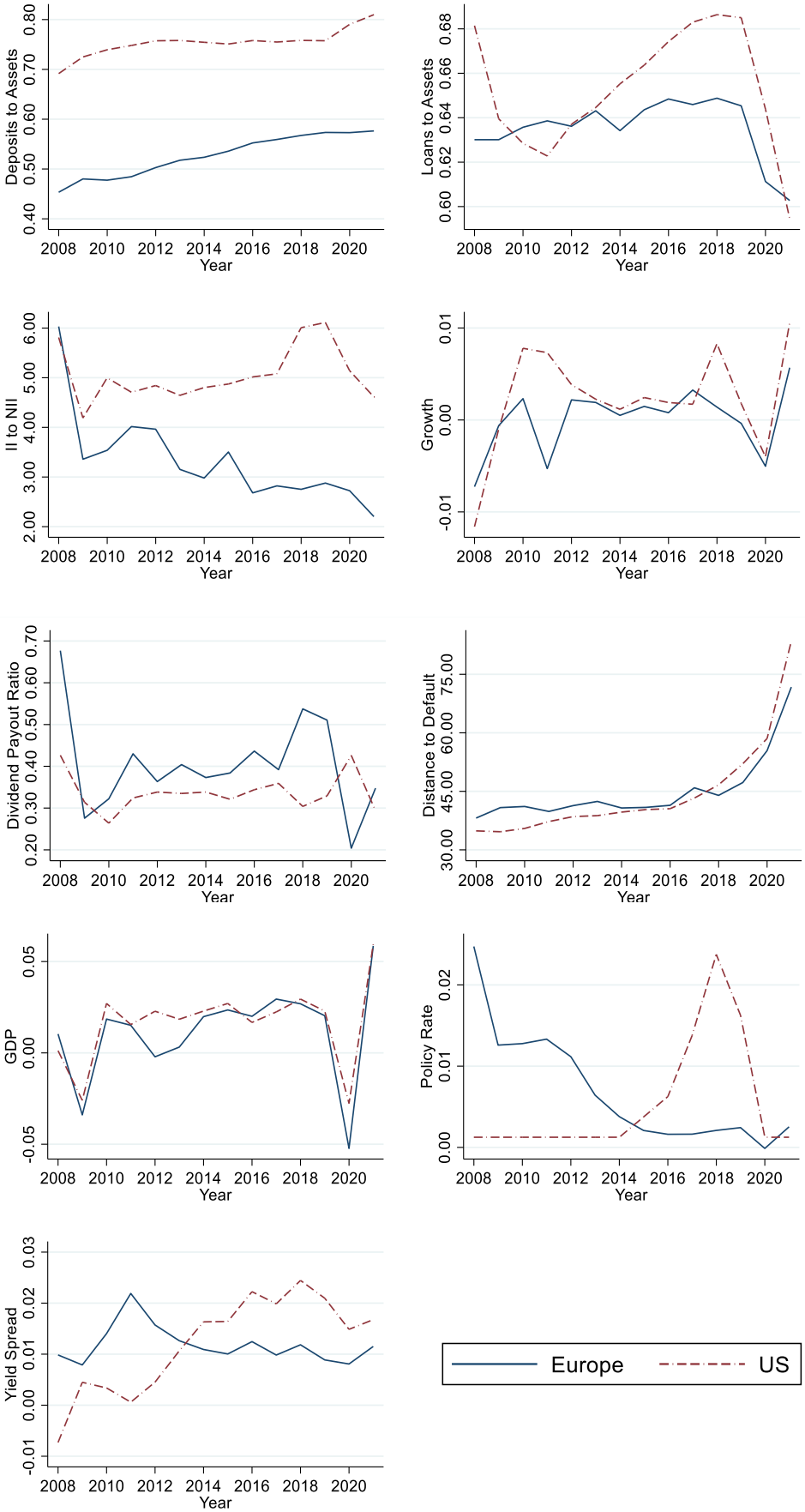
[31] Available at: https://www.bis.org/statistics/cbpol/cbpol_doc.pdf

Annex F – Variable Specification Summary

Variable Name	Variable Type	Variable Category	Measures
PBV	Dependent variable	Performance Indicator	Market value of equity / Book value of equity
Total Assets	Independent Variables (Bank-related Variables)	Size	Natural logarithm of Assets
ROE		Profitability	Net Income/Total Equity
Net Interest Margin			(Interest Income-Interest expenses)/ Interest Earning Assets
Equity to Assets		Leverage	Book value of equity / Total Assets
Cost to Income		Cost Efficiency	Cost / Income
Reserves to Assets		Capital Adequacy	Cash & Balances at Central Bank / Total Assets
Tier 1 Ratio			Tier 1 Capital / Risk Weighted Assets (RWA)
NPL to Gross Loans		Asset Quality	Non-performing loans / Gross loans
LLP to NPL			Loan Loss Provisions / Non-performing loans
Deposits to Assets		Business Model	Total Deposits / Total Assets
Loans to Assets			Gross Loans / Total Assets
II to NII			Interest income / Non-interest income
Growth		Growth	Annual Net Income Variation/Total Assets
Dividend Payout Ratio		Payout Ratio	Paid Dividends / Net Income
Distance to Default		Risk	Equation described in Chapter 4.2
GDP	Independent Variables (Market Variables)	Macroeconomy	Country Year-on-year GDP growth
Policy Rate			Country Policy Rate
Yield Spread			Country's 10Y Government Bond-10Y Germany Bond

Annex G - Variable Evolution Over Time for US and European Banks




Deposits to Assets
0.40 0.50 0.60 0.70 0.80
Loans to Assets
0.60 0.62 0.64 0.66 0.68
II to NII
2.00 3.00 4.00 5.00 6.00
Growth
-0.01 0.00 0.01
Dividend Payout Ratio
0.20 0.30 0.40 0.50 0.60 0.70
Distance to Default
30.00 45.00 60.00 75.00
GDP
-0.05 0.00 0.05
Policy Rate
0.00 0.01 0.02
Yield Spread
-0.01 0.00 0.01 0.02 0.03
2008 2010 2012 2014 2016 2018 2020
Year
Europe
US

Annex H - Difference in means test between European and US banks' PBV

Year	Difference in means (European-US Banks PBV)	Observations
Full Period	-0.448***	2685
	(-18.11)	
2008	-0.400***	161
	(-4.17)	
2009	-0.00950	165
	(-0.10)	
2010	-0.234**	168
	(-2.45)	
2011	-0.305***	171
	(-3.62)	
2012	-0.301***	183
	(-3.70)	
2013	-0.531***	185
	(-5.36)	
2014	-0.437***	189
	(-4.89)	
2015	-0.449***	193
	(-4.97)	
2016	-0.810***	200
	(-8.69)	
2017	-0.437***	211
	(-5.34)	
2018	-0.608***	214
	(-6.51)	
2019	-0.520***	215
	(-6.13)	
2020	-0.472***	215
	(-6.05)	
2021	-0.549***	215
	(-0.99)	

Notes: *t* statistics are shown in parentheses. ***, ** and * indicate significance at 1%, 5% and 10%, respectively.

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