The Impact of Capital Requirements on Italian Bank Lending

by

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Abstract

This paper investigates the role of bank capital requirements on Italian credit supply from 2002 to 2018. It employs panel structural VAR methods to disentangle the effects of regulatory shocks from broader macroeconomic and credit market disruptions. Using data for 29 Italian regional and diversified banks, it finds that an anticipation of a one percentage point increase in the risk-weighted total capital ratio lowers average lending by as much as -2.92 percent after two years and -1.51 percent in the steady-state. This contractionary response is most pronounced for larger and better-capitalized Italian banks, which curb credit by an average of -4.98 percent in the five years following a regulatory shock. Significant heterogeneity is also detected at the cross-country level, with lending remaining permanently subdued for French (-1.29 percent), Spanish (-0.69 percent), and Portuguese (-0.12 percent) banks, but positive for German banks (0.04 percent).

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1 Introduction

The Global Financial Crisis (GFC) of 2007-08 unveiled countless deficiencies in financial regulation – the excessive build-up of risky mortgage lending; the systemic breach in accounting standards; the deliberate neglect of prudential capital requirements. These signs were visible from the early-1990s, when banks accumulated debt backed by inadequate levels of capital and reserves. Consequently, the Basel Committee on Banking Supervision (BCBS) published a set of voluntary, precautionary standards to enhance risk management and strengthen bank transparency. Formalized as the Basel Accords in 1988, these sought to safeguard against financial calamities by instituting harmonized leverage caps, liquidity requirements, and minimum capital ratios. Two official revisions of the Basel Agreements have been published thus far – Basel II (2004-2009) and Basel III (2010-present). These have been amended and transposed into European Union law via the Capital Adequacy Directives (1993-2003), the Capital Requirements Directives (2006-2012), and the Capital Requirements Regulation (2013-present), respectively. At the domestic level, the Bank of Italy imposes additional macroprudential clauses tailored to specific Italian bank branches.

A vast literature expresses consternation over the macroeconomic implications of prudential objectives, positing that Basel II, for example, merely promoted unconventional business practices that contributed to and reinforced the GFC. Others blame the U.S. 'capital crunch' episode of the l990s for the imposition of stringent capital requirements, which forced banks to cut back on loan growth and raise bank capital. While minimum capital ratios may impose substantial social costs in the form of bank profitability, share prices, and loan supply, advocates claim that the ramifications of regulation are outweighted by the benefits of long-run financial stability. Since moral hazard leads to the suboptimal accumulation of bank capital, unanticipated losses may be magnified by institutions' inability to absorb them. By placing limits on excessive risk-taking behavior, macroprudential regulation helps reduce the incidence and severity of financial downturns.

This thesis contributes to the modern literature on financial regulation, exploring the implications of risk-weighted total capital requirements on Italian bank lending behavior from 2002 to 2018. It exploits time-varying regulation imposed on 29 regional and diversified Italian banks to ascertain the impact of successive capital shocks on credit supply. It contributes to the literature by analyzing how individual banks react to capital requirements, over what time horizon, and which categories of sectoral lending are most severely impacted. It addresses the following questions in particular: (i) how does bank-specific loan growth respond to common regulatory shocks? (ii) what factors drive this underlying heterogeneity? (iii) how do the effects on lending compare across different sectors of the economy?

The final section of the paper contrasts Italian bank lending responses to that of German banks, replicating the SVAR procedure for an unbalanced panel of 28 regional and diversified German banks. It pools such responses to generate fitted values for 30 French, 30 Spanish, and 15 Portuguese banks, panel members that lack adequate data for conventional time series analysis. In doing so, it draws inferences about: (i) the relative importance of regulatory shocks across different Eurozone countries; (ii) the sources of country-specific heterogeneity; and (iii) the proportion of cross-country variation in bank lending explained by changes in capital requirements.

The main issue examined in this paper is whether banks liquidate or expand the asset side of their balance sheet in response to tighter regulation. One strand of theory posits that better-capitalized banks face lower funding costs, are better sheltered against deposit risk, and have larger buffers that allow for an expansion of credit. An alternative literature states that since access to new capital is costly, banks respond to tighter requirements by contracting credit. In the latter case, information frictions may make equity more expensive if stockholders do not have sufficient information about the value of the bank.

This paper produces four novelties with respect to the existing literature: First, it introduces a novel mixed identification SVAR strategy predicated on European bank-customer relationships. Second, it addresses the dual challenges of cross-sectional dependency and dynamic heterogeneities in ways that existing methods do not. Third, it regresses sample distribution estimates against cross-sectional correlates to uncover potential sources of heterogeneity among individual banks. Fourth, it uses fitted cross-sectional regression estimates to generate heterogeneous responses for French, Spanish, and Portuguese banks that lack adequate data for traditional VAR analysis.

Preliminary results indicate that anticipations of tighter bank capital requirements have an economically sizeable, negative impact on Italian credit supply. This effect is most pronounced for larger Italian banks, which curb long-run lending by -5.40 percent compared to -1.51 percent for the sample. The intuition behind this result is that larger Italian banks inherit the highest share of non-performing loans as a percentage of total loans. Given the statistically significant, inverse relationship between bank non-performing loans and loan growth, it is unsurprising to uncover a significant relationship between total assets (proxy for bank size) and lending.

Findings from the Italian case closely complement that of the German case. In both countries, non-performing loans and non-performing assets are important determinants of bank lending. Since larger German banks are the least burdened by impaired loans, they exhibit the most subdued responses to regulatory shocks. Among these banks, lending is increased by 0.72 percent after the first year and 0.42 percent in the long-run. This is high compared to the German sample average, where lending peaks at 0.07 percent in the five years following the shock. One plausible explanation for this is that larger German banks are the least burdened by non-performing loans, a result corroborated by a statistically significant second-stage correlation between total assets and bank-specific German lending responses.

The policy implications of this paper are manifold. Crucially, if one accepts the premise that bank size is a critical determinant of bank lending, then the imposition of tighter regulation might have deleterious effects on the Italian macroeconomy. This is because domestic households and firms, traditionally reliant on local banks for funds, may be unable to obtain the necessary credit for financing. Along similar lines, the planned imposition of additional capital buffers for Global and Other Systemically Important Institutions (identified by bank size) could provoke even sharper permanent reductions in bank lending. Finally, since NPL exposure tends to impair banks' ability to finance the real economy, authorities should take measures to reduce impaired loans as a means of enhancing banking-sector resiliency.

The remainder of the paper is structured as follows: Section 2 presents background on financial regulation and terminology for Italian, European, and global banks. Section 3 discusses the theoretical and empirical literature on bank capital requirements and lending, while Section 4 presents an overview of the data selection process. Section 5 addresses shortcomings in the econometric literature, provides a non-technical summary of panel SVAR methods, and motivates the chosen identification approach. Section 5 discusses heterogeneity in bank-level impulse responses and variance decompositions, and Section 6 concludes.

2 Background

2.1 Basel Accords

Formalized in June 1988, Basel I marked the first international initiative to regulate banks' capital holdings. A response to the international debt crises of the 1980s, Basel I was introduced to raise the quality and quantity of bank capital. With higher capital ratios to absorb losses, better-capitalized banks would face lower costs of financial distress. This would contribute to long-term financial stability and growth by reducing banks' dependence on public funds, mitigating incentives for excessive risk-taking, and alleviating the social costs of an economic downturn. In 1988, the BCBS laid out a voluntary set of minimum risk-weighted capital requirements to be phased-in by the end of 1992. These required financial institutions to hold a core capital ratio (Tier I Capital to RWAs) of at least 4 percent and a total capital ratio (Tier I plus Tier II capital to RWAs) of at least 8 percent.

- Tier I Capital: Banks' core capital, including shareholders' equity and disclosed reserves;
- Tier II Capital: Banks' supplementary capital, including revaluation reserves, undisclosed reserves, general loan-loss reserves, subordinated debt, and hybrid capital instruments;
- Risk-Weighted Assets: The weighted sum of different categories of banks' assets or off-balance sheet exposures, where weights reflect relative levels of risk.

Simplicity in the measurement of RWAs led to a revised regulatory framework in June 2004. More complex in its calculation of capital adequacy, Basel II was predicated on three mutually reinforcing pillars – minimum capital requirements (Pillar I); the supervisory review process (Pillar II); and market discipline (Pillar III). Pillar I laid out new calculations of regulatory capital, expanded from two tiers to three, two new methodologies for the calculation of credit risk (the standard approach and internal-ratings based approach), and the inclusion of operational risk in the calculation of RWAs (formerly limited to market risk and credit risk). Pillar II provided an improved framework for regulators to manage systemic, reputational, liquidity, legal, and concentration risk. Pillar III required regulated institutions to publish annual reports on capital holdings, risk exposure, and risk assessment processes to enhance bank transparency.

The current framework for capital adequacy, Basel III was announced in December 2010 as a response to the GFC. Lax supervision and enforcement, coupled with discretion in the calibration of Basel II risk weights, prompted the BCBS to revise its approach to financial regulation. First, Basel III introduces two new capital buffers – the Capital Conservation Buffer (CCB) and the Counter-Cyclical Buffer (CCyB) – to be phased-in from January 2018 to

January 2022. Second, while the total risk-adjusted capital requirement is to remain unchanged at 8 percent, financial institutions will be required to raise their share of common equity and Tier I capital holdings (relative to Tier II), and exclude Tier III capital from their calculations of total capital. Third, Basel III imposes an additional liquidity requirement and non-risk-based leverage ratio (total debt-to-total equity) to ensure ample liquidity holdings in the event of a stress test. The full-set of prudential capital requirements includes:

- Countercyclical Buffer (CCyB): Based on the deviation of the ratio of credit-to-GDP from its long-term trend, the CCyB prompts financial institutions to accumulate more capital when cyclical systemic risk is judged to be rising. It combats pro-cyclicality and dampens excessive credit growth by taking into account specificities of national economies.

- Capital Conservation Buffer: This is an additional capital buffer of 0 percent to 2.5 percent of a bank's total exposures that is met with an additional amount of Common Equity Tier I capital (to be phased-in by 2019). If this buffer is breached, automatic safeguards are imposed to limit the amount of dividends or bonus payments made by banks.

- Systemically Important Institutions: Identified at the national level, these are additional Common Equity Tier I capital requirements imposed on G-SII (Globally Systemically Important Institutions) or O-SII (Other Systemically Important Institutions).

- Leverage Ratio: The leverage ratio is set at 3 percent of Tier I Capital and must be met in tandem with risk-based capital requirements. This specified calibration is internationally-agreed upon, and applies to all credit institutions and investment firms.

- Net Stable Funding Ratio: The EU Commission is in the process of introducing a harmonized and binding Net Stable Funding Ratio – that is, the ratio of an institution's available stable funding relative to its required stable funding over a one-year horizon. This helps combat excessive maturity mismatch and ensures that financial institutions have sustainable stable funding structures. It is set to come into force two years after the proposal's acceptance.

- Total Loss-Absorbing Capacity: This standard deals with the 'too-big-to-fail' issue by requiring specific banks to hold sufficient amounts of readily bail-in-able liabilities. G-SIBs will be required to respect the minimum Total Loss-Absorbing Capacity (TLAC) requirement of at least 16 percent of RWAs from 1 January 2019 and at least 18 percent from 1 January 2022. The minimum TLAC must also comprises 6 percent of the Basel III leverage ratio denominator from 1 January 2019 and 6.75 percent from 1 January 2022.

2.2 European Financial Regulation

Following the implementation of Basel II in June 2004, the European Union (EU) enacted legislation that transposed the global regulatory framework into a preparative text titled the Capital Requirements Directive (CRD). Introduced in January 2007, the CRD I superseded the Capital Adequacy Directive (CAD) first issued in 1993, and was later modified in September 2009 (CRD II) and November 2011 (CRD III). It should be noted that the EU capital rules do not fully mirror those stipulated by Basel. Rather, they are amended to reflect the specificities of the Single Market context.

Most recently, the Capital Requirements Regulation (CRR) and CRD IV packages were devised to reflect the new global standards put forward in Basel III. These were first published in December 2010, and proposed an initial phase-in approach to capital requirements from January 2014 to January 2019. As a response to delays in Basel III, these were subsequently pushed back from January 2017 to January 2027. Key distinctions between the Basel Accords and its EU variant include, but are not limited, to:

- The CRD package is legislative in nature and binding in all EU Member States. It applies to all banks and investment firms, independent of their size or geographical outreach. This differs from Basel arrangements, which are envisaged to apply exclusively to internationally active banks.

- The full spectrum of calculation approaches for capital requirements are available for all EU banks and investment firms, irrespective of their level of complexity or sophistication. This is not the case in the U.S., where only the most advanced methodologies (IRB) are used to calculate minimum capital requirements.

- External credit assessment institutions (ECAIs) must comply with minimum EU requirements to enable them to provide credit risk estimations under the standardized approach. This is both to limit the potential risks for regulatory arbitrage and to ensure that compliance costs are equal across the EU.

- The CRD aims to enhance supervisory transparency by stipulating a minimum set of disclosure requirements from the authorities of EU Member States. These include the publication of legal texts, the provision of statistical data, and the exercise of certain discretionary measures.

- The EU capital framework enhances the role of the 'consolidated supervisor,' an authority responsible for the supervision of cross-border EU banking to foster supervisory convergence, financial integration, and financial stability.

2.3 Italian Financial Regulation

At the national-level, the Bank of Italy abides by the regulatory requirements laid out in EU legislative text (CAD/CRD). As per the CRD IV, it also has the discretion to set the Countercyclical Buffer and identify Systemically Important Institutions (GSII/OSII). This information is outlined in the Bank of Italy's Circular No. 285, which replaces the Circular No. 263, and specifies the following:

- Countercyclical Buffer: This buffer is set at 0.00 percent of RWAs in 2016, 2017, and 2018. The most recent deviation of the bank-credit-to-GDP ratio (January 2018) from its long-term trend was -12 percent, which does not warrant an adjustment. Following the Bank of Italy, the Italian economy's macro-financial conditions are generally weak, and the growth of business lending continues to hover around zero.

- Capital Conservation Buffer: The requirement for Italian institutions is to maintain a Capital Conservation Buffer of Common Equity Tier I Capital equal to 2.50 percent of banks' RWAs. This will follow a gradual-phase in approach: 1.250 percent from 1 January 2017 to 31 December 2017; 1.875 percent from 1 January 2018 to 31 December 2018; 2.5 percent from 1 January 2019. In Comunicazione del 31 Marzo 2014 – SIM e Gruppi di SIM, the Bank of Italy also exempted small and medium-sized investment firms from building this buffer. It did so by exercising the option in Article 129 (2) of the CRD IV.

- Systemically Important Institutions: The Bank of Italy has identified four O-SIIs (UniCredit, Intesa Sanpaolo, Gruppo Banco BPM, Monte dei Paschi di Siena) and their corresponding O-SII buffer rates.[1]

- Liquidity Coverage Ratio: The minimum Liquidity Coverage Ratio is set to rise from 80 percent between 1 January 2017 and 31 December 2017 to 100 percent from 1 January 2018 onwards. The Bank of Italy has the discretion to set stricter liquidity ratios until such requirements are harmonized by EU authorities.

- Leverage Ratio: As with the former, Italian regulator bodies do not stipulate a minimum requirement for the Leverage Ratio. This ratio must still be reported to regulators as part of the CRD's supervisory clause.

- Net Stable Funding Ratio: No minimum requirement exists for Net Stable Funding Ratio in the Italian legal framework, but this ratio must still be reported to the relevant authorities.

[1] Refer to Figure 1 for the evolution of total capital requirements for Italian O-SII institutions.

2.4 Channels of Adjustment

Banks can adjust to higher risk-weighted capital requirements through four broad channels: (i) boosting retained earnings; (ii) issuing new equity; (iii) liquidating assets; and/or (iv) adjusting asset quality.[2] The first two strategies target the numerator of the total capital ratio, while the latter two target the denominator of the total capital ratio. It should be noted that banks' choices among these four strategies determine the real macroeconomic effects of regulatory tightening on bank lending. A contraction of credit, for example, could constrain economy-wide consumption and investment, while a reduction in dividend payouts would have an isolated effect on banks' existing shareholders.[3]

- Boosting Retained Earnings: This strategy involves increasing banks' retained earnings, defined as the accumulation of net income less dividend payments, either by cutting dividend pay-outs or boosting profits elsewhere. The latter can be done by widening the lending spread, although this may be constrained by competitive pressures and/or lending rates offered by alternative funding channels.[4] Alternatively, banks can raise profit margins on other business lines, including advisory and custody services, and/or reduce operating expenses.

- Equity Issuance: The issuance of new equity, either via an offering on open markets or placing bloc shares with external investors, can boost banks' capital ratios. This is the least attractive option, as the issuance of new shares dilutes the value of existing shares.

- Asset Liquidation: Another set of adjustment strategies involves shrinking the asset side of banks' balance sheets. Examples include selling assets outright, curbing loan growth, or tightening lending standards.

- Asset Quality: This process involves reducing risk-weighted assets by replacing riskier assets with safer ones. For example, banks might choose to substitute high-risk assets such as debentures with low-risk cash or government securities or bonds.

[2] As per a BIS Quarterly Review (2013) report, European banks have adjusted to more stringent requirements in order of adjusting asset quality, raising additional capital, and cutting back on total assets.

[3] A reduction in bank lending need not be bad for the macroeconomy in the long run, especially if banks have overheated the economy through unsustainable debt booms. The extensive deleveraging process following the GFC, one accompanied by a clean-up of bank balance sheets and reduction in aggregate demand, is by no means complete.

[4] Widening lending spread refers to increasing the spread between the interest rates banks charge for loans and the interest rate they pay on funding.

3 Literature Review

3.1 Rationale for Higher Capital Requirements

3.1.1 Incentive Structures

One key function of capital requirements is that they curb incentives for excessive risk-taking. Theoretical studies prove that higher bank capital can: (i) improve the screening and monitoring of bank borrowers (Holmstrom and Tirole, 1997; Allen, Carletti and Marquez, 2011; Mehran and Thakor, 2011) and (ii) reorient bank portfolios towards safer risk-weighted assets (Furlong and Keeley, 1989; Calomiris and Kahn, 1991; Rochet, 1992). As for the latter, Thakor (1996) shows that differential risk-weights induce banks to shift towards lower-risk assets in response to higher capital requirements. Empirical works corroborate such claims, with Schepens (2006) finding that a Belgian tax reform on bank capital reduced risk-taking by lowering banks' NPL-to-total loan ratios and volatility of return on assets. Similarly, Berger and Bouwman (2013), Calomiris and Mason (2003), and Calomiris and Wilson (2004) find that higher bank capital strengthens banks' competitive positions and probability of survival during banking crises and 'normal' times.

Regulation can contrarily raise banks' risk appetites if the shift towards safer assets, which can lower banks' expected future returns, adversely affects their future profit streams (Santomero and Kim, 1988) and charter values (Zhang, 2018). This can drive financial activities to the unregulated shadow banking sector, which operates outside the purview of supervisors (Erasmo, 2018). Along similar lines, Besanko and Kanatas (1996) present a theoretical model in which higher bank capital, which increases the number of bank shareholders and dilutes existing insiders' ownership, reduces the marginal benefit of monitoring. This conclusion is supported by Awdeh, El-Moussawi, and Machrouh (2011), who find a positive correlation between bank capital requirements and risk-taking for a panel of 41 Lebanese banks.

3.1.2 Funding Costs

The Modigliani-Miller (MM) Theorem (1958), which posits that the value of a firm is entirely unaffected by how it is financed, implies that adjusting the debt-equity ratio should not affect banks' overall funding costs. Admati et al. (2013) provide descriptive support for this view, postulating that the required return on equity declines with a higher proportion of equity (as shareholders bear less asset risk). Similarly, additional equity injections, which reduce banks' bankruptcy risk, can leave funding costs unchanged as they lower the interest rate banks pay on their debt. It follows that better-capitalized banks make more auspicious lending and investment decisions than those subject to 'debt overhang,' a condition in which highly leveraged banks are unable to finance potentially profitable future projects due to existing debt burdens (Myers, 1977). Finally, debt can create more significant frictions and governance problems than equity because debt distorts the lending and incentive decisions of financial institutions (Admati et al., 2013).

Highly restrictive in its assumptions, the MM theorem dismisses the role of financial frictions and distortions as determinants of bank capital structure. Indeed, the principal argument against holding more equity is that it penalizes banks through three channels. First, since debt financing is largely subsidized by public tax legislation, a shift toward equity financing implicitly lowers banks' profitability margins. This conclusion is bolstered by Cummings (2016), who finds that tighter equity requirements significantly raise banks' funding costs because equity requires a higher return than debt. Using data for Australian banks, he estimates that a 5 percent increase in the capital-to-asset ratio drives borrowing costs up by 20 basis points on an annual basis. Second, it has been claimed that higher equity requirements lower banks' return on equity, in turn reducing bank value. This view is held by Hellwig (2010), who proves that maintaining a capital buffer is inherently costlier if new equity injections dilute the value of existing shares. According to Van den Heuvel (2008), this arises when financial markets interpret the decision to issue equity as a 'negative signal,' a fundamental outcome of pecking-order theory. Finally, it has been shown that debt plays a positive role in mitigating frictions due to governance and asymmetric information (Jensen, 1986). That is, debt serves as a 'disciplining device' that prevents managers from squandering funds (Harris and Raviv, 1990).

3.2 Effects of Financial Regulation on Bank Lending

3.2.1 Theoretical Literature

The positive spill-overs of bank capital requirements on credit supply are well-documented in the theoretical literature. Studies show that better-capitalized banks compete more effectively for deposits, accumulate more retained earnings, are better protected against maturity mismatch, and are less subject to 'debt overhang' (Kishan and Opiela, 2000; Calomiris and Mason, 2003; Calomiris and Wilson, 2004; Kim, Kristiansen, and Vale, 2005). Collectively, these render banks more profitable by smoothing their lending capacities and reducing the pro-cyclicality of loan growth. Evidence for this claim is presented by Carlson, Shan and Warusawitharana (2013), who report that U.S. banks with higher capital ratios exhibited stronger loan growth than their counterparts during the GFC of 2008 to 2010.

3.2.2 Empirical Literature

Empirical investigations on the relationship between bank capital ratios and lending have produced highly inconclusive results. This is primarily attributed heterogeneity of the samples considered, as well as differences in identification approaches, time periods, and types of financial ratios examined.

One strand of literature finds that raising regulatory requirements confers significant macroeconomic benefits via higher loan growth. Bernanke and Lown (1991), for example, estimate that a 1 percent increase in bank capital requirements translated into a 2 to 3 percent rise in U.S. loan growth from 1990 to 1991. Similarly, Buch and Prieto (2014) report that higher bank capital ratios were associated with increased business loan volumes for a sample of 81 German banks in the period 1965-2009.

On the other hand, studies have supported the claim that banks curb lending in response to higher capital requirements. An early work by Peek and Rosengren (1997), for example, shows that Japanese bank lending operations in the U.S. declined sharply following a binding risk-based capital requirement implemented by Japanese regulatory authorities. Similarly, Cosimano and Hakura (2011), evaluating the impact of the Basel III capital requirements on bank lending rates and loan growth worldwide, find evidence that a 1.3 percent increase in the Basel III total capital ratio caused large banks to raise their lending rates by 16 basis points and curtail loan growth by 1.3 percent. A similar study by Aiyar, Calomiris, and Wieladek (2015) on changes in the U.K. regulatory environment find that a one percent increase in the required equity ratio contracted loan supply to domestic non-financial borrowers by 6-7 percent. Finally, Daníelsson et al. (2001), Kashyap and Stein (2004), and Repullo and Suarez (2012) all show that tightening risk-weighted capital ratios during an economic downturn dampens aggregate loan growth by more than during an upswing. They attribute this result to the sensitivity of risk-weights to the pro-cyclicality of asset prices.

3.2.3 Italian Literature

The debate on bank capital and lending behavior in Italy is equally unresolved. While Angeloni et al. (1995) Buttiglione and Ferri (1994), Chiades and Gambacorta (2004), and Fanelli and Paruolo (2003) all confirm the existence of a 'bank capital channel' in the 1990s – that macroprudential actions lower the supply of loanable funds available to banks, in turn curtailing loan growth – de Bondt (1999), Favero et al. (1999) and King (2002) note that this effect is specific to bank size and liquidity. A recent paper by Mustilli et al. (2017), exploring the impact of the Basel II regulation on credit supply in Italy, shows that higher regulatory capital requirements are associated with a major contraction of credit. Similarly, De Santis and Surico (2013) find a significant and heterogeneous effect of macroprudential policies on Italian bank lending behavior, reporting that savings banks with lower initial capitalization and liquidity levels cut back on lending far more than cooperative and commercial banks. At present, no study has found a positive impact of the Basel accords on Italian bank lending.

4 Bank-Level Data

4.1 Bank Variables

The bank-level data used in this paper come from S&P Global's Capital IQ, an online platform that provides data on consolidated financial statements and historical ratios for domestic and international banks. The three key variables used in the panel SVAR include: (i) total capital levels; (ii) total capital ratios, used to calculate the total capital buffer; and (iii) gross loans.[5]

To match quarterly capitalization data with annual loan growth data, all balance sheet items are transformed to an annual frequency. Banks with fewer than ten years of continuous data, extreme loan values, or substantial missing data are dropped from the sample, and observations for the first four quarters for newly-merged banks are excluded to reduce volatility. Missing values for categories of sectoral lending are interpolated using the Litterman interpolation procedure.

The consolidated estimation sample contains panel data for 29 regional and diversified Italian banks over the period Q4 2002 to Q4 2018. To conduct the comparative analysis, panel data for 28 regional and diversified German banks over the period Q4 2004 to Q4 2018 are used. Both panels are unbalanced, and data must be available for a minimum of ten banks for each time period. This ensures that there is a sufficient cross-sectional dimension present to reasonably estimate the common structural shocks.

4.2 Second Stage Data

To study variation in bank-level impulse responses, data for 54 static bank-specific correlates are individually regressed against bank-specific responses in the second stage.[6] Data on individual bank characteristics are drawn from S&P Global Capital IQ, and averaged over the course of the bank's lifetime (starting in 2000). These variables includes data on return on assets, net income, total coverage ratios, provision for loan losses, and non-performing loans.

4.3 Fitted Value Data

Finally, to generate fitted values for a subset of European banks, data for bank-specific NPAs are compiled from S&P Global Capital IQ for 30 French banks, 30 Spanish banks, and 15 Portuguese banks. For consistency, this bank-specific correlate is averaged over the course of the bank's lifetime (starting in 2000). Data from the IMF's Financial Soundness Indicator (FSI) database is also used to analyze comparative NPL stocks for different EU banks.[7]

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[5] Refer to Table 3 for Financial Glossary.

[6] Refer to Technical Appendix A for an overview of the second stage and fitted value method developed in Pedroni (2013).

[7] Refer to http://data.imf.org/fsi for more information.

5 Empirical Approach

5.1 Approaches in the Literature

The empirical literature has taken varied approaches to isolating the effects of capital requirements on bank credit. Estimating this causal chain is non-trivial, as various confounding factors such as macroeconomic conditions, demand factors, and monetary policy decisions drive credit growth. As such, the identification challenge requires disentangling changes in bank lending caused by changes in macroprudential requirements from all other endogenous drivers of bank credit.

One strand of literature employs loan-level data to address non-random matching issues between borrowers and lenders. Brun et al. (2014), for example, exploit the two-way interaction between banks and firms to estimate the effect of an easing of capital requirements on French corporate lending. Similarly, Jimenez et al. (2017) quantify the real effects of bank lending using matched firm-bank level balance-sheet data from the credit register of Spain. While a micro approach allows one to isolate bank capital from the quality, risk, and demand of borrowers, such a dataset is not available for Italy.

Another strand of literature employs vector autoregressive (VAR) models based on past statistical relationships between capital and other macroeconomic variables. Variations of Berropside and Edge's (2010) recursive model remain the preferred identification method, originally a six-variable system with three macroeconomic variables – real GDP, price inflation, and the policy rate – and three bank-level variables – bank loan growth, capital ratios, and lending standards. This method involves implementing a Choleski decomposition that assumes a recursive relationship between reduced form innovations and initial period responses. One pervasive critique is that this identification strategy fails to disentangle regulatory shocks from broader shocks to bank capital. Increases in bank capital ratios may be attributed to, or caused by, shocks to bank characteristics unrelated to regulation.

The more recent literature employs structural VAR methods that impose timing restrictions, derived using some underlying economic theory or a priori knowledge, on the vector moving average (VMA) representation of the economy.[8] Meeks (2014), for example, develops a set of mixed identification restrictions in a four-variable system with a vector of macroeconomic variables, bank lending variables, a system-wide capital ratio, and the trigger ratio. The baseline assumption is that the trigger ratio, a breach of the additional capital requirement that would 'trigger' regulatory action on behalf of U.K. supervisors, were not directly observed by the public, and thus had no bearing on macroe-

[8]Rather than employing an ad hoc statistical method, solving the identification problem requires positing a set of timing restrictions that separate out contemporaneous links between variables.

conomic variables. Similarly, Noss and Toffano (2014), estimating the impact of tighter bank capital requirements in the U.K., use an SVAR model with sign restrictions to capture aggregate changes in lending. In doing so, they assume that tighter regulation has a contractionary effect on bank lending at least in the short-run.

5.2 Panel Structural VAR

This paper employs the panel structural VAR technique developed in Pedroni (2013) to study variation in bank-lending responses.[9] This methodology accounts for two important challenges that characterize panel datasets: (i) dynamic heterogeneity across individual members of the panel;[10] and (ii) cross-sectional dependence that arises from dynamic interdependence among panel members.[11] Without controlling for dynamic heterogeneity, estimation of the average dynamic responses to regulatory shocks becomes inconsistent, and without controlling for cross-sectional dependence, inference about the dynamic responses become inconsistent.[12]

Pedroni (2013) addresses both such challenges by exploiting the orthogonality conditions associated with structural time series methods. This is done by decomposing structural shocks into their orthogonal idiosyncratic and common counterparts, and obtaining efficient estimates of the bank-specific loadings of the common shocks.[13] Towards this end, Pedroni (2013) shows that the cross-sectional averages contain identifiable information on the common shocks when the structural shocks are orthogonal to each another. That is, the role of idiosyncratic shocks in driving movements in the cross-sectional averages becomes negligible as the cross sectional dimension grows large.

This approach allows one to estimate the dynamic responses of individual banks to common regulatory shocks, which capture regulatory changes that impact all sample banks, as well as idiosyncratic regulatory shocks, which affect an individual or narrow subset of banks (while controlling for the common shocks). The sample distribution of the estimated bank-specific impulse responses can then be used to: (i) decipher the sources driving underlying bank heterogeneity; and (ii) obtain fitted-value estimates for banks that lack sufficient data for conventional time series analysis.

[9] Refer to Technical Appendix A for a technical overview of Pedroni (2013).

[10] A failure to address heterogeneity in bank dynamics is equivalent to treating all individual bank responses as if they were homogeneous.

[11] The issue of cross-sectional dependence arises as banks are interdependent and often respond to the same unobserved external shocks.

[12] Pedroni, Peter and Montiel, Peter. "Trillema-Dilemma: Constraint or Choice?" Pp. 6

[13] Idiosyncratic structural shocks are bank-specific and do not have an impact beyond the aggregation unit of individual banks. Common structural shocks have an impact beyond the aggregation unit of individual banks.

5.2.1 Shock Identification

Anticipation effects can be problematic for the identification of regulatory shocks. Specifically, banks' expectations of tighter capital requirements will prompt them to adjust their capital ratios in a gradual manner, not uniquely on the date of the regulatory announcement.[14] Moreover, the ability to respond and the timing of this adjustment will differ drastically across banks – larger, more profitable banks will conceivably build-up their capital stock in a more rapid and less disruptive manner than their smaller counterparts.

To address this issue, the preferred identification approach interprets period-by-period regulatory shocks as changes in banks' expectations of future regulatory changes. Using this framework, common regulatory shocks may be defined as shared anticipations of future regulatory policies, while idiosyncratic regulatory shocks may be interpreted as individual anticipations of bank-specific regulation. Thus, while common shocks capture changes in regulation imposed on all Italian banks, idiosyncratic shocks describe regulatory changes that impact only an individual bank or narrow subset of banks (controlling for the common regulatory shocks). An example of the latter would be the G-SII or O-SII requirement which imposes additional Common Equity Tier I capital requirements on nationally-identified systemically important institutions.

The proposed SVAR identification scheme relies on a set of short-run and long-run restrictions for a three-variable system in the order of: (i) total capital buffer; (ii) gross loans; and (iii) total capital level. The primary shock of interest is the one-unit common regulatory shock, interpreted as a one percentage point permanent increase in the total capital requirement.[15] The choice of the common shock reflects our interest in comparing banks' dynamic loan responses to shared anticipations of future regulatory changes.[16] This implicitly assumes that all banks have perfect information and foresight regarding future hikes in the total capital requirement, a reasonable assumption given the Basel Committee's frequent and transparent policy announcements.

[14] Announcement date for Basel II was June 2004 and Basel III was December 2010.

[15] Note that in SVAR analysis structural shocks are in general unit shocks. For the purpose of this exercise, shocks are interpreted as anticipations of a one percentage point increase in the total capital requirement, in line with historical changes in bank regulation.

[16] Idiosyncratic regulatory shocks are not analyzed as less than ten percent of sample banks are subject to tighter regulation as per the G-SII and O-SII requirements. Nonetheless, the dynamic responses of bank lending to idiosyncratic regulatory shocks are reported in Figures 16 and 17 of Appendix B.

5.2.2 Identifying Restrictions

The first restriction posits that regulatory shocks have no long-run effect on bank capital buffers: $A_i(1)_{3,1} = 0$. This assumption is corroborated by empirical evidence in Bridges et al. (2014), which finds that banks raise their capital ratios one-for-one in response to a one percentage point permanent increase in the total capital requirement. This finding, consistent with that presented in Siklós (2016), suggests that banks intend to preserve their long-term capital buffers one-for-one when faced with regulatory changes.

The second restriction assumes that structural innovations to bank capital requirements have no contemporaneous effects on lending: $A_i(0)_{3,2} = 0$. This assumption is specific to a handful of Eurozone countries – Italy, Germany, France, Spain, and Portugal – in which bank lending is characterized by customer relations rather than arm's length lending. While the former is typified by long-term relationships between banks and their customers, the latter assumes no such collusion or interaction between the two parties.

One prominent example of this close-knit European business model is the German house bank, a financial institution that acts as the sole credit provider for a domestic business. Italian banks exhibit equally close linkages with their customers: as per a survey conducted by the FITD (2001), small businesses made up 34.5 percent of large Italian banks' loan portfolios compared to 6.8 percent for large businesses. Using the standardized risk-weight approach, around 21.9 percent of such loans were rated CCC (junk status) using S&P Global's ratings methodology in 2001. Thus, in spite of their high historical default probabilities, the market for intermediated finance in Italy, and Europe more generally, continues to be characterized by tight-knit relations.

The nature of this long-term lending relationship implies that Italian and German banks, predominantly serving individuals and smaller firms, will be reluctant to cut loan growth in the immediate period. Instead, they employ either one of the other recapitalization strategies (issuing new equity, cutting dividend pay-outs, etc.) upon impact.[17][18] Bank lending is left completely unrestricted thereafter, allowing banks to adjust both their capital levels and asset holdings in ways that completely offset changes in the short-term capital buffer.

Finally, regulatory shocks are distinguished from global macroeconomic shocks (ε_{it}^{G}) that affect all of the systems' variables contemporaneously and in the steady state. An event such as the Global Financial Crisis of 2008-09, for example, would have conceivably altered bank profitability, lending decisions, and the size of banks' capital buffers. This shock is distinguished from an internal bank profitability shock (ε_{it}^{P}), which need not impact banks' decisions to amend

[17] Refer to Section 2.4 for comprehensive list of adjustment strategies.

[18] Refer to Figure 18 for the dynamic Italian response of total capital to common regulatory shocks.

their buffers over the long-term: $A_i(1)_{2,1} = 0$. An unanticipated hike in loan default rates, for instance, may impact lending contemporaneously and in the long-term, but may be compensated for by an accumulation of capital that keeps the long-term capital buffer intact. In the event that the capital buffer changes, the shock is reclassified as a global shock under ε_{it}^R.

5.2.3 Matrix Representation

The short-run restrictions can be summarized in matrix form using $\Delta z_{it} = A_i(0)\varepsilon_{it}$, where $A_i(L)_{3,2} = 0$:

$$\begin{bmatrix} lnB_{it} \\ lnL_{it} \\ lnK_{it} \end{bmatrix}^{SR} = \begin{bmatrix} A_i(0)_{1,1} & A_i(0)_{1,2} & A_i(0)_{1,3} \\ A_i(0)_{1,2} & A_i(0)_{2,2} & 0 \\ A_i(0)_{1,3} & A_i(0)_{2,3} & A_i(0)_{3,3} \end{bmatrix} \begin{bmatrix} \varepsilon_{it}^G \\ \varepsilon_{it}^P \\ \varepsilon_{it}^R \end{bmatrix}$$

Similarly, the long-run structural form can be expressed using $\Delta z_{it} = A_i(L)\varepsilon_{it}$, where $A_i(1)_{2,1} = 0$ and $A(1)_{3,1} = 0$:

$$\begin{bmatrix} lnB_{it} \\ lnL_{it} \\ lnK_{it} \end{bmatrix}^{LR} = \begin{bmatrix} A_i(1)_{1,1} & 0 & 0 \\ A_i(1)_{1,2} & A_i(1)_{2,2} & A_i(1)_{3,2} \\ A_i(1)_{1,3} & A_i(1)_{2,3} & A_i(1)_{3,3} \end{bmatrix} \begin{bmatrix} \varepsilon_{it}^G \\ \varepsilon_{it}^P \\ \varepsilon_{it}^R \end{bmatrix}$$

where lnB_{it} – Annual log change in bank-specific total capital buffer;

lnL_{it} – Annual log change in bank-specific gross loans;

lnK_{it} – Annual log change in bank-specific total capital;

ε_{it}^G – Structural global shock;

ε_{it}^P – Structural profitability shock;

ε_{it}^R – Structural regulatory shock.

6 Results

The panel structural VAR approach employed in the previous section generates a set of impulse responses and variance decompositions that capture heterogeneous movements in bank lending for all sample banks. These address questions such as: (i) how does bank lending respond to common regulatory shocks over time? (ii) how much cross-bank and cross-country variation is there in such responses? (iii) what factors drive such underlying heterogeneity?

6.1 Italian Bank Responses to Regulatory Shocks

6.1.1 Impulse Responses and Variance Decompositions

Using sample averages, Italian banks curb lending by at most -2.92 percent two years following a regulatory shock, -1.79 percent after five years, and -1.51 percent in the long-run (Figure 3). This restrictive lending effect is most pronounced for larger Italian banks than (smaller) banks, which cut lending by at most -9.85 percent (-0.09 percent) after two years, and reach a steady state value of -5.40 percent (0.01 percent) after eight years (Figure 4).

Such results are consistent with the empirical literature. Namely, the median long-run response of lending to a one percent increase in the regulatory requirement oscillates around -1 percent to -4 percent. Francis and Osborne (2009), for example, report a steady state value of -1.20 percent; Cosimano and Hakura (2011) of -1.30 percent; and Bridges et al. (2014) of -3.50 percent. On the Italian front, Conti, Nobili, and Signoretti (2018) observe a -3.0 percent to -3.4 percent reduction in the stock of loans (to non-financial firms and households) following a 1.5 percentage point increase in the Tier I capital requirement, while Gambacorta and Mistrulli (2004) obtain a result of -0.2 percent for banking institutions over the same time frame (1992 to 2001).

A sectoral decomposition of loan growth reveals that at the 25th quantile, lease loans are cut the most drastically after three years (-1.21 percent), closely followed by consumer loans (-0.77 percent). As with commercial loans (0.72 percent), the median response of mortgage loans (0.02 percent) is positive at the steady state, and is as high as 4.26 percent for the 75th quantile after five years. Although the relative differences are negligible, these results indicate that policy tightenings may induce differential effects on lending for different sectors of the economy (Figure 5).

Variance decompositions convey the total forecast variance in lending attributed to structural innovations in bank capital requirements. On average, regulatory shocks account for between 3 percent to 18 percent of the variation in bank lending across all time periods (Figure 6). This pales in comparison to structural global shocks and profitability shocks, which help explain 41 percent and 48 percent of the variation in average bank lending respectively (Figures 7 and 8).

6.1.2 Second Stage Results

Second-stage results reveal that individual bank responses are inversely correlated with total assets and total revenue (proxies for bank size), as well as non-performing loans (as a percentage of total loans), non-performing assets (as a percentage of total assets), and loan loss provisions (as a percentage of NPLs).[19] These coefficients, obtained by regressing sample distribution estimates of the impulse responses against static cross-sectional correlates, are statistically significant at all steps apart from the first (Table 4).[20] A significant, inverse relationship is also found between bank capitalization (Tier I capital ratio, Tier II capital ratio, and Core Tier I capital ratio), and bank lending.

6.1.3 Discussion of Results

The relationship between bank capitalization and credit supply has been tested both theoretically and empirically. Numerous studies show that in response to tighter regulation, larger and better-capitalized banks are least likely to contract credit supply for two reasons: (i) larger banks (with higher net worth) face lower agency costs of borrowing, allowing them to raise external funds more readily than smaller banks (Bernanke and Gertler, 1995; Holmstrom and Tirole, 1997); and (ii) better-capitalized banks have more equity to absorb losses following unanticipated shocks to their loan portfolios (Kishan and Opiela, 2000; Van den Heuvel, 2002).

On the contrary, it is argued that better-capitalized banks, more risk-adverse than their counterparts, maintain higher capital ratios because their lending portfolios are inherently riskier (Kim and Santomero, 1988; Rochet, 1992; Hellman, Murdock and Stiglitz, 2000). Thus, banks with higher capital buffers respond more negatively to regulatory shocks because they select ex ante riskier lending portfolios with higher returns. This could potentially explain why larger Italian banks, despite boasting higher capital ratios and capital buffers, may be exhibiting the most extreme negative responses to regulatory shocks (Figures

[19] Size classifications are made by banks' average total assets (in euros) since 2000. Small cap represents banks with total assets under 20000 euros, mid cap between 20000 euros and 40000 euros, and large cap over 40000 euros.

[20] The static cross-sectional correlates represent bank-specific characteristics (averaged since 2000). These bank-specific correlates are individually regressed against the associated bank's lending response to common regulatory shocks for each step of the impulse response. Refer to Equation 1 of Technical Appendix A.2 for details.

23 and 24).

Another plausible explanation for bank-level heterogeneity is credit quality. Specifically, a high stock of NPLs can affect credit supply through three channels: (i) deteriorating credit quality translates into higher risk weights and lower effective capital ratios, prompting banks to curb lending by more drastic amounts; (ii) higher NPL burdens may signal greater idiosyncratic risk or managerial problems, raising banks' external funding costs in ways that dampen credit supply; and (iii) the need to accumulate higher loan-loss provisions (to maintain the coverage ratio) may depress banks' return on assets and profitability levels. It follows that larger Italian banks, inheriting the highest proportion of NPLs and NPAs in the sample, are the most vulnerable to unanticipated shocks to their portfolios (Figures 27 and 29).

6.2 German Bank Responses to Regulatory Shocks

6.2.1 Impulse Responses and Variance Decompositions

In relative terms, the German median response to regulatory shocks is 0.01 percent after five years compared to -1.79 percent in Italy (Figure 9). There is less heterogeneity in long-run lending responses in Germany than in Italy, the former ranging from -0.07 percent (25th quantile) to 0.04 percent (75th quantile), and the latter from -1.39 percent to 0.01 percent. Finally, regulatory shocks account for relatively more of the variation in German bank lending than (Italian) bank lending – between 3 percent (3 percent) and 21 percent (18 percent) averaged across all time periods (Figure 11).

As in Italy, this heterogeneity can be explained by bank size – larger German banks exhibit positive loan growth across all periods, peaking in the fifth year (0.58 percent) and plateauing at 0.44 percent after ten years (Figure 10). Credit supply is permanently restricted for smaller German banks, however, with values hovering around -0.21 percent on average. This tightening effect is less drastic in Germany than in Italy, where lending for larger banks is cut by -5.40 percent in the steady-state.

6.2.2 Second Stage Results

Contrary to the Italian case, German bank lending responses are positively correlated with banks' total assets, but negatively correlated with NPLs and NPAs (Table 5). In line with the intuition above, larger German banks are the least burdened by impaired loans, rendering them less susceptible to cuts in lending (Figure 28 and 30). Figures 27 and 28 contrast the composition of NPLs among larger Italian and German banks, the former making up an average ratio of 11.94 percent of NPLs-to-total loans compared to 1.33 percent for the latter. For smaller banks, this value is 7.47 percent in Italy against 3.18 percent in Germany. This is evidence to suggest that in periods of tighter regulation, bank credit quality is a critical determinant of bank lending.

Replicating the second stage analysis for variance decompositions, German and Italian bank-level variation is primarily driven by NPLs, NPAs, and other measures of capitalization (Table 7). The coefficient on total assets is not significant when correlated against German bank-specific variance decompositions, but is for Italy. Specifically, regulatory shocks account for a mere 2.2 percent of the variation in lending for the top-four Italian banks compared to 6.02 percent for the top-five German banks.

6.3 European Bank Responses to Regulatory Shocks

The use of time series SVAR methods to estimate coefficients for French, Spanish, and Portuguese banks poses two empirical challenges. First, the time series data for Spain and Portugal are of an insufficient length for conventional VAR analysis. Second, the amount of noise in French bank data would generate unreliable estimates from traditional time-series analysis. In this context, it is reasonable to employ Pedroni's (2013) fitted value method to interpolate dynamics for non-panel-member banks. This approach exploits the orthognoalization property of structural identification methods to simulate heterogeneous lending responses to common regulatory shocks. In doing so, it accounts for both cross-sectional dependence and dynamic heterogeneity in bank-specific lending responses.

Impulse responses for 30 French, 30 Spanish, and 15 Portuguese are obtained using the fitted regression values from the second stage.[21] This process involves regressing the estimated common lending responses of a panel of 57 German and Italian banks against a static cross-sectional correlate.[22] The correlated static measure used in this analysis is NPAs-to-total assets, which exhibits significance at the 10 percent level for all 20 steps of the impulse response. This method is not without its shortcomings, however, as it implicitly assumes that NPAs are inversely correlated with bank lending in France, Spain, and Portugal. This is not a trivial exercise, however, as NPAs are bound to impact bank profitability and weigh in on the allocation of credit.

The fitted dynamics in Figure 12 compare the lending responses of Italian, German, French, Spanish, and Portuguese banks to a common one percent hike in the total capital requirement. The average lending responses for France (Figure 31) and Spain (Figure 32) closely mimic that of Italy, reaching their lowest points after three years, and remaining in negative territory in the long-run. The steady-state value for French banks is -1.25 percent compared to -1.26 percent for Italian banks and -0.68 percent for Spanish banks. This tightening effect is much less pronounced in Portugal (Figure 33), where bank lending is

[21]Refer to Equation 1 in Technical Appendix A.2

[22]Refer to Equation 2 in Technical Appendix A.3

positive after the second year (0.35 percent) and fourth year (0.14 percent), and zero or mildly negative otherwise. Such dynamics resemble that of German banks, in which 75 percent of banks exhibit neutral or positive loan responses to regulatory shocks.

The European lending responses closely mimic the data on national NPL-to-total gross loans across Europe (Figure 14). As per the IMF's Financial Soundness Indicator, France (4.51 trillion), Spain (2.78 trillion), and Italy (2.52 trillion) are burdened by a much higher volume of NPLs relative to Portugal (1.75 trillion).[23] While the data are unavailable for Germany, cross-country statistics show that the NPL-to-total gross loan ratio stood at 14.38 percent for Italy compared to 1.50 percent for Germany in 2018 (Figure 15). This corroborates the underlying hypothesis that NPLs are potentially the main determinant of bank lending during periods of regulatory tightening.

Comparing results for all five European countries reveals that bank size is an important predictor of bank lending (Figure 13). Specifically, a significant inverse relationship exists between total assets and lending responses at most steps of the impulse response. At the national level, the top-five French banks cut lending by an average of -7.20 percent (compared to -0.01 percent for the remaining sample), while in Spain the top-three banks curb credit by -6.09 percent (compared to -0.02 percent) across all time period (Figures 34 and 35). No such relationship can be inferred for Portuguese banks, where smaller banks exhibit similar negative lending patterns to their larger counterparts (Figure 36). Unlike in Italy and Germany, this result cannot be explained by bank asset quality – in France and Spain, the largest banks inherit the lowest stock of NPLs to total loans.

[23] Refer to http://data.imf.org/fsi.

7 Conclusion

There is a strong consensus that reforming the global financial system requires a phasing-in of higher capital requirements. All else equal, this should curb risk-taking, reduce the procyclicality of lending, and foster long-run financial stability. Using panel data for 29 Italian banks, this paper has shown that the transition towards more stringent requirements will not be seamless. Specifically, it finds that anticipations of tighter capital requirements are associated with a permanent and economically-sizable contraction in bank lending. There is evidence of significant cross-bank heterogeneity in lending responses, with larger and more NPL-burdened Italian banks exhibiting the sharpest reductions in credit.

The implication is that tighter capital requirements may have adverse macroeconomic consequences via reduced consumption and investment. This is critical as Italian households and firms, traditionally reliant on local banks for funding, may be starved of potential bank credit.[24] While the slowdown in bank lending may be picked up by non-bank financial institutions (NBFIs), this will likely exacerbate overall financial fragility. It is argued that largely unsupervised NBFIs, operating outside the purview of regulators, have the potential to fuel credit bubbles and asset overpricing.[25]

It should be emphasized, however, that a slowdown in bank lending need not be an undesirable feature over the long-term. As exemplified by the recent GFC, the build-up of excess leverage contributed to an unsustainable debt boom that left 'debt overhang' in its wake.[26] The ensuing deleveraging process, which has involved an extensive clean-up of bank balance sheets, is often cited as a precondition for sustained macroeconomic stability. In this light, a contraction in bank credit may be perceived as a positive upshot of tighter regulation, relieving Italian banks of their existing NPL burdens.

[24] Larger Italian banks make up 88.2 percent of bank lending in the sample. In the aggregate, Italian banks accounted for approximately 68 percent of total credit in Italy in 2018 (FSB, 2019).

[25] Refer to FSB (2019) for statistics on NFBIs in Italy.

[26] Cohen, Benjamin H. "How have banks adjusted to higher capital requirements?." BIS Quarterly Review, September (2013). Pp. 27

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9 Figures and Tables

Table 1: Italian Bank Characteristics

	Average	**Median**	**Minimum**	**Maximum**	**Std Dev**
Loans					
Gross Loans	66586.2	22334.4	68.8	586055.0	119918.4
Commerical Loans	10359.9	4315.4	34.6	74316.2	15840.9
	[23.6%]	[18.7%]	[2.0%]	[100.0%]	[11.8%]
Mortgage Loans	31886.6	11034.0	0.1	209070.0	50632.0
	[45.2%]	[47.2%]	[0.1%]	[73.9%]	[20.5%]
Consumer Loans	2773.1	502.7	2.9	21426.6	5393.6
	[5.1%]	[2.5%]	[0.2%]	[68.7%]	[7.7%]
Lease Finance	4781.2	1138.3	0.0	39458.8	8557.0
	[4.8%]	[4.7%]	[0.0%]	[13.7%]	[2.7%]
Other Loans	21714.8	4122.0	3.6	248509.0	45859.2
	[23.5%]	[19.4%]	[0.4%]	[74.0%]	[17.6%]
Domestic Loans	64597.3	22317.9	68.8	586055.0	116853.3
	[96.6%]	[100.0%]	[100.0%]	[24.9%]	[14.0%]
Foreign Loans	10422.8	402.3	1.1	66889.0	18790.7
	[6.4%]	[4.6%]	[0.1%]	[22.5%]	[5.5%]
Impaired Loans	8760.0	2081.2	1.3	84359.0	17001.6
	[10.5%]	[7.3%]	[0.6%]	[47.3%]	[11.0%]
Capital Ratios					
Tier I Capital Ratio	9.9%	8.6%	4.3%	135.2%	8.5%
Tier II Capital Ratio	3.2%	2.9%	30.4%	0.2%	2.9%
Total Capital Ratio	13.3%	10.4%	7.6%	29.3%	5.4%
Capital Level					
Tier I Capital	5619.9	1765.4	18.6	54703.0	10597.8
Tier II Capital	2025.6	542.6	0.1	21034.0	3707.1
Total Capital	7393.4	2262.8	19.0	64454.2	13684.4
Capital Buffer					
Tier I Capital Buffer	4.9%	4.6%	0.4%	11.2%	2.0%
Tier II Capital Buffer	-1.8%	-1.7%	-4.0%	-0.1%	0.8%
Total Capital Buffer	3.6%	3.3%	-1.5%	10.9%	2.2%
Asset Quality					
Non-Performing Loans	9.0%	9.6%	1.9%	16.5%	4.0%
Non-Performing Assets	6.6%	6.8%	0.1%	13.2%	3.3%
Allow. for Credit Losses	14.8%	5.4%	0.8%	122.3%	25.1%
Key Financials					
Total Assets	87653.9	24768.8	-13.0	823908.2	204466.0
Total Equity	32509.6	1804.6	-96.4	823908.2	152505.4
Total Revenue	7575.5	1339.6	-1431.9	78933.0	17035.9
Net Income	7575.5	1339.6	-1431.9	78933.0	17035.9
Profitability					
Return on Assets	0.3%	0.3%	-1.2%	1.7%	0.5%
Return on Equity	4.2%	3.7%	-22.5%	29.9%	10.5%
SG&A Margin	107.6%	80.2%	43.4%	566.3%	93.9%

Notes: Data averaged for 29 Italian regional and diversified banks from Q4 2000 to Q4 2018. Brackets denote loan type as a percentage of total loans. Allowance for Credit Losses and Non-Performing Loans expressed as a fraction of total loans; Non-Performing Assets as a fraction of total assets. Key financial variables reported in Euros.

Table 2: German Bank Characteristics

	Average	**Median**	**Minimum**	**Maximum**	**Std Dev**
Loans					
Gross Loans	76683.9	27562.8	398448.0	204.0	89076.8
Capital Ratios					
Tier I Capital Ratio	15.1%	12.0%	4.0%	54.7%	9.7%
Tier II Capital Ratio	3.8%	3.7%	0.0%	8.5%	1.9%
Total Capital Ratio	18.3%	15.2%	8.4%	54.7%	9.6%
Capital Level					
Tier I Capital	5519.6	2298.0	287.1	31727.0	7149.8
Total Capital	6994.6	2435.7	354.0	41437.0	9183.7
Capital Buffer					
Tier I Capital Buffer	10.3%	7.2%	0.0%	50.7%	9.4%
Total Capital Buffer	10.2%	7.2%	0.4%	49.9%	9.6%
Asset Quality					
Non-Performing Loans	2.8%	2.2%	16.0%	0.0%	2.5%
Non-Performing Assets	1.8%	1.3%	12.8%	0.0%	2.0%
Allow. for Credit Losses	1.3%	1.1%	5.7%	0.0%	1.1%
Key Financials					
Total Assets	144750.4	45693.0	844103.0	2589.3	180154.7
Total Equity	4942.0	1753.1	30125.0	235.2	6718.9
Total Revenue	1913.9	487.0	17915.0	-2387.0	3248.3
Net Income	78.8	79.1	1917.0	-6297.0	789.9
Profitability					
Return on Assets	0.2%	0.2%	1.3%	-3.5%	0.5%
Return on Equity	2.2%	5.7%	21.1%	-207.5%	20.3%
SG&A Margin	2.2%	5.7%	21.1%	-207.5%	20.3%

Notes: Data averaged for 28 German regional and diversified banks from Q4 2000 to Q4 2018. Brackets denote loan type as a percentage of total loans.Allowance for Credit Losses and Non-Performing Loans expressed as a fraction of total loans; Non-Performing Assets as a fraction of total assets. Key financial variables reported in Euros.

Table 3: Financial Glossary

Variable	Definition
Capitalization	
Tier I Capital	Includes Common Stockholders' Equity Capital, Non-Cumulative Perpetual Preferred Stock and any related surplus, Minority Interests in Equity Capital Accounts of Consolidated Subsidiaries. Excludes Goodwill, Other Disallowed Intangible Assets, and Disallowed Deferred Tax Assets.
Tier II Capital	Includes Preferred Stock not qualifying as Tier I, Long-term Debt and other instruments qualifying as Tier II, Aggregate Allowance for Credit Losses up to a certain percentage of Risk-Weighted Assets. Excludes Investments in certain subsidiaries.
Total Capital	Sum of Tier I Capital and Tier II Capital.
Risk-Weighted Assets	Total of 'on' and 'off' balance sheet items calculated by assigning risk weights as per the guidelines issued by the FDIC.
Tier I Capital Ratio	Tier I Capital as a percentage of Total Risk-Weighted Assets.
Total Capital Ratio	Total Capital as a percentage of Total Risk-Weighted Assets.
Loans	
Gross Loans	Gross amount of loans advanced to borrowers. Includes loans given to banks, loans given to customers, financial leases, and total portfolio loans. Excludes loans held for sale.
Commercial Loans	Loans disbursed to a Corporation, Commercial Enterprise, or Joint Venture, usually short-term, as a source of Working Capital not backed by a Mortgage Security.
Mortgage Loans	Long-term Commercial Loans secured by Real Estate.
Consumer Loans	Loans given to individuals for the purchase of domestic and household durable goods on hypothecation. It includes all forms of installment credit other than Home Mortgage Loans and Open-End Credits.
Lease Finance	A contract between a lessor and a lessee for the use of an asset, subject to state terms and limitations, for a specified period and at a specified payment.
Other Loans	Loans given by the Bank other than Commercial Domestic Loans, Construction Loans, Commercial Mortgage Loans, Residential Mortgage Loans, Consumer Loans, Foreign Loans, and Lease Financing.
Domestic Loans	Loans given by the bank to customers inside the country where it is situated.
Foreign Loans	Loans given by the bank to customers outside the country where it is situated through its foreign branches and subsidiaries.

Notes: Variable definitions taken from S&P Global Capital IQ Financial Glossary.

Table 4: Italy Second Stage Results

Variable	Year 1	Year 2	Year 3	Year 5	Year 10	Year 15
Total Assets	0.010*	-0.013***	-0.045***	-0.072***	-0.071***	-0.071***
in millions	[0.006]	[0.003]	[0.013]	[0.021]	[0.019]	[0.019]
Total Revenue	3.921	-8.461***	-3.022***	-4.711***	-4.624***	-4.625***
in millions	[0.326]	[1.759]	[0.666]	[0.926]	[0.942]	[0.942]
Net Income	-0.031	-0.480**	-0.227	-0.301**	-0.305**	-0.304**
in thousands	[0.034]	[0.222]	[0.079]	[0.132]	[0.118]	[0.118]
Non-Performing Assets	-0.849	-32.42***	-12.48***	-20.64***	-17.53***	-17.63***
% total assets	[2.276]	[14.81]	[5.431]	[8.348]	[7.999]	[7.989]
Non-Performing Loans	-0.398	-26.45**	-10.03**	-16.61**	-14.35**	-14.43**
% total loans	[1.683]	[10.70]	[3.939]	[6.241]	[5.770]	[5.760]
Tier I Capital Ratio	-0.103	-1.247*	-0.526**	-0.816**	-0.710*	-0.719**
	[0.099]	[0.658]	[0.023]	[0.384]	[0.353]	[0.353]
Core Tier I Capital Ratio	-0.000	-2.075***	-0.796***	-1.223***	-1.170***	-1.171***
	[0.000]	[0.306]	[0.101]	[0.179]	[0.154]	[0.152]
Tier II Capital Ratio	0.077	-3.507 ***	-1.256***	-2.090***	-1.827***	-1.845***
	[0.140]	[1.072]	[0.392]	[0.628]	[0.583]	[0.581]
Total Equity + Loan Loss Allowance	-0.010	-1.991**	-0.775**	-1.250**	-1.063**	-1.072**
% total loans	[0.128]	[0.807]	[0.296]	[0.472]	[0.437]	[0.436]
Provision for Loan Losses	-0.051	-0.828	-0.353*	-0.542*	-0.464	-0.470
% total loans	[0.081]	[0.545]	[0.199]	[0.320]	[0.293]	[0.293]
Common Equity	-1.589	-19.12**	-75.09	-12.24**	-10.49**	-10.56**
% total equity	[1.234]	[8.046]	[2.940]	[4.683]	[4.331]	[4.332]

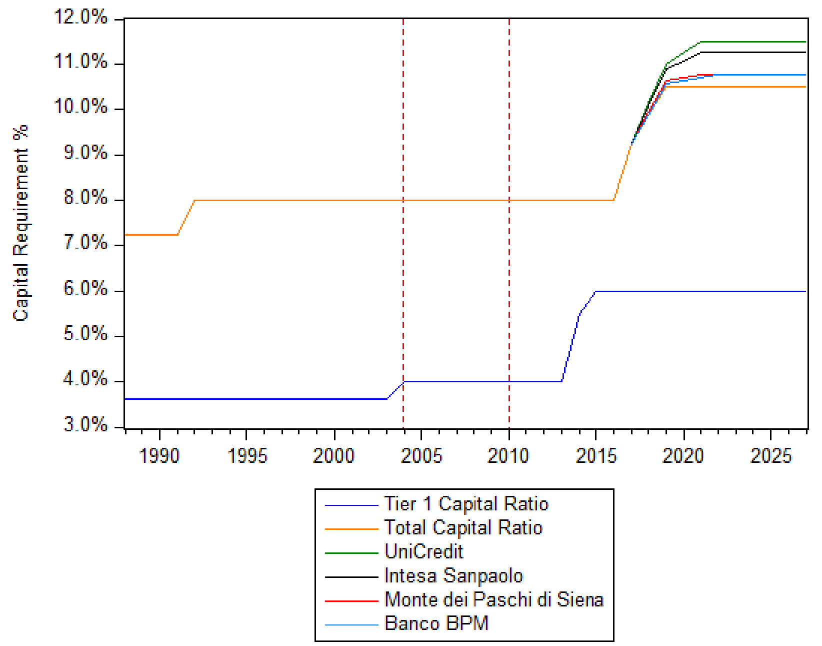
Notes: This table presents coefficients from the bivariate regression described in Equation 1 of the Technical Appendix. Each bank-specific outcome variable (averaged since 2000) is regressed against the corresponding bank-specific response of gross loans to common regulatory shocks. Significant results indicate a correlation between bank-specific characteristics and dynamic impulse responses. Standard errors in brackets. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 5: Germany Second Stage Results

Variable	Year 1	Year 2	Year 3	Year 5	Year 10	Year 15
Total Assets	0.021*	0.012*	0.016*	0.019**	0.037*	0.014*
in millions	[0.020]	[0.005]	[0.009]	[0.005]	[0.007]	[0.007]
Total Revenue	1.224	0.706*	0.914	1.112*	0.774	0.778
in millions	[0.842]	[0.399]	[0.624]	[0.061]	[0.479]	[0.483]
Net Income	-0.025	-0.106	-0.143	-0.167*	-0.124	-0.125
in thousands	[0.013]	[0.061]	[0.094]	[0.092]	[0.072]	[0.072]
Total Liabilities	0.022*	0.012*	0.017*	0.020**	0.014*	0.014*
in millions	[0.012]	[0.006]	[0.009]	[0.009]	[0.007]	[0.007]
Total Equity	0.537	0.306	0.427	0.491*	0.351	3.561
in millions	[0.369]	[0.175]	[0.270]	[0.265]	[0.208]	[0.210]
Total Investments	0.050*	0.028**	0.037*	0.045**	0.031*	0.031*
in millions	[0.027]	[0.013]	[0.020]	[0.019]	[0.015]	[0.015]
Non-Performing Assets	-8.221**	-14.37	-57.92**	-45.58	-42.22*	-41.94*
% total assets	[3.223]	[19.33]	[24.26]	[26.87]	[19.91]	[19.99]
Non-Performing Loans	-8.210**	-14.37	-57.96**	-45.50	-41.93*	-41.89*
% total loans	[3.022]	[19.33]	[24.25]	[26.87]	[19.91]	[19.99]

Standard errors in brackets. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Figure 1: Evolution of Capital Requirements for Italian Banks



Notes: Vertical dashed lines denote publication of Basel II (June 2004) and Basel III (December 2010) regulatory frameworks.

Figure 2: Descriptive Statistics for Italian Banks

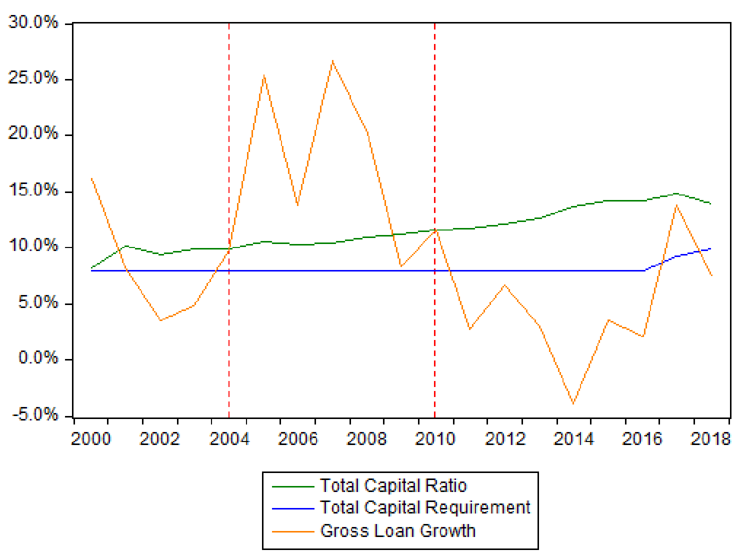
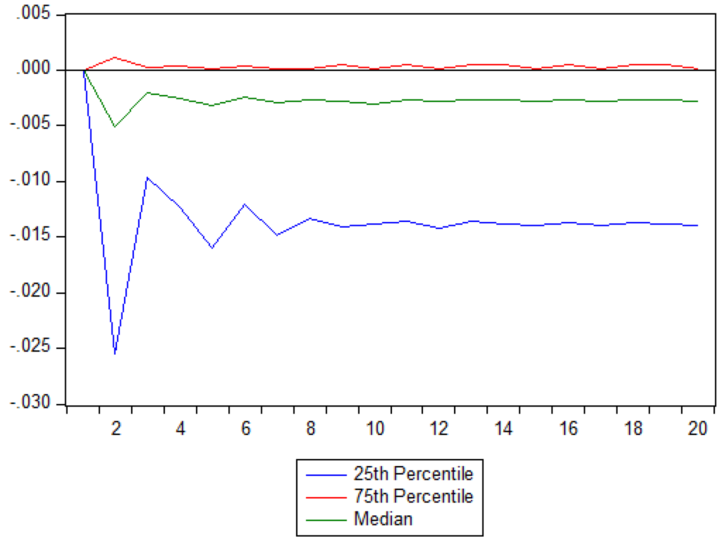
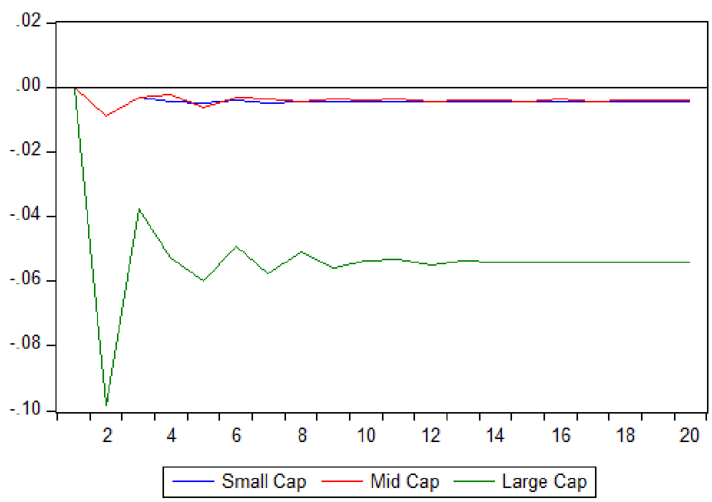


Figure 3: Response of Italian Bank Lending to Common Regulatory Shocks



Notes: This figure exhibits the annual response of gross loans to a one-unit common regulatory shock in percentage terms (or equivalently, a shock that raises the total capital requirement by one percent). Period-by-period regulatory shocks are interpreted as shared bank anticipations of future regulatory changes.

Figure 4: Common Italian Lending Responses by Bank Size



Notes: Size classifications are made by banks' average total assets (in euros) since 2000. Small cap represents banks with total assets under 20000 euros, mid cap between 20000 and 40000 euros, and large cap over 40000 euros.

Figure 5: Median Italian Lending Responses by Loan Type

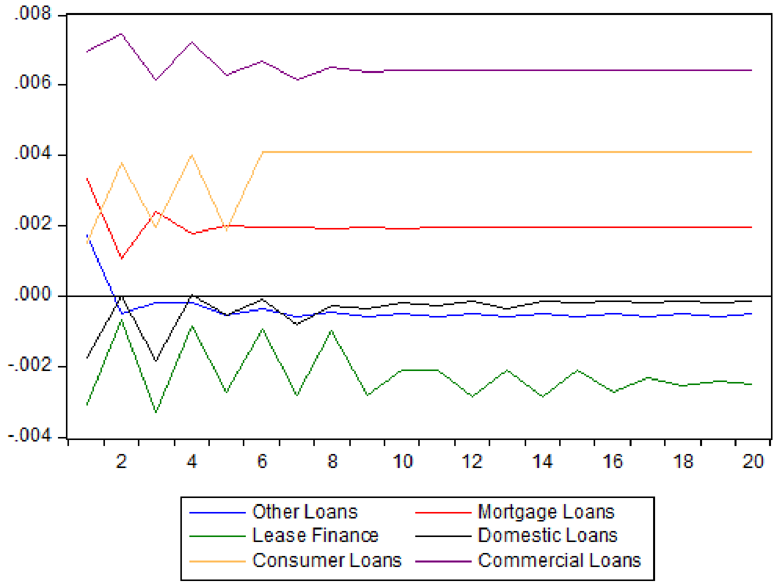
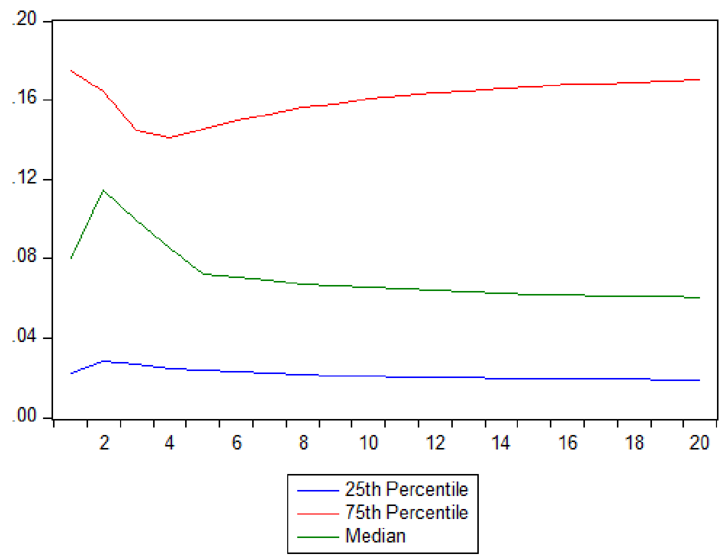
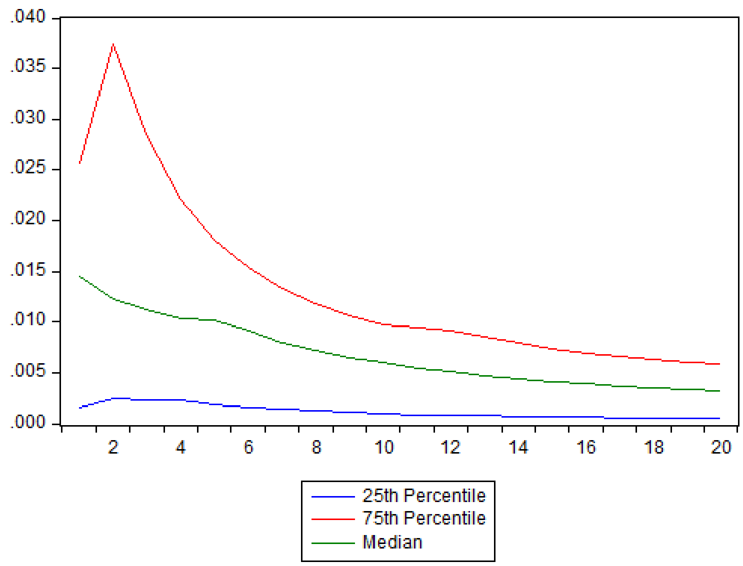


Figure 6: Share of Variance of Italian Bank Lending due to Regulatory Shocks



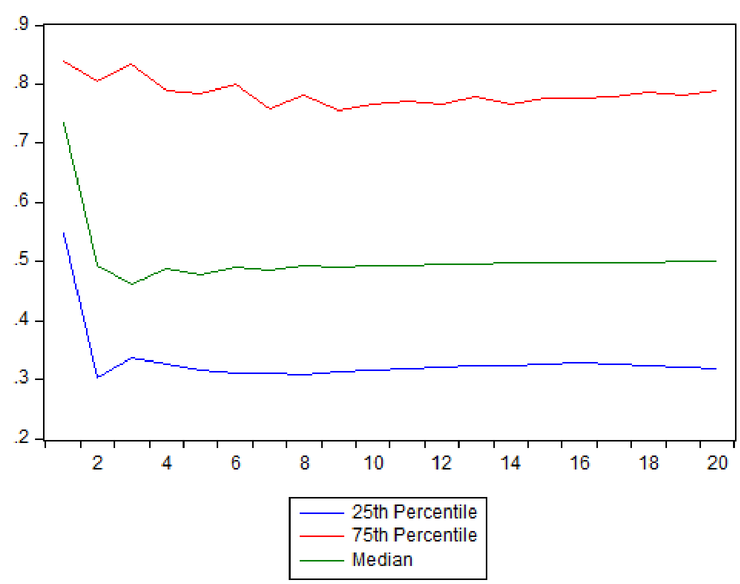
Notes: Variance decompositions quantify the relative importance of a regulatory shock relative to all others shocks in the system. This figure describes the percent variation in Italian bank lending to a one-unit increase in the total capital requirement.

Figure 7: Share of Variance of Italian Bank Lending due to Global Shocks



Notes: Global shocks impact bank total capital buffers, total capital levels, and gross loans in the contemporaneous period and in the long-run.

Figure 8: Share of Variance of Italian Bank Lending due to Profitability Shocks



Notes: Profitability shocks impact bank total capital levels and gross loans in the short- and long-run, but total capital buffers only in the long-run.

Figure 9: Response of German Bank Lending to Common Regulatory Shocks

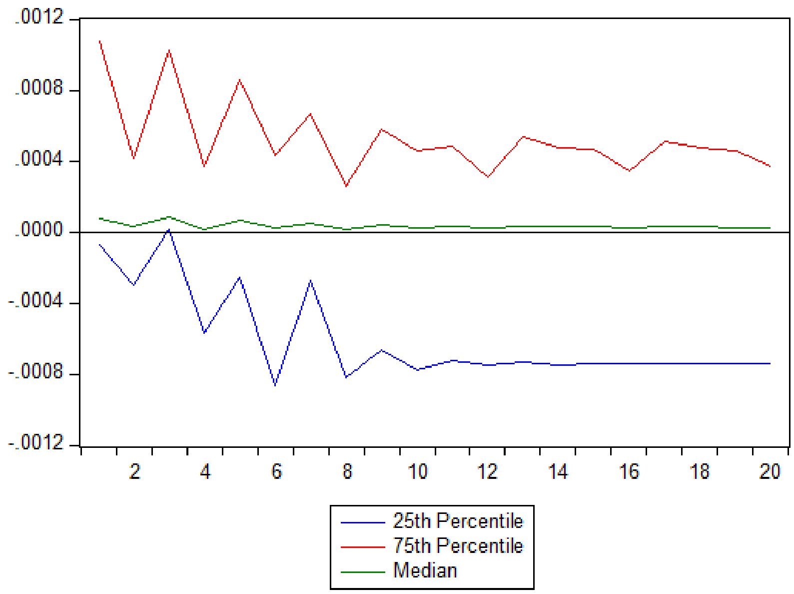
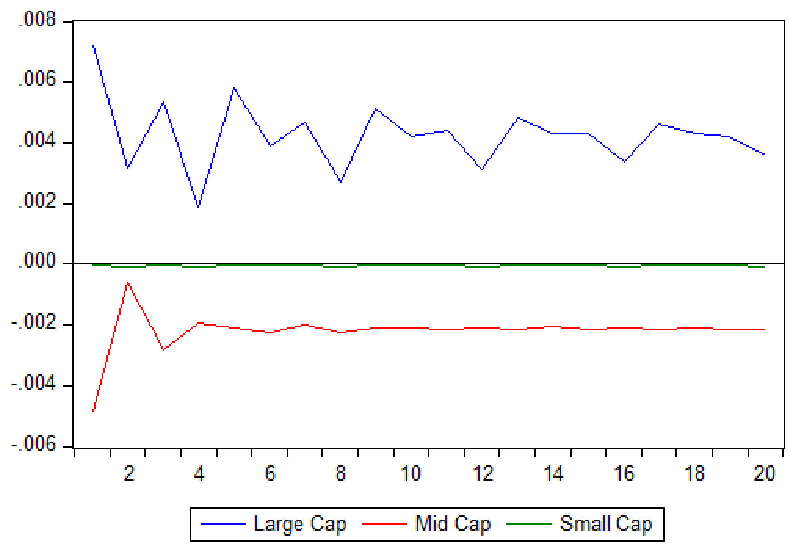


Figure 10: Common German Lending Responses by Bank Size



Notes: Size classifications are made by banks' average total assets (in euros) since 2000. Small cap represents banks with total assets under 20000 euros, mid cap between 20000 and 40000 euros, and large cap over 40000 euros.

Figure 11: Share of Variance of German Bank Lending due to Regulatory Shocks

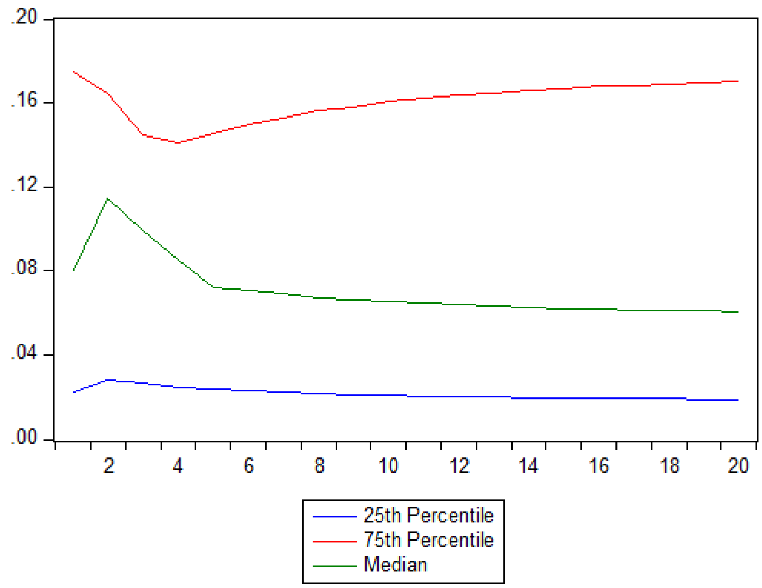
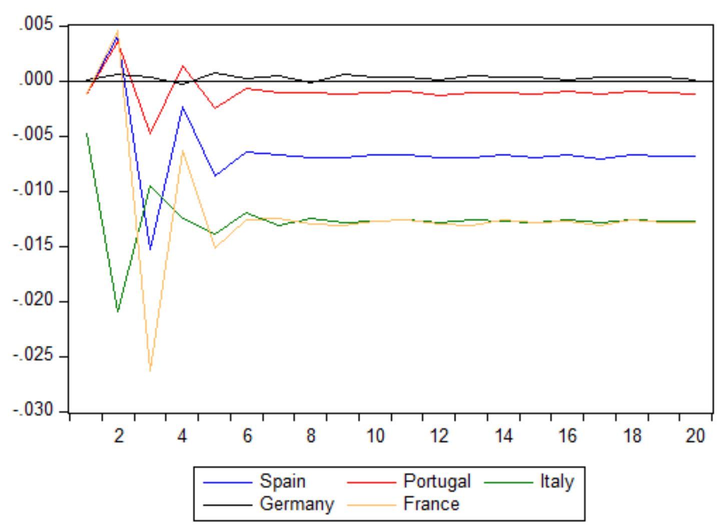
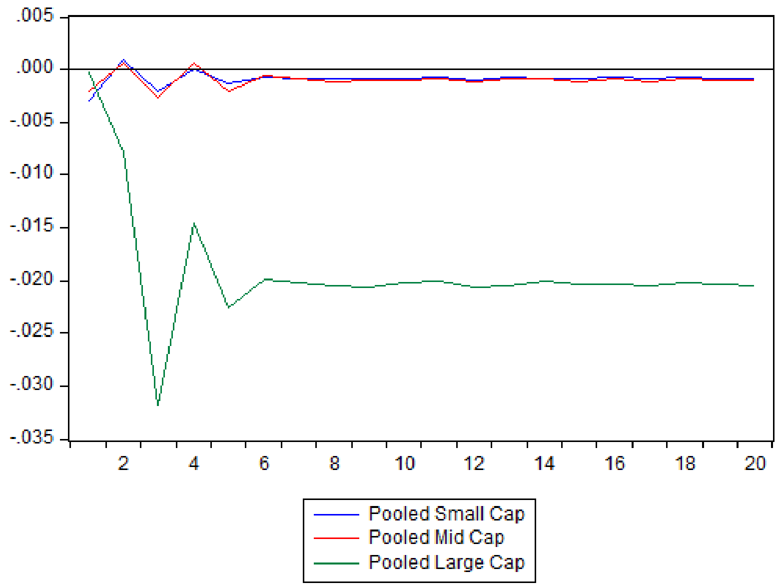


Figure 12: Response of Average European Bank Lending to Regulatory Shocks



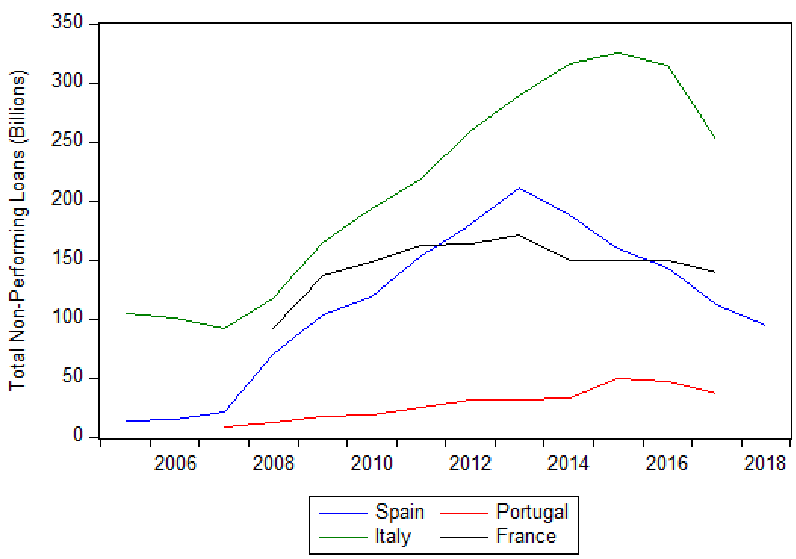
Notes: Average French, Spanish, and Portuguese bank lending responses generated using fitted value method developed in Pedroni (2013).

Figure 13: Pooled European Bank Lending Responses by Bank Size



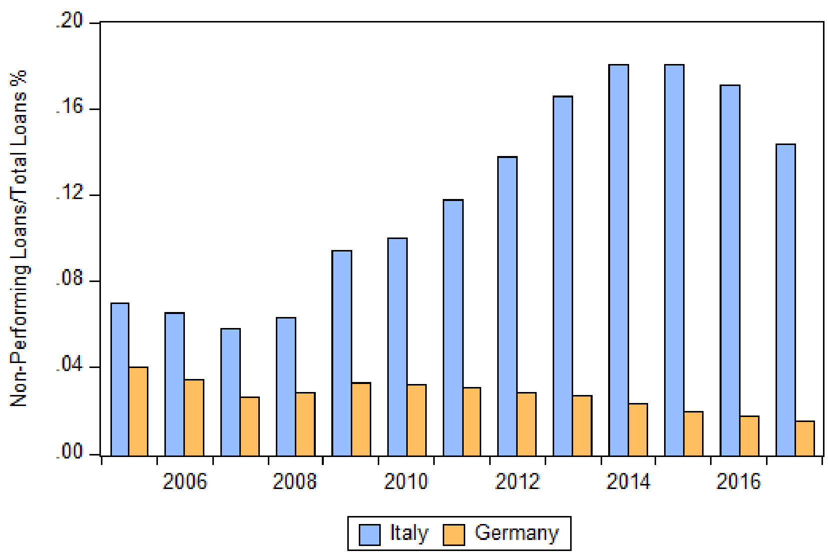
Notes: Size classifications are made by banks' average total assets (in euros) since 2000. Small cap represents banks with total assets under 10000 euros, mid cap between 10000 and 40000 euros, and large cap over 40000 euros.

Figure 14: Total Non-Performing Loans for Eurozone Countries



Notes: Data from IMF FSI database: http://data.imf.org/fsi.

Figure 15: Comparative Non-Performing Loans to Total Gross Loans



Notes: Data from IMF FSI database: http://data.imf.org/fsi.

Appendices

A Technical Appendix

A1. Estimation Algorithm for Panel SVARs[27]

First consider a three-dimensional demeaned structural vector moving average (VMA) with dimensions $i = 1, ...N, t = 1, ...T_i$ to denote an unbalanced panel:

$$\Delta z_{it} = A_i(L)\varepsilon_{it}$$

where $A_i(L)$ is the matrix polynomial in the lag operator L; ε_{it} is a vector of unobservable structural shocks with mean zero and $E[\varepsilon_{it}\varepsilon'_{it}] = I_{MxM}$; and Δz_{it} is a vector of observed endogenous variables.

To identify the unobserved structural shocks ε_{it}, it is necessary to find a unique mapping from the reduced form $\{F_i(L), \mu_{it}\}$ to the structural form $\{A_i(L), \varepsilon_{it}\}$:

$$\Delta z_{it} = F_i(L)\mu_{it} = A_i(L)\varepsilon_{it}$$

This process requires imposing a set of recursive immediate effect restrictions on $A_i(0)$ and steady state restrictions on $A_i(1)$. Since $F_i(0) = I$, evaluating at L=0:

$$F_i(0)\mu_{it} = A_i(0)\varepsilon_{it}$$

$$\mu_{it} = A_i(0)\varepsilon_{it}$$

$$\varepsilon_{it} = A_i(0)^{-1}\mu_{it}$$

Since $F_i(L)A_i(0) = A_i(L)$, evaluating at L=1:

$$F_i(1)A_i(0) = A_i(1)$$

$$A_i(0) = F_i(1)^{-1}A_i(1)$$

Letting $\Omega_{\mu,i} = E[\mu_{it}\mu'_{it}]$ be the variance-covariance matrix of the reduced form shocks and $\Omega_{\varepsilon,i} = E[\varepsilon_{it}\varepsilon'_{it}]$ be that of the structural form shocks:

$$\Omega_{\mu,i}(0) = E[\mu_{it}\mu'_{it}] = E[F_i(0)\mu_{it}\mu'_{it}F_i(0)'] = E[A_i(0)\varepsilon_{it}\varepsilon'_{it}A_i(0)']$$

$$= A_i(0)E[\varepsilon_{it}\varepsilon'_{it}]A_i(0)'$$

$$\Omega_{\mu,i}(0) = A_i(0)A_i(0)'$$

$$\Omega_{\mu,i}(1) = E[\mu_{it}\mu'_{it}] = E[F_i(1)\mu_{it}\mu'_{it}F_i(1)'] = E[F_i(1)A_i(0)\varepsilon_{it}\varepsilon'_{it}A_i(0)'F_i(1)']$$

$$= E[A_i(1)\varepsilon_{it}\varepsilon'_{it}A_i(1)'] = A_i(1)E[\varepsilon_{it}\varepsilon'_{it}]A_i(1)'$$

$$\Omega_{\mu,i}(1) = A_i(1)A_i(1)'$$

[27] Refer to Pedroni, Peter. "Lecture Notes for Topics in Advanced Econometrics" Pp. 378-398

This system of equations is under-determined without a set of identifying restrictions. Specifically, estimations of the reduced form short-run covariance matrix $\Omega_{\mu,i}(0)$ and the long-run covariance matrix $\Omega_{\mu,i}(1)$ provide only $\sum_{k=1}^{N} k = \frac{1}{2}N(N+1)$ restrictions for the unknown elements of the short-run matrix $A_i(0)$ and long-run matrix $A_i(1)$, respectively.

To obtain consistent estimates of the heterogeneous member-specific impulse responses and variance decompositions, Pedroni (2013) exploits the orthogonality conditions associated with structural time series identification to decompose structural shocks into their orthogonal idiosyncratic and common components:[28][29]

$$\varepsilon_{it} = \Lambda_i' \bar{\varepsilon}_t + \tilde{\varepsilon}_{it}$$

$$E[\varepsilon_{it}\varepsilon_{it}'] = \begin{bmatrix} \Omega_{i,\bar{\varepsilon}} & 0 \\ 0 & \Omega_{i,\tilde{\varepsilon}} \end{bmatrix}$$

$$E[\varepsilon_{it}] = 0 \,, E[\tilde{\varepsilon}_{it}\tilde{\varepsilon}_{it}'] = 0 \,, E[\bar{\varepsilon}_t\bar{\varepsilon}_t'] = 0$$

where ε_{it} are composite structural shocks; $\bar{\varepsilon}_t$ are common structural shocks; $\tilde{\varepsilon}_{it}$ are idiosyncratic structural shocks; Λ_i is a diagonal matrix that reflect the relative importance of common shocks; and $\Omega_{i,\bar{\varepsilon}}$ and $\Omega_{i,\tilde{\varepsilon}}$ are diagonal covariance matrices with arbitrarily normalizable variances.[30]

The composite structural shocks ε_{it} are obtained by running individual time series SVARs for each panel member. The common structural shocks $\bar{\varepsilon}_t$ can be recovered by computing the common time effects of the differenced data:

$$\Delta\bar{z}_t = N_t^{-1} \sum_{i=1}^{N_t} \Delta z_{it}$$

Pedroni (2013) shows that when the cross sectional averages contain identifiable information on the common shocks when the structural shocks are orthogonal to one another. This is because the role of idiosyncratic shocks in driving movements in the cross sectional averages becomes negligible as the cross sectional dimension grows large:

$$\Delta\bar{z}_t = N_t^{-1} \sum_{i=1}^{N_t} A_i(L)(\Lambda_i\bar{\varepsilon}_t + \tilde{\varepsilon}_{it})$$

$$\Delta\bar{z}_t = \left(N_t^{-1} \sum_{i=1}^{N_t} A_i(L)\Lambda_i \right) \bar{\varepsilon}_t + N_t^{-1} \sum_{i=1}^{N_t} A_i(L)\tilde{\varepsilon}_{it}$$

[28] Idiosyncratic structural shocks are member-specific and do not have an impact beyond the aggregation unit of individual panel members. Common structural shocks have an impact beyond the aggregation unit of individual panel members.

[29] This method is robust to the potential combination of cross sectional dependence and dynamic heterogeneity.

[30] Pedroni, Peter. "Lecture Notes for Topics in Advanced Econometrics" Pp. 397

$$N_t^{-1}\sum_{i=1}^{N_t} A_i(L)\Lambda_i\tilde{\varepsilon}_t \to E[A_i(L)\tilde{\varepsilon}_{it}] = A_i(L)E[\tilde{\varepsilon}_{it}] = 0 \; as \; N_t \to \infty$$

$$\Delta\bar{z}_t \to \left(N_t^{-1}\sum_{i=1}^{N_t} A_i(L)\Lambda_i\right)\bar{\varepsilon}_t \; as \; N \to \infty$$

where $\bar{A}_i = A_i(L)\Lambda_i$ is the member-specific response to a common structural shock.

The time effects can then be used to estimate the reduced form VARs for each panel member i using a specified information criteria to compute the lag truncation P_i:

$$\bar{R}(L)\Delta\bar{z}_t = \bar{\mu}_t$$

$$\bar{R}(L) = I - \sum_{j=1}^{\bar{P}} \bar{R}_j L^j$$

Estimates of the common structural shocks can be obtained using a set of structural identifying restrictions that relate the VMA form to the structural form: $\bar{\varepsilon}_t$:

$$\Delta\bar{z}_t = \bar{F}(L)\bar{\mu}_t = \bar{A}(L)\bar{\varepsilon}_t$$

Evaluating at L=0 yields mappings of the reduced form to the structural form via the impact matrix $\bar{A}(0)$:

$$\bar{\mu}_t = \bar{A}(0)\bar{\varepsilon}_t$$

$$\bar{F}(L)\bar{A}(0) = \bar{A}(L)$$

Similarly, evaluating at L=1 provides a mapping from the steady state response matrix $\bar{A}(1)$ to the impact matrix $\bar{A}(0)$:

$$\bar{F}(1)\bar{A}(0) = \bar{A}(1)$$

The orthogonal properties of the common shocks imply that the reduced form long-run covariance matrix can be related to the short-run $\bar{A}(0)$ and long-run $\bar{A}(1)$ responses as follows:

$$\Omega_{\bar{\mu}}(0) = \bar{A}(0)\bar{A}(0)'$$

$$\Omega_{\bar{\mu}}(1) = \bar{A}(1)\bar{A}(1)'$$

To find the diagonals of the loading matrix Λ_i, compute the simple correlation between the composite structural shocks ε_i and common structural shocks $\bar{\varepsilon}_i$ for each panel member i. This can also be done on the basis of simple OLS regression, as the regressors are orthogonal to the residuals and the slope matrix is diagonal:

$$\hat{\Lambda}_i = \frac{\hat{\sigma}_{\varepsilon_{it},\bar{\varepsilon}_t}}{\hat{\sigma}^2_{\bar{\varepsilon}_t}}$$

After obtaining estimates of Λ_i, decompose the composite structural VMA form to obtain the member-specific impulse responses to common shocks $\bar{A}_i(L)$ and idiosyncratic shocks $\tilde{A}_i(L)$:

$$A_i(L)\varepsilon_{it} = A_i(L)(\Lambda_i\bar{\varepsilon}_t + \tilde{\varepsilon}_{it})$$

$$A_i(L)\varepsilon_{it} = A_i(L)\Lambda_i\bar{\varepsilon}_t + A_i(L)\wedge_i\tilde{\varepsilon}_{it}$$

To ensure that the common and idiosyncratic impulse responses are similarly sized, re-standardize the idiosyncratic shocks to unit shocks:

$$A_i(L)\varepsilon_{it} = A_i(L)\Lambda_i\bar{\varepsilon}_{it} + A_i(L)(I - \Lambda_i\Lambda_i')^{1/2}\tilde{\varepsilon}^*_{it}$$

$$A_i(L) = \bar{A}_i(L) + \tilde{A}_i(L)$$

where $\bar{A}_i(L) = A_i(L)\Lambda_i$ represent member-specific responses to unit common structural shocks; and $\tilde{A}_i(L) = A_i(L)(I - \Lambda_i\Lambda_i')^{1/2}\tilde{\varepsilon}_{it}$ represent member-specific responses to unit idiosyncratic structural shocks.

A2. Second Stage Estimation

To study variation in member-specific responses, regress the desired panel impulse response estimates $A_i(L)$, $\bar{A}_i(L)$, $\tilde{A}_i(L)$ against a collection of static member-specific observations by simple OLS regression:

$$A_{i,s} = \alpha_s + \beta_s' x_i + \eta_{i,s} \tag{1}$$

where $A_{i,s}$ is the panel impulse response estimate for member $i = 1, ..., N$; x_i is a Kx1 vector of member-specific cross-sectional observations; and s is the desired step of the impulse response function.

A3. Fitted Value Estimation

The sample distribution of the estimated member-specific impulse responses can also be used to obtain fitted-value estimates for panel members that lack sufficient data for traditional time series analysis. Specifically, it is possible to infer structural dynamics for members that do not belong to the original panel. To do so, use the fitted regression values from (1) to compute the impulse response estimates for the h^{th} member (which need not be an original panel member):

$$A^*_{h,s} = \hat{\alpha}_s + \hat{\beta}_s' x_h \tag{2}$$

where $A^*_{h,s}$ is the panel fitted response estimate for member h at step s; x_h is a vector of member-specific cross-sectional observations for h; and $\hat{\alpha}_s$ and $\hat{\beta}_s'$ are fitted values from the second stage regression in (1).[31]

[31] Equations (1) and (2) use estimates of member-specific composite shocks for the second stage and fitted value estimation. The same process can be replicated for estimates of member-specific common and idiosyncratic shocks.

B Additional Figures and Tables

Table 6: Comparative Second Stage Results for Impulse Responses

Variable	**Country**	**Year 1**	**Year 2**	**Year 3**	**Year 5**	**Year 10**	**Year 15**
Total Assets	Germany	0.021*	0.012*	0.016*	0.019**	0.037*	0.014*
in millions	Italy	0.010*	-0.013***	-0.045***	-0.072***	-0.071***	-0.071***
Total Revenue	Germany	1.224	0.706*	0.914	1.112*	0.774	0.778
in millions	Italy	3.921	-8.461***	-3.022***	-4.711***	-4.624***	-4.625***
Net Income	Germany	-0.025	-0.106	-0.143	-0.167*	-0.124	-0.125
in thousands	Italy	-0.031	-0.480**	-0.227	-0.301**	-0.305**	-0.304**
Non-Performing Assets	Germany	-8.221**	-14.37	-57.92**	-45.58	-42.22*	-41.94*
% total assets	Italy	-0.849	-32.42***	-12.48***	-20.64***	-17.53***	-17.63***
Non-Performing Loans	Germany	-8.210**	-14.37	-57.96**	-45.50	-41.93*	-41.89*
% total loans	Italy	-0.398	-26.45**	-10.03**	-16.61**	-14.35**	-14.43**

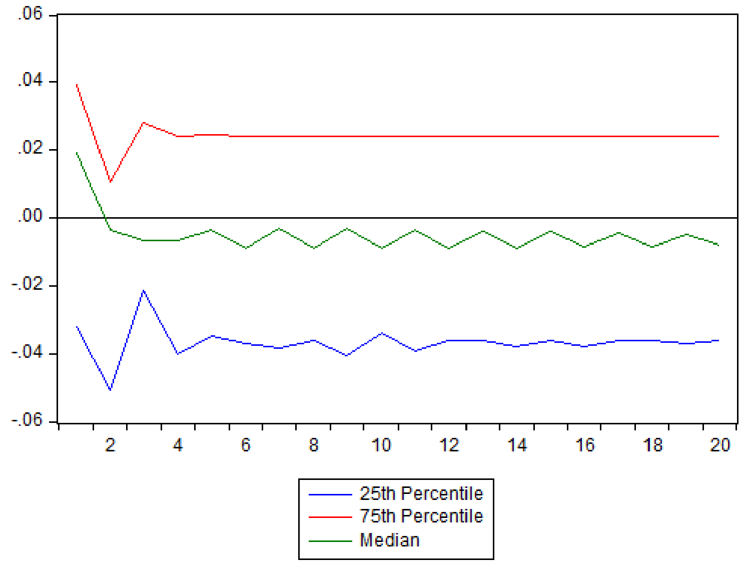
Notes: This table presents comparative coefficients from the bivariate regression described in Equation 1 of the Technical Appendix. Significant results indicate a correlation between bank-specific characteristics and lending responses to common regulatory shocks. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 7: Comparative Second Stage Results for Variance Decompositions

Variable	**Country**	**Year 1**	**Year 2**	**Year 3**	**Year 5**	**Year 10**	**Year 15**
SG&A Margin	Germany	2.447***	2.260***	2.149***	2.061***	1.917***	1.870***
	Italy	0.471**	0.574*	0.515*	0.496*	0.472	0.461
Net Income	Germany	0.325***	0.376***	0.335***	0.341***	0.336***	0.334***
	Italy	0.152***	0.161**	0.147*	0.140*	0.132*	0.130
Total Deposits	Germany	1.341*	1.615***	1.442**	1.449**	1.391**	1.382**
	Italy	1.346*	1.616***	1.445**	1.440**	1.396**	1.382**
Total Liabilities	Germany	6.341**	7.042***	6.438***	6.517***	6.392***	6.373***
	Italy	2.341***	2.487**	2.402**	2.398**	2.387**	2.386**
Non-Performing Assets/Total Assets	Germany	6.913**	7.124**	6.663**	6.455**	6.165**	6.064**
	Italy	1.182***	1.493***	1.337**	1.332**	1.306**	1.298**
Non-Performing Loans/Total Loans	Germany	5.052*	5.313***	4.913	4.794	4.602**	4.531**
	Italy	1.092**	0.978**	0.980**	0.964**	0.952**	0.948**
Allowance for Credit Losses/Total Loans	Germany	0.140*	1.507**	1.405**	1.378**	1.319**	1.294*
	Italy	1.831***	2.301***	2.092***	2.083**	2.064**	2.052**
Tier I Capital Ratio	Germany	0.796**	0.678*	0.670**	0.631*	0.578*	0.561*
	Italy	1.207***	1.599***	1.483***	1.497***	1.489***	1.489***
Core Tier I Capital Ratio	Germany	0.796**	0.678*	0.670**	0.6313*	0.578*	0.561*
	Italy	1.207***	1.599***	1.483***	1.497***	1.489***	1.489***
Total Capital Ratio	Germany	0.728**	0.654**	0.633**	0.601**	0.555**	0.540**
	Italy	0.931***	1.221***	1.135***	1.145***	1.139***	1.139***
Coverage Ratio	Germany	1.046 **	1.180**	1.087**	1.029*	0.948*	0.922*
	Italy	2.439***	3.323***	3.085***	3.138***	3.140***	3.151***

Notes: This table presents comparative coefficients from the bivariate regression described in Equation 1 of the Technical Appendix. Each bank-specific outcome variable (averaged since 2000) is regressed against the associated bank-specific variation in lending due to common regulatory shocks. Significant results indicate a correlation between bank-specific characteristics and dynamic variance decompositions. Coefficients should not be compared across variables as units are restandardized for all bank variables. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Figure 16: Response of Italian Bank Lending to Idiosyncratic Regulatory Shocks



Notes: Idiosyncratic structural shocks are bank-specific and do not have an impact beyond the aggregation unit of individual banks. They describe regulatory changes that impact only an individual bank or narrow subset of banks (controlling for common regulatory shocks).

Figure 17: Idiosyncratic Italian Bank Lending Responses by Bank Size

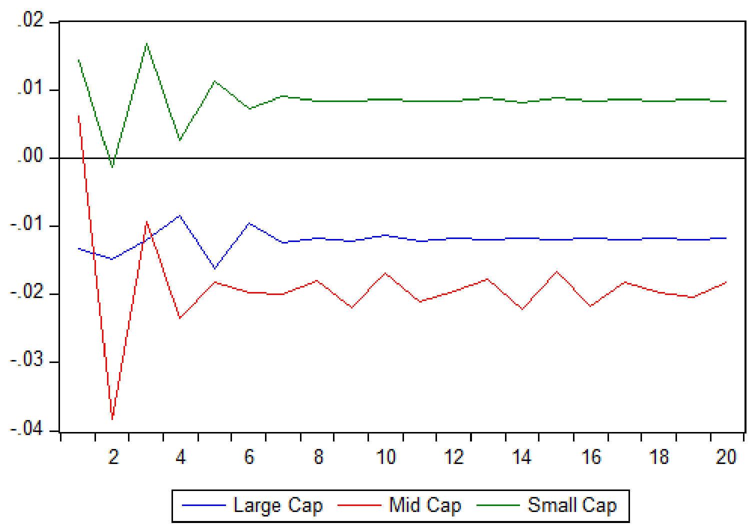
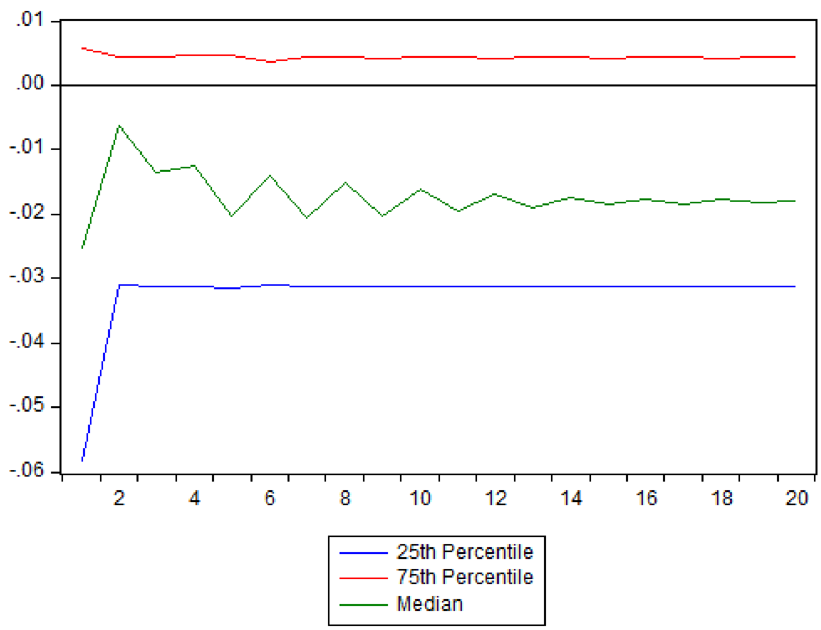


Figure 18: Italian Response of Total Capital to Common Regulatory Shocks



Notes: This figure exhibits the annual response of gross loans to a one-unit common regulatory shock in percentage terms (or equivalently, a shock that raises the total capital requirement by one percent).

Figure 19: Sample Evolution of Total Capital Ratio for Italian Banks

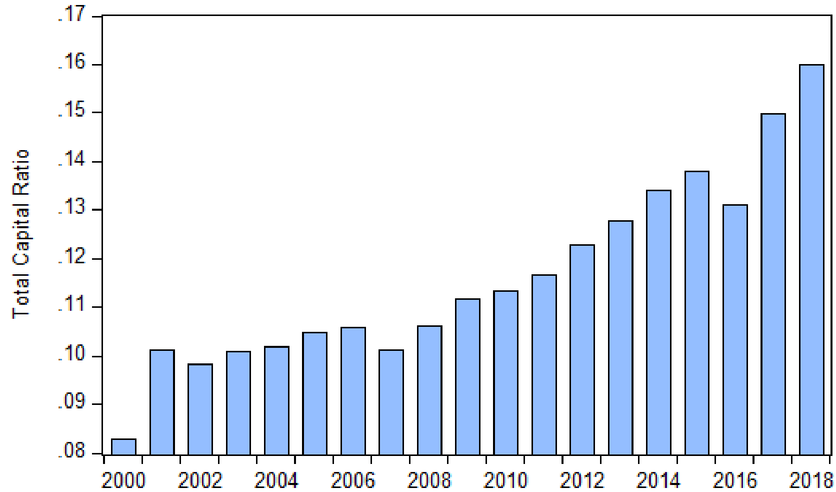


Figure 20: Sample Evolution of Tier I Capital Ratio for Italian Banks

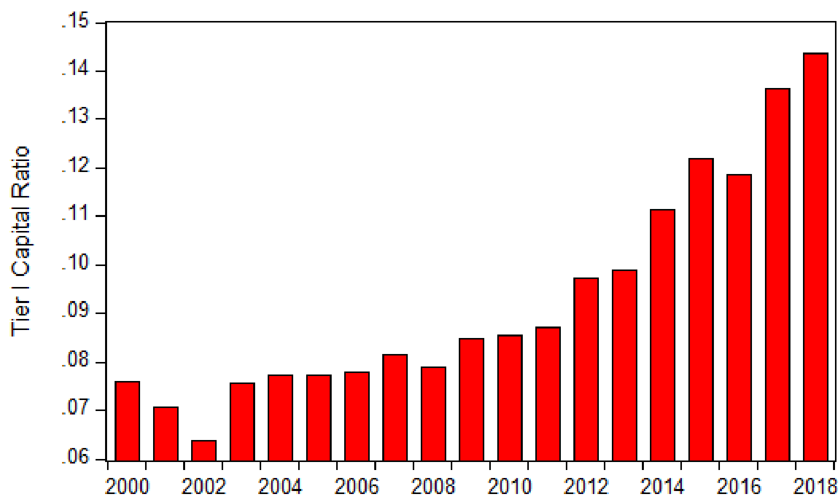


Figure 21: Sample Evolution of Gross Loans for Italian Banks

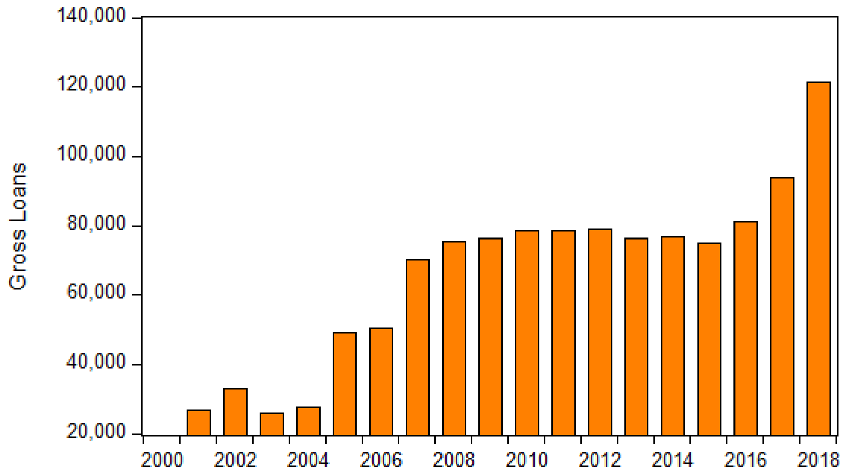


Figure 22: Sample Composition of Loans for Italian Banks

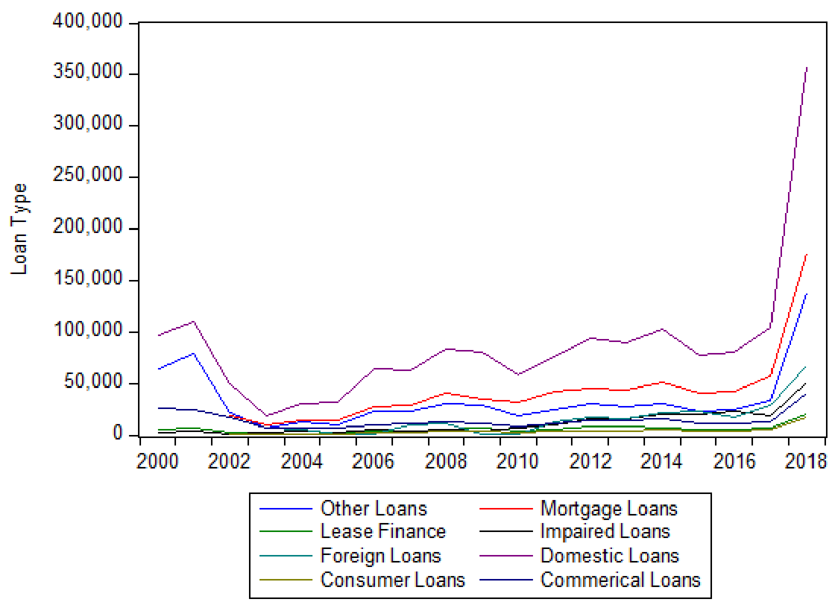


Figure 23: Sample Italian Total Capital Ratio by Bank Size

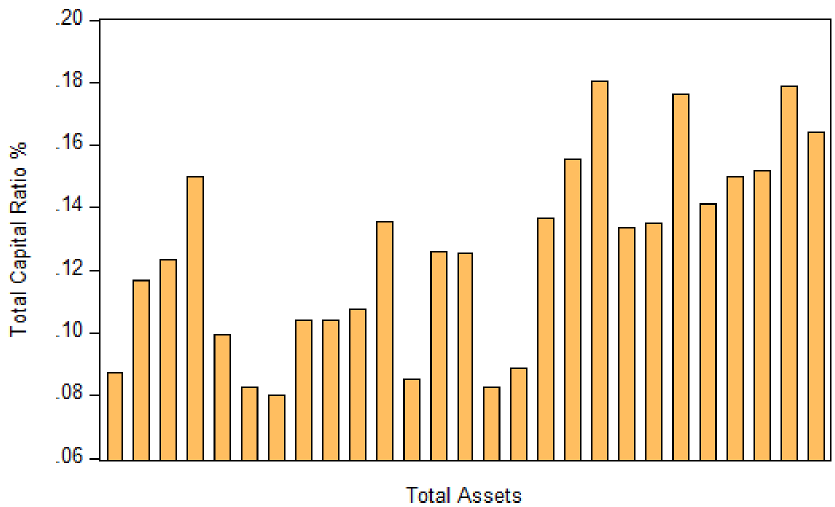


Figure 24: Sample Italian Total Capital Buffer by Bank Size

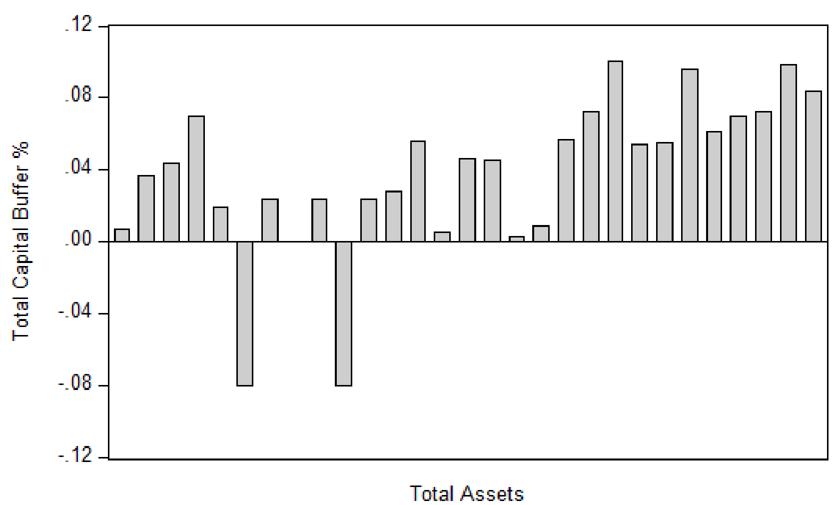


Figure 25: Sample Evolution of Total Capital Ratio for German Banks

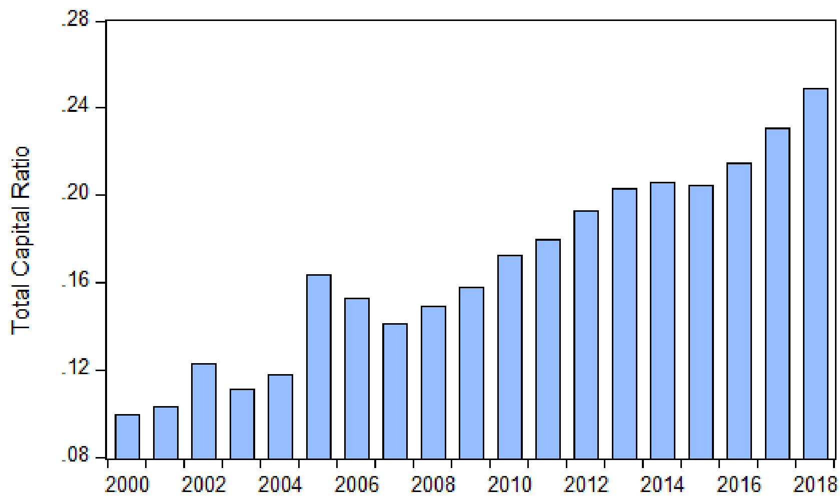


Figure 26: Sample Evolution of Gross Loans for German Banks

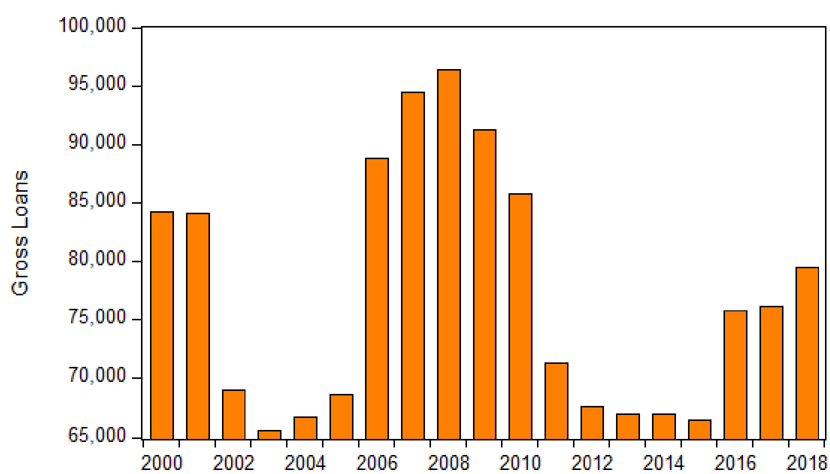


Figure 27: Italian Sample Non-Performing Loans by Bank Size

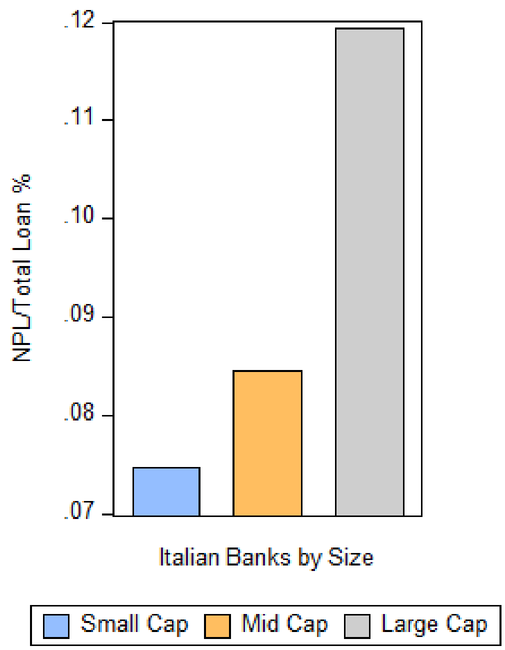


Figure 28: German Sample Non-Performing Loans by Bank Size

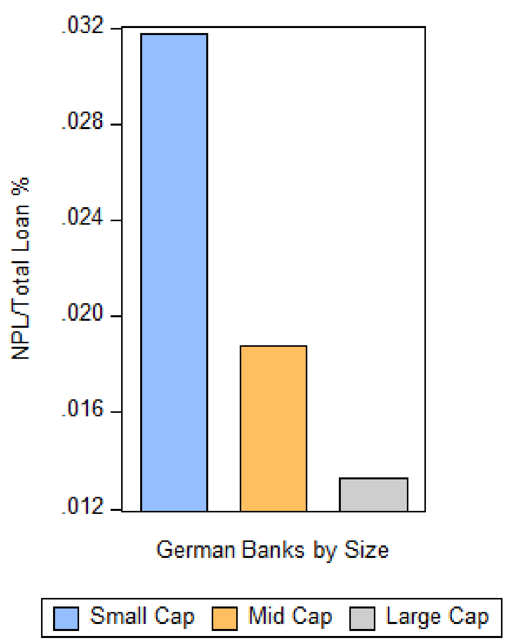


Figure 29: Italian Sample Non-Performing Loans by Bank Size

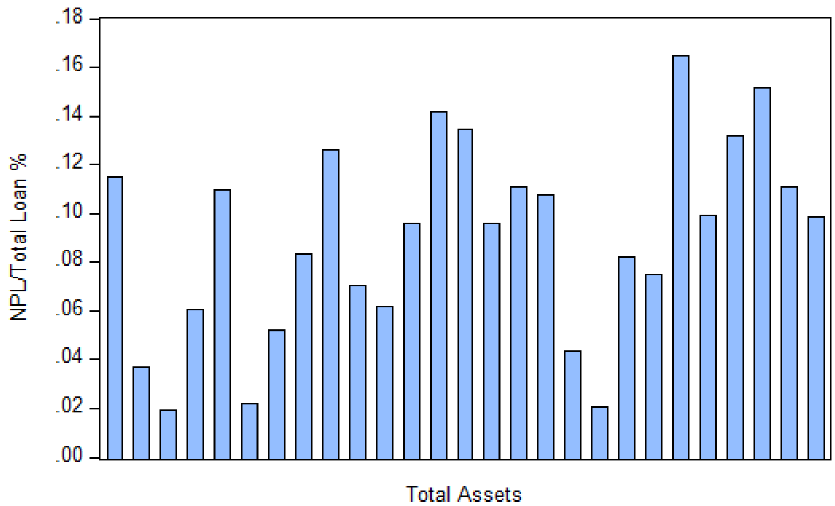


Figure 30: German Sample Non-Performing Loans by Bank Size

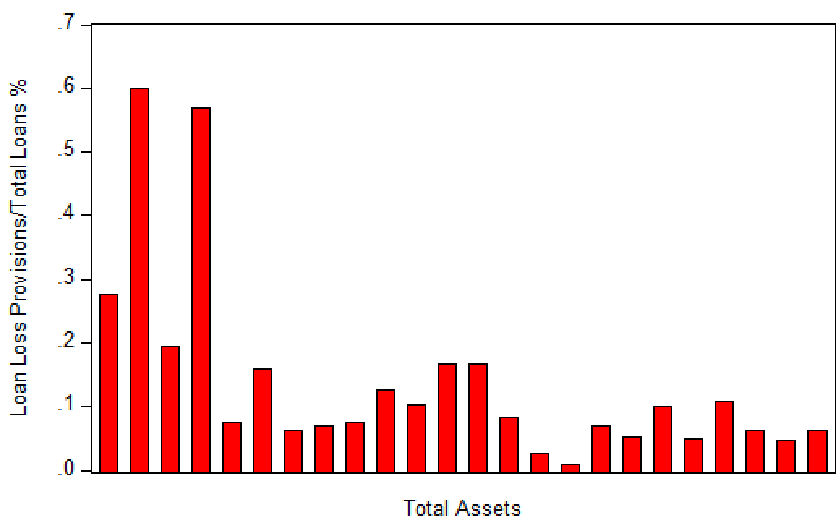


Figure 31: Average Response of French Bank Lending to Common Regulatory Shocks

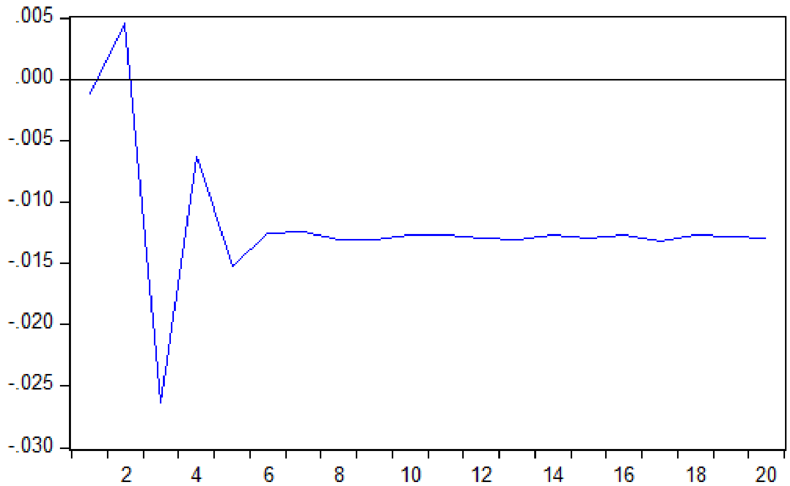


Figure 32: Average Response of Spanish Bank Lending to Common Regulatory Shocks

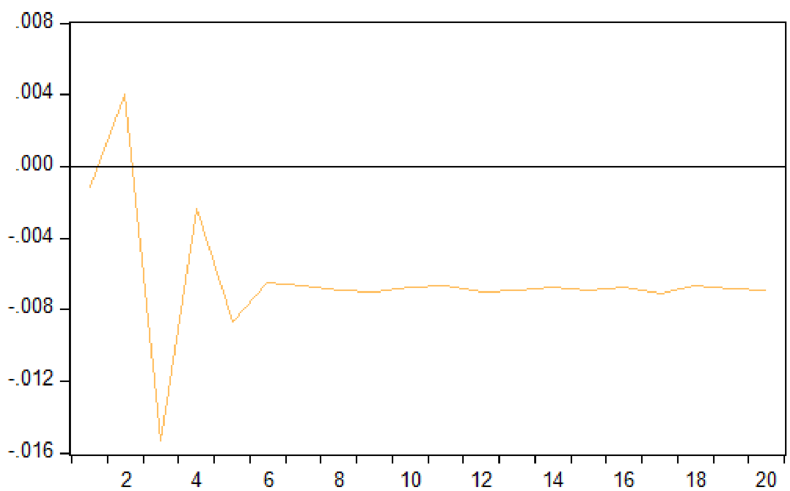


Figure 33: Average Response of Portuguese Bank Lending to Common Regulatory Shocks

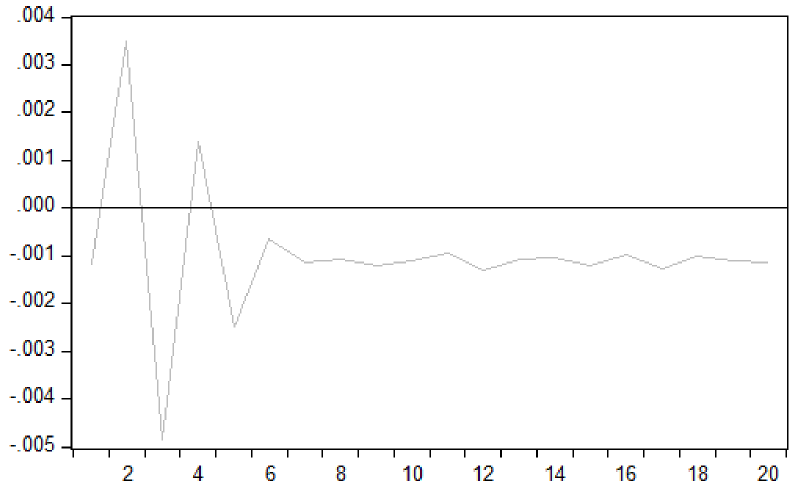


Figure 34: Average French Lending Responses by Bank Size

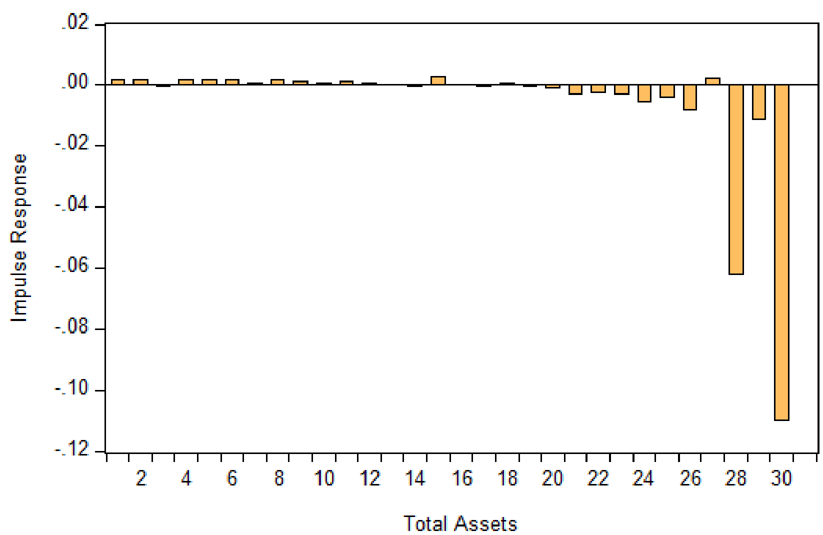


Figure 35: Average Spanish Lending Responses by Bank Size

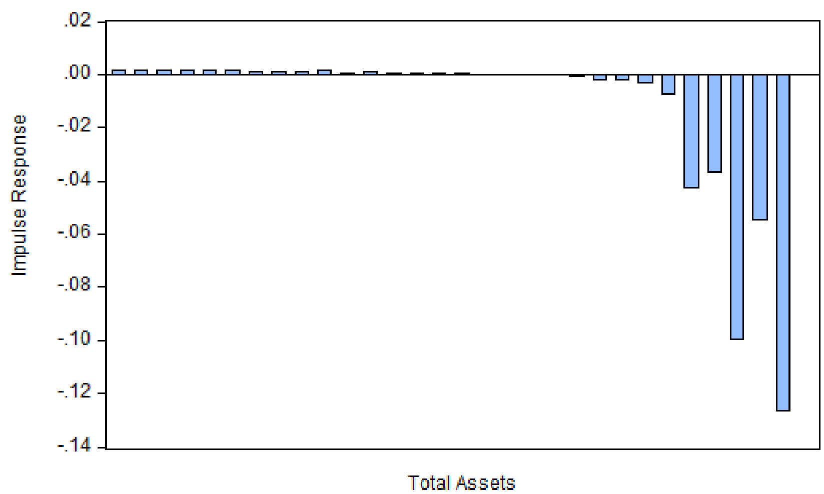


Figure 36: Average Portuguese Lending Responses by Bank Size