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Taming Housing and Financial Market Instability: The Effect of Heterogeneous Banking Regulations

A Case Study for the German Banking Market Based on the German Systemic Risk Buffer

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Abstract

During the last decade, property prices in Germany steadily appreciated and reached an all-time high in 2022. In the wake of the global financial crisis that was triggered by a housing market bubble in the U.S., banking authorities introduced an additional systemic risk buffer. This buffer aims to cover in a flexible way systemic risk that is not addressed by other capital adequacy requirements, e. g., in certain market segments. In Germany, from February 2023 onwards, a systemic risk buffer of 2 % is applied for all exposures that are secured by residential property. We introduce a heterogeneous agent-based model of a housing and a financial market to assess the ability of this new regulatory measure to dampen instability in the housing market and mitigate feedback effects on the financial sector. Conducting different computational experiments reveals that imposing a sectoral systemic risk buffer has no stabilizing effect on the housing market. However, the banking sector gets more sound if banks are obliged to the buffer. The buffer constrains market activities in the housing market and restricts housing transactions, constructions, and homeownership. These negative effects of an additional capital requirement can be diminished if the buffer is aligned to the individual business models of financial intermediaries and their institutional frameworks. If different bank types are subject to tailored buffer ratios, the volatility of the housing market can be reduced, the financial market can be stabilized and macroeconomic activities in the housing market can be cushioned.

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I. Introduction

During and in the aftermath of the financial crisis, the German housing market was comparably stable, while several other countries experienced a deep decline in real estate prices. The U.S. market had to record a price drop of approximately 50 index points (Statista 2023a).[1] In contrast, the property price index of Germany only forfeited a maximum of 5 index points in 2008 and 2009 compared to 2004 (Statista 2023b).[2] As early as 2010, prices started to recover slightly. Since then, property prices in Germany steadily appreciated and reached an all-time high in 2022 (Statista 2023b). The zero-interest rate policy triggered by the financial crisis fueled credit demand. The resulting increase in the money supply put upward pressure on real estate prices. Both phenomena, the effects of the financial crisis as well as the development of property prices in recent years display the close interconnectedness between the housing and the financial market.

Financial accelerator theories have long been indicating these mutual dependencies (*Bernanke* and *Gertler* 1995; *Bernanke* et al. 1999; *Kiyotaki* and *Moore* 1997; *Hammersland* and *Jacobsen* 2008). However, until the financial crisis, banking regulation mainly focused on microprudential measures to supervise the soundness of financial institutions. The global economic breakdown caused by lax lending, risky business practices, and excessive leverage of banks put emphasis on interdisciplinary regulation and the design and implementation of macroprudential policies.

As a response, the Basel Committee on Banking Supervision (*BCBS*) passed the Basel III Accords that shall be applied by all internationally active banks (BCBS 2017a). These standards aim at strengthening the regulation, supervision, and risk management of banks by introducing a diverse set of macroprudential measures (BCBS 2011). Two particular tools of the Basel III rules are the countercyclical capital buffer (*CCyB*) and the systemic risk buffer (*SyRB*). The *CCyB* aims to mitigate the procyclical effects of the existing regulatory requirements. It allows national authorities to impose an additional capital ratio in

[1] This statistic records the S&P/Case-Shiller real estate index of the U.S. from 1987 to 2021 while January 2000 = 100.

[2] This statistic records the German real estate price development from 2004 to 2022 on a quarterly basis while Q1 2004 = 100.

times of excessive credit growth that serves as a buffer to protect financial institutions against future potential losses (BCBS 2019b). In recessional times, it can be released to ensure that banks continue to supply sufficient credit. The *SyRB* is intended to mitigate risks arising from domestic or European exposures or particular economic sectors that may lead to disruption in the domestic financial sector or the domestic real economy (Deutsche Bundesbank 2022). Both tools complement the prevailing capital adequacy requirements of banks.

As of February 1st, 2022, the German regulatory authority introduced a *CCyB* of 0.75% and a *SyRB* for exposures secured by residential property of 2.0% that has to be applied from February 1st, 2023 (BaFin 2022a; BaFin 202b). Both ratios oblige banks to expand their equity. While the introduced *CCyB* affects all kinds of exposures equally, the *SyRB* especially focuses on mortgage lending. The rise in *CAR* increases the cost of financing residential property, thus restraining the supply of credit for housing investment. Due to the mutual dependencies between the housing market and the financial market, it can be assumed that the tightened *CAR* affect real estate lending and housing market cycles. Furthermore, the introduction of this sectoral *SyRB* affects individual banks to a varying extent since according to business models and risk aversions, banks feature different volumes of mortgage exposures.

The study by *Braun* (2023), extending the framework set in *Braun* et al. (2022), reveals that the stability of the housing and the financial market can be improved if different types of financial institutions are obliged to comply with different levels of *CAR*. Given these insights, this paper tests whether this also applies in the case of the *SyRB*. We extend the agent-based model of *Braun* (2023) by introducing the requirement that banks need to hold an additional 2.0% of equity when financing homeownership. Doing this, we first investigate how this measure affects the housing market and the financial market. Furthermore, we evaluate whether it is reasonable from the perspective of financial and housing market soundness to subject different types of financial intermediaries to the same or to different regulatory requirements in the special case of the sectoral *SyRB* for mortgage lending.

The computational experiment reveals that the sectoral *SyRB* imposed in Germany, is not effective in mitigating sectoral risk arising from the housing market. Housing market volatility is not reduced if all banks need to hold an additional 2.0% of equity for exposures that are secured by residential property. However, the solidity of the financial market is increased. Due to a more profound equity base, banks display a lower probability of insolvency. This positive effect comes with adverse macroeconomic constraints on the housing market. The higher equity requirements limit housing market activity. A differentiation of the capital requirements for different types of intermediaries in housing finance could alleviate these constraints without endangering financial stability.

We introduce lower *CAR* for the housing financing activities of the specialized German building and loan associations (*Bausparkassen*, BLs). Ruled by their special law, German BLs' business practices are focused on the financing of residential property, which makes them particularly efficient to cushion housing market activities. Interestingly, the differentiation in capital requirement also elevates the overall solidity of the banking sector.

The rest of this paper is organized as follows. Section 2 briefly introduces the model of *Braun* (2023) and the model extension developed for this study. The results of the computational experiments are presented in section 3. Section 4 concludes.

II. Model Structure

1. Overview

The model used for this case study is introduced by *Braun* (2023). It represents a macroeconomic real estate business cycle model featuring a housing market and a financial market and belongs to the class of agent-based computational models (ABM). The agent-based approach to economics addresses the modeling of economic systems, incorporating their real-world complexity and adaptivity. It replicates real-world economies in which agents with deviating expectations interact with each other and impact market development endogenously. These agents are heterogeneous in terms of their characteristics, and their expectations about future market conditions, and they are adaptive to changing environments. Incorporating these features, ABMs are superior to dynamic stochastic equilibrium models (DSGE) that are characterized by the rational behavior of a stylized agent, infinite foresight, and market equilibrium (*Ackerman* 2002; *Gaffeo* et al. 2008). An ABM sets up an environment in which microscopic agent behavior aggregates into macroeconomic dynamics (*Farmer* and *Foley* 2009; *Dosi* 2012; *Kirman* 2016). In that, it allows studying credit and liquidity market dynamics that are affected by heterogeneous agent-specific solvency and liquidity risks. Relating to this, an ABM is a particularly suitable approach for policy analysis and to assess the impact of changing regulatory requirements on housing and credit market dynamics.

The model of *Braun* (2023) replicates a housing market and a financial market. The housing market is populated by two types of heterogeneous agents: buyers and sellers. Potential house buyers seek for acquiring residential property according to their individual circumstances and their preferences for housing investments. Sellers evaluate ongoing market conditions and form expectations about future market developments. Based on this, they decide whether to sell their existing properties or keep them, speculating for future house price appreciations. Together with residential construction firms, they state housing supply. The financial market's supply side is populated by two types of financial intermediaries, conventional banks (CBs) and building and loan associations (BLs), the demand side by the acquirers of housing. Following the maxim of profit maximization, banks decide whether to finance residential property or invest available funds in an alternative investment portfolio. Related to this, banks display a decisive counterpart in mortgage lending. They enable home seekers to become homeowners and, at the same time, decide by whom and when a residential property can be bought. The model incorporates two binding constraints: while potential buyers are constrained in borrowing, banks are constrained in conducting business according to the regulatory requirements of Basel III. In detail, banks need to comply with the applicable regulations of CAR including a $CCyB$. Based on this, we extend the existing model and further subject banks to another regulatory measure, the $SyRB$. As introduced by German national authorities, it applies to all exposures secured by residential property and, thus, directly impacts the housing market.

The housing market and the financial market form a macroeconomic environment. In each market, agents interact with each other and create endogenous market structures. Through cross-market interactions, market participants further impact adjacent markets and create feedback effects from the housing to the financial market and vice versa. Due to the close interconnectedness and the mutual dependencies of both markets, changing market conditions affect both markets to varying extents. In the following, we examine whether the regulatory $SyRB$, introduced by German authorities to all types of financial intermediaries equally, achieves its regulatory goal to mitigate systemic risk originating from the housing market.[3]

2. The Housing Market

The housing market of *Braun* (2023) and *Braun* et al. (2022) is characterized by households and residential construction firms that trade residential property. Potential house buyers derive utility from owning a dwelling and consuming other consumer goods. They earn a periodical income that is fully spent in each period, and they are endowed with a fixed amount of equity which is fully spent on the housing investment. Furthermore, buyers are adaptive agents that evaluate previous market conditions and make individual assumptions about future market developments. Every potential buyer is characterized by individual measures of these characteristics. This ensures a sufficient degree of heterogeneity in housing demand.

[3] Note: In the following, we briefly explain the relevant model features for this case study. For detailed explanation, see *Braun* (2023).

At the beginning of each period, buyers evaluate personal and ongoing market conditions and consider the possibility of homeownership. Via the individual utility parameters for consumption and residential property, only those agents enter the housing market who positively assess owning a housing unit. Income and available equity constrain housing investment and determine a potential buyer's maximum periodical expenditure for buying a residential property. This amount states a potential buyer's reservation price. Based on past price information, he forms a price expectation that may deviate from the reservation price, and he states a bid that is the minimum of the expected price and the reservation price.

Real estate sellers can either be households who sell already existing owner-occupied dwellings, or residential property firms that build and sell new ones. Both are agents with heterogeneous attitudes toward market development. Based on past market performance and individual market sentiments, they decide every period anew whether to provide housing supply. A seller only offers his housing unit for sale if he assumes that selling and investing freed up liquidity in an alternative investment bears higher profit than keeping the dwelling and speculating for house price appreciation in future periods. To form an ask price, he adjusts his reservation price which is the previously observed price level according to his perceived market power which corresponds to whether a buyer's or a seller's market prevails.

A transaction of residential property takes place if a buyer's bid equals or exceeds a seller's reservation price. The model deviates from classical approaches that determine one equilibrium price. Instead, it follows the approach of *Filatova*, *Parker*, and *van der Veen* (2007) and allows prices to be built by bilateral bidding. The auction process is modeled as a first-price-sealed bid auction. Bids are assigned to offers in descending order through which the model implicitly accounts for quality differences of real estate objects. As in reality, the house price index and its development over time is the key measure for agents to assess current market conditions and form expectations about future developments. It is calculated as the mean of the prices of all transactions that have been conducted during one period.

3. *The Financial Market*

The financial market's supply side features two types of financial intermediaries: CBs and BLs. Both of them are economic institutions that aim to maximize profit. To achieve this, every bank follows its individual perception of market conditions and forms expectations about future price developments. Based on this, they build their own investment strategy and decide how to allocate funds. The model setting offers three investment opportunities for both bank types.

They can either hold cash, grant mortgages to potential house buyers or invest in another risky asset which is supposed to be a diversified market portfolio of financial assets that represents any alternative investment opportunities of banks. Cash earns no interest and is supposed to be risk-free (BCBS 2017b). Granting loans as well as investing in the alternative market portfolio AI, in contrast, generates profit that is associated with default and/or price risk.

According to the Accords of Basel III, banks need to hold a sufficient amount of equity to absorb losses that may arise due to risky business activities. The capital adequacy requirements (CAR) are defined as a bank's Common Equity Tier1 capital $(CET1)$ relative to its total risk-weighted assets (RWA) which must meet a minimum level of 4.5 %.

The latest financial crises lead to a strong consensus that the banking regulation in force was not sufficient. Instead of mitigating its extent, it further exacerbated the collapse by procyclical regulatory requirements (*Blundell-Wignall* and *Atkinson* 2010; *Goodhart* and *Hofmann* 2007; *Kowalik* 2011). The countercyclical capital buffer $(CCyB)$ is a new macroprudential tool, designed to mitigate the procyclicality of previous regulatory requirements and avoid destabilization of the economy by excessive credit growth (BCBS 2019b; IMF 2011). The $CCyB$ complements the minimum-CAR and tightens banks' business activities (BCBS 2019b). This set of rules constrains banks' in conducting risky business.

Another regulatory tool introduced by Basel III is the systemic risk buffer $(SyRB)$. It is intended to counteract systemic risks which could lead to severe economic disruption, with serious effects on the domestic financial sector or the domestic real economy (Deutsche Bundesbank 2022). It complements the CAR and the $CCyB$ and aims to address systemic risks that are not covered by them (European Systemic Risk Board 2023). The buffer can be imposed by national authorities for domestic or European exposures as well as for specific economic sectors. While there is no maximum limit for the $SyRB$, its minimum level is 0.5%. In 2022, the German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht) decided to introduce a $SyRB$ on a sectoral basis for all exposures that are secured by residential property. This imposes German banks from February 2023 to hold an additional 2.0% of equity when residential property is financed and collateralized by the respective dwelling.

We extend the model of *Braun* (2023) by the $SyRB$ and test its effects on the housing and the mortgage lending market. In this approach, the interacting banks need to comply with the static minimum level of CAR which is:

$$CAR = \frac{CET1}{RWA} = \frac{CET1}{(rw_T * T) + (rw_{AI} * AI)} \geq \overline{\in} \text{ with } \overline{\in} = 4.5\,\%, \tag{1}$$

where a bank's RWA represent its assets weighted each according to its risk of default according to the guidelines of the BCBS (BCBS 2019a).[4]

The $CCyB$ extends CAR and imposes banks to further capital requirements in times of excessive credit growth that is judged to be associated with a build-up of system-wide risk. To model this macroprudential regulation, previous credit growth is used as an indicator to account for economic and financial cycles. The $CCyB$, denoted by κ_t^m, varies between $0 \leq \kappa_t^m \leq 2.5\%$ and is calculated as:

(2)
$$\kappa_t^m = \begin{cases} \kappa_{min} & for\ \frac{\Delta M}{M} \leq 0 \\ \kappa_{max} * \frac{\Delta M}{\Theta M} & for\ 0 < \frac{\Delta M}{M} < \Theta \\ \kappa_{max} & for\ \frac{\Delta M}{M} \geq \Theta \end{cases},$$

where $\frac{\Delta M}{M}$ is the percentage change of aggregate mortgages from the previous to the current period and Θ is the threshold of mortgage growth above which κ_t^m is set at its maximum.[5] According to prevailing market conditions, the minimum requirement of capital for banks is

$$CAR = \frac{CET1}{(rw_T * M) + (rw_{AI} * AI)} \geq \overline{\in}_3 + \kappa_t^m \text{ where } 4.5\% \leq \overline{\in}_3 + \kappa_t^m \leq 7.0\%.$$

The $SyRB$ only needs to be provided for mortgages that are secured by residential property but only $CET1$ may be used to meet the buffer requirements (*Deutsche Bundesbank* 2022). This increases CAR for residential exposures to:

(3)
$$CAR_T = \frac{CET1}{RWA} = \frac{CET1}{(rw_T * T)} \geq \overline{\in}_T \text{ with } \overline{\in}_T = 6.5\%.$$

The regulating authority imposes the introduced regulatory requirements of Basel III to all types of financial intermediaries equally. Banking systems, however, often constitute of different banking institutions. The underlying model of this case study introduces a diversified financial market that is populated by two

[4] According to the regulatory setup, cash is risk-free. Equity instruments are assigned a risk weight of 100%. The risk weight of mortgage loans depends on the custom LTV of the borrower. According to the BCBS, the LTV is defined as the mortgage amount divided by the value of the property. This implies a LTV ratio for the model of $LTV = \frac{(T-E)}{P_i}$. The risk weights of the respective LTVs are summarized in Table 4 in the appendix. For detailed information see *BCBS* (2017b).

[5] In the simulation results presented below, $\Theta = 5\%$. This represents the average long-time increase of mortgage loans in Germany (*German Central Bank* 2019).

institutional bank types. CBs are assumed to be institutions that conduct conventional banking business, including, as one relevant business area, housing finance. BLs are an institutional form of specialized financial intermediaries that are mainly active in the financing of private housing. Both bank types differ according to their business models, mortgage lending behavior, and investment strategies. In addition to national laws, BLs are subjected to particular legal requirements: the Building Society Act (*Bausparkassengesetz*) and the Building Society Decree (*Bausparkassenverordnung*). Those regulations direct BLs' business model to collect deposits and grant loans for purposes of building, buying or modernizing owner-occupied residential property (sect. 1 (1) to (3) *BauSparkG*). Furthermore, they are restricted in funding and investment opportunities to protect customers from potential misuse of deposits (*Müller* 1990; Sect. 4 and sect. 6 *BauSparkG*).

The financial institutions of both types are assumed to be risk-neutral and profit-maximizing. They decide between loan granting and investing in AI, and only accept a mortgage if the expected profit exceeds the profit of the alternative investments. To consider the default risk of borrowers, they constrain lending according to the individual non-default probability of potential borrowers, which is determined by their periodical income and their mortgage-to-income ratio. Furthermore, they collateralize the financed dwelling. Especially CBs base their lending decision on past development and future expectations of collateral values (*Collyns* and *Senhadji* 2005; *Freund* et al. 1998; *Herring* and *Wachter* 1999; *Niinimäki* 2009). On the other hand, the mortgage lending process of BLs is strongly influenced by the special attributes of their core product, contractual saving for housing (CSH). This is characterized by an extended savings phase before loan granting, which creates a long-term relationship with potential house buyers that reveals useful borrower information (*Kirsch* and *Burghof* 2016). Instead of mainly accounting for collateral values, they rely to a greater extent on endogenously created customer insights. BLs' specialized regulation further impacts mortgage lending decisions as they are legally restricted in investment opportunities. CBs in contrast chose freely between mortgage lending and investing in the AI-portfolio. This leads to higher flexibility for CBs in investment strategies, a lower dependency on the mortgage market, and better profit opportunities.

In addition to the housing market, *Braun* (2023) models a capital market on which the second risky investment option, AI can be traded by CBs and BLs. Both bank types form expectations about the price development of AI and trade shares according to their investment strategy. As for mortgage lending, Basel III rules require banks to hold equity when investing in the risky market portfolio. Depending on their distribution of RWA, they may trade AI voluntarily or do fire sales in order to free up liquidity and comply with CAR.

The model described above creates a macroeconomic environment that incorporates a housing market and a financial market, and a capital market as outside investment option.[6] All of these markets replicate agent-based market behavior and build endogenous market structures. This allows the investigation of market dynamics and spillover effects to adjacent markets induced by changing environments. By incorporating two types of financial intermediaries, the model builds a diversified financial market including a heterogeneous product landscape to finance residential property. These are important features to reflect real market conditions and make implications for financial and housing market stability.

III. Computational Experiments

We conduct several computational experiments to analyze whether a homogenously introduced *SyRB* is effective in reducing risks originating in the real estate market and avoiding disruption on the financial market. The model presented in the previous sections is used to generate numerical simulations that provide insights into market mechanisms and lending behavior of banks if they need to keep an additional amount of equity to finance owner-occupied dwellings. We ensure for the robustness of the results by conducting robustness tests for all of the simulation scenarios. These are presented in the appendix. Small deviations may occur due to different simulation runs.

We create three different scenarios which are investigated individually and compared to each other. In the first one, banks only need to comply with regulatory *CAR* according to Basel III and the *CCyB*. This reflects an economy in which the authority detected excessive credit growth and wants to counteract procyclicality. This scenario serves as a base scenario. In a second scenario, we introduce a sectoral *SyRB* of 2.0 % for mortgage loans. The tightened capital requirements apply to all types of banks equally. In a third scenario, we vary the *SyRB*-ratio for BLs. For each scenario, 100 periods are simulated.

In every computational environment, we evaluate stability measures of the housing market and the banking sector. We account for the intensity of house price movements in terms of their standard deviation and address prevailing mortgage interest rates. To assess borrowers' risk and overall economic wealth, we measure the borrowers' non-default probability, the transaction rate of houses,

[6] In the underlying model, the equilibrium at the capital market is also endogenous.

their construction rate, and the rate of homeownership.[7] To get an indication of changing market conditions, we detect market limitations by examining the volatility of credit in terms of credit volume and the number of granted mortgage loans. The fragility of the banking sector is indicated by the Z-score which is calculated as $Z_{i,t} = \frac{ROA_{i,t} + \left(\frac{E}{A}\right)}{\sigma(ROA_{i,t})}$.[8] It measures banks' distance from insolvency and is a key indicator of financial stability (*Boyd* and *Runkle* 1993; *Lepetit* and *Strobel* 2015; *Roy* 1952).

1. *Calibration of the Simulation Setting*

The parameters used to calibrate the model follow those of *Braun* (2023). The calibration is based on empirical evidence, data obtained from the literature, and assumptions that mimic the relations and conditions of real economies. To initialize the market mechanisms, the housing market is populated with 60 buyers and 30 sellers. After a trade has been conducted, both agents leave the market. The same holds true if a potential buyer has been unsuccessful in acquiring a dwelling for 10 periods. He is assumed to be too old to redeem a loan and stays a tenant. A buyer cannot be a seller in the same period and vice versa. In subsequent periods, a former seller can become a buyer. In each period, beginning from period 2, a random number of potential buyers in a range of [30,36] and potential sellers in a range of [10,12] enter the housing market. Every potential buyer and seller is equipped with individual characteristics and follows the decision process described in the previous sections. Table 1 summarizes the model parameters to initially calibrate the market settings.[9]

[7] The transaction rate, the homeownership rate, and the construction rate are calculated as follows: $Transaction\ Rate = \frac{N_{transactions,t}}{\min\left(N_{buyers,t}, N_{sellers,t}\right)}$,

$Homeownership\ Rate = \frac{N_{transactions,t}}{N_{potential\ buyers,t}}$,

$\text{Construction Rate} = \frac{N_{constructions,t}}{\left(N_{new\ sellings,t} + N_{left\ over}\right)}$.

[8] ROA is the return on assets and $\left(\frac{E}{A}\right)$ denotes the equity to assets ratio. Z-scores are highly skewed. Thus, we transform the values using the natural logarithm and calculate $\ln(Z_{i,t}) = \ln\left(\frac{ROA_{i,t} + \left(\frac{E}{A}\right)}{\sigma(ROA_{i,t})}\right)$.

[9] For detailed explanations see *Braun* (2023).

Table 1

Initial simulation parameters

Parameter	**Description**	**Value**
	Buyers	
α	Preference for consumption	[0, 1]
Υ	Income	[100, 1000]
e_b	Individual market expectation	[–0.1, 0.1]
E	Equity	[0, 0.35]
	Sellers	
e_s	Individual market expectation	[–0.1, 0.1]
ς	Markdown ratio	0.95
	Housing Market	
$P_{h,t}$	Price index	2500
ΔP_{t-1}	Price change in t-1	50
ΔP_{t-2}	Price change in t-2	50
N_{Buyers}	Number of buyers	60
$N_{Sellers}$	Number of sellers	30
r_p	Redemption rate	0.1
r_t	Loan interest rate	0.02
	Credit Institutions	
e_h	Individual market expectation	[–0.1, 0.1]
e_{AI}	Individual market expectation	[–0.192, 0.192]
r_d	Default rate of return	0.001
χ	Loan-to-value	0.8
ψ	Threshold of price decline	0.03
D	Loan default rate	0.01
	Financial Market	
r_f	Risk free interest rate	0.01
r_{AI}	Market return	0.084
f_{t-1}	Fundamental value of AI	1008
μ	Drift	0.1215
σ	Volatility	0.192
p_m	Market price of AI	1000
Θ	Threshold of mortgage growth	0.05

The financial market consists of 79 financial intermediaries, out of which 53 are CBs and 26 are BLs. This composition is obtained from the Bankfocus database and represents the German financial market.[10] Each bank is characterized by its individual simplified balance sheet which is displayed in Table 2. The balance sheet positions are initially calibrated to Bankfocus data. Thus, we ensure a distribution of *RWA* which represents real market conditions. To extract any stationary balance sheet compositions, we use the average of ten years, i. e., from 2012 – 2021. As the German BaFin decided in 2022 that banks need to meet a 2.0 % sectoral *SyRB* from February 2023 this data base fits the case study well. All investments or disinvestments are accounted for in the respective balance sheet variables. In line with the banks' business activities, balance sheet positions vary every period. At the end of each period, the respective balance sheet positions are recalculated.[11]

Table 2

Balance sheet structure of banks

Assets		**Liabilities**	
Cash (C)		Debt (D)	
Risky Assets		Equity (E)	
	Mortgages (T)		Free equity
	Alternative Investment (AI)		Regulatory equity for T
			Regulatory equity for AI

2. *Results*

In our simulations, we create a market setting in which two types of financial intermediaries, CBs and BLs, either serve the mortgage market, invest available funds in the capital market, or hold cash. According to market conditions such as house prices, share prices, or borrower quality, but also influenced by parameters such as risk aversions, future market expectations, or individual balance sheet compositions, they decide between their business options. By financing housing investment, they interact with potential home buyers enabling them to

[10] The data set contains every CB and BL of the German financial market which are classified as credit institutions according to the national Banking Act (sect. 1 KWG), grant mortgage loans to households, and for which the respective balance sheet data was available. Group companies are only included once with the parent company.

[11] We refrain from modeling funding opportunities explicitly. Instead, the amount of debt is calculated as the difference between total assets and equity.

acquire residential property, and thus influencing endogenously created housing market cycles. When conducting risky business, the banks of both types need to comply with the actual *CAR* of Basel III, including a *CCyB*. This computational environment serves as a base scenario.

As a second scenario, we additionally introduce a sectoral *SyRB* for all exposures secured by residential property in the amount of 2.0%. This reflects German conditions in which a *SyRB* has to be applied as of February 1st, 2023. All interacting banks are subject to both regulatory buffers and need to comply with them. In a third simulation scenario, we deviate from German regulations and subject BLs to a lower *SyRB*. The study by *Braun* (2023) reveals that committing BLs to lower *CAR* than CBs helps to create a more stable housing market and increases the soundness of the banking sector. Following these insights, we test whether this also holds true for a sectoral *SyRB*. To do this, we oblige BLs to a *SyRB* of 0.5% while CBs still need to apply the 2.0% buffer.[12]

In all of the tested market settings, agents are conducting business following their expectations and perceptions of market conditions, thus influencing house price movements. In each setting, the market proceeds in cycles, and prices fluctuate around their mean. This can be seen in Figure 1 which displays the resulting house price dynamics in the different simulation scenarios. Potential home buyers and sellers form expectations based on perceived market conditions. Previous house price appreciations spur investment motives and inflate prices. The increase in the price level diminishes housing affordability. In the same course, potential sellers withhold their offer, hoping for further house price appreciations. Reduced supply and an inflated price level mitigate positive price trends, leading them to a peak before they start to fall. The initiated depreciation of house prices depresses future market expectations. This pushes the market down. A recession sets in. Agents perceive changed market conditions and align their actions accordingly. The decrease in prices attracts potential buyers and the fall bottoms out when bids start to pick up again. As banks finance a large share of housing investment, they highly affect market developments. Tightened *CAR* increase the cost of conducting business. The introduction of an *SyRB* will alter banks' mortgage lending decisions, which may create spillover effects on the housing market.

12 According to Section 10e of the German Banking Act, the minimum level of an introduced *SyRB* is 0.5%. We follow this law in our simulation and reduce the obligated *SyRB* to this level for BLs. This does not provide evidence that this is the most effective *SyRB*-level for BLs.

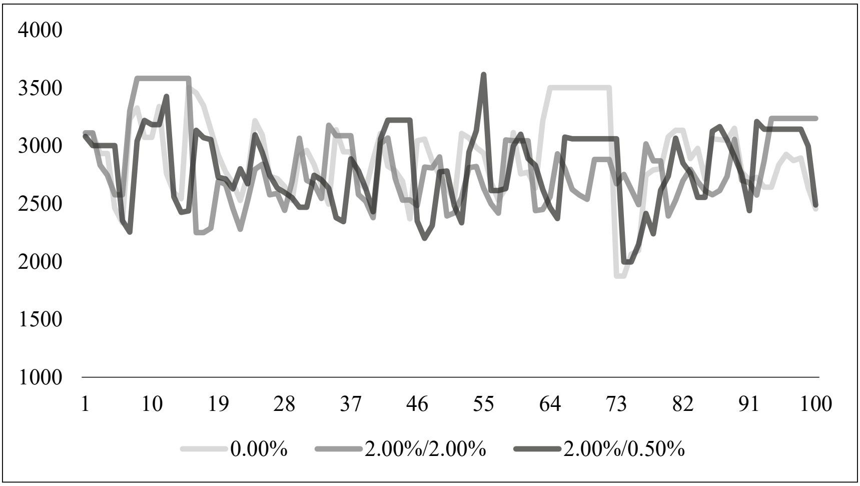

Figure 1: House price dynamics in the simulation scenarios[13]

Figure 1 presents the house price dynamics in the three different simulation scenarios over time. The property prices develop quite similarly in all of the computed market settings. These movements indicate only a slight impact of an additional sectoral regulatory buffer on the housing market. This indication is confirmed by Table 3. Table 3 provides the statistical properties of the evaluated scenarios. We analyze the model via computer simulations by running extensive Monte Carlo simulation experiments composed of 100 independent runs. The volatility of housing prices, indicated by their standard deviation, shows a marginal increase in housing price volatility if all bank types need to hold an additional 2.0% of equity when they finance owner-occupied dwellings. This indicates that a cross-institutional introduced *SyRB* is not able to improve the stability of the real estate market. Instead, it diminishes its solidity, even if only to a marginal amount. Concluding from this result, a homogenously applied *SyRB* fails in achieving its regulatory goals. The buffer that is intended to counteract sectoral risks is not effective in lowering housing market volatility. If we vary the amount of the *SyRB* for BLs and oblige them to hold only an additional 0.5% of equity, the results change. The standard deviation of house prices decreases and the market gets more stable. Housing market dynamics get less volatile, and the sectoral risk arising from the property market can be mitigated.

[13] *Note*: The figure displays the development of trend-adjusted housing market cycles of one exemplary simulation run in which exogenous factors such as inflation or changes in market interest rates are not considered.

Table 3

Statistical measures of the simulation scenarios

***SyRB*-Scenario**		**0.0 %***	**2.0 %/2.0 %**	**2.0 %/0.5 %**
House Price	Min	2.036.396	2.153.500	1.995.770
	Max	3.571.386	3.587.295	3.582.119
	Mean	2.922.757	2.962.311	2.901.063
	Std	210.157	211.213	183.972
Mortgage Interest Rate	Min	0.002	0.012	0.011
	Max	0.069	0.075	0.073
	Mean	0.027	0.036	0.034
	Std	0.015	0.015	0.009
Non-Default Probability	Min	0.095	0.052	0.031
	Max	0.975	0.817	0.995
	Mean	0.726	0.746	0.706
	Std	0.017	0.018	0.013
Transaction Rate	Min	0.000	0.000	0.000
	Max	0.744	0.766	0.800
	Mean	0.197	0.163	0.185
	Std	0.046	0.050	0.037
Homeownership Rate	Min	0.000	0.000	0.000
	Max	0.699	0.719	0.736
	Mean	0.157	0.134	0.150
	Std	0.038	0.041	0.030
Construction Rate	Min	0.000	0.000	0.000
	Max	0.720	0.629	1.363
	Mean	0.058	0.048	0.059
	Std	0.016	0.018	0.053
Loan Amount	Min	1.000	30.350	26.113
	Max	726.605.75	622.002.72	720.470.23
	Mean	125,258.42	109,264.73	115,695.71
	Std	33,635.89	37,278.20	27,500.11
No. of Loans	sum	2065	1958	2045

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SyRB-Scenario		0.0 %*	2.0 %/2.0 %	2.0 %/0.5 %
Mortgage Market Penetration	CBs	0.569	0.660	0.521
	BLs	0.431	0.340	0.479
Z-Score	Min	2.037	2.312	2.467
	Max	3.238	3.398	3.299
	Mean	2.370	2.748	2.836
	Std	0.285	0.150	0.145

*Base scenario

As shown in previous studies, the mortgage lending practices of BLs help to stabilize the housing market cycles and to prevent real estate crises (*Braun* et al. 2022; *Molterer* et al. 2017). These insights are confirmed by the results from the computational experiments conducted in this study. The mortgage market penetration of the two investigated bank types reveals that, the higher the market penetration of BLs, the lower the standard deviation of housing prices (Table 3). In the base scenario, in which CBs and BLs do not have to comply with the *SyRB*, CBs slightly dominate the mortgage lending market (0.569 vs. 0.431). When the sectoral buffer is introduced for both financial institutions equally, BLs forfeit market shares. The *SyRB* particularly affects BLs due to their stronger focus on property financing. Holding an additional amount of equity to lend for dwellings increases the cost of mortgage granting. As such, BLs need to reject applicants and are restricted in business opportunities. The loss of market shares is in favor of the CBs that profit from tougher lending conditions for BLs. As CBs tend to lend procyclical, housing market stability suffers. If BLs only need to hold 0.5% as *SyRB*, they gain market shares. The mortgage market penetration of BLs reaches 0.479 while this of CBs is 0.521 The lower *CAR* in comparison to CBs enable BLs to expand their core business. This promotes competition that positively affects housing market stability.

The introduction of the *SyRB* increases the costs of mortgage lending for financial institutions. To compensate for these costs, banks raise mortgage interest rates. This can also be seen in Table 3. In the 2.0% / 2.0% – scenario, interest rates rise to 0.036. In the 2.0% / 0.5% – scenario, interest rates rise to a lower extent than in the 2.0% / 2.0% – scenario, i. e., to 0.034. In contrast to BLs, CBs chose freely between alternative investment opportunities. This induces higher indifference rates for CBs that drive mortgage interest rates. Since BLs' special regulation limits their investment options and thus focuses their business on housing financing, the mortgage interest rates charged by them are lower. The market penetration of the financial institutions in the respective scenarios leads to higher interest rates in the 2.0% / 2.0% – scenario, while an increased market activity of BLs in the 2.0% / 0.5% – scenario prevents high mortgage interest rates.[14]

An increase in mortgage interest rates induced by higher *CAR* makes housing investment more expensive and damages housing affordability. As a result, more prosperous borrowers in terms of higher initial equity and lower LTVs will get a loan preferentially. This makes the non-default probability in the 2.0% / 2.0% *SyRB*-environment rise to 0.746. In the 2.0% / 0.5% *SyRB*-environment, the non-default probability further improves to 0.706. One reason for a lower probability of default and more profound borrowers in the 2.0% / 0.5%-scenario might be the fact that BLs also use endogenously created customer information to decide about lending instead of mainly focusing on market developments. These results indicate that a *SyRB* positively affects borrower stability. However, the effect is more pronounced if different institutional bank types have to comply with an individual buffer size.

The positive effect of a sectoral *SyRB* on borrower's non-default probability coincides, however, with diminished housing market activity. Increased capital costs for banks and more expensive financing conditions for potential buyers lower the transaction rate of dwellings to 0.163 in the 2.0% / 2.0%-scenario, compared to 0.197 in the base scenario. An additional buffer of 2.0% for all bank types significantly affects housing market dynamics and constrains market activities. If BLs need to hold only 0.5% instead of 2.0%, the transaction rate is 0.185. Since a requirement of 0.5% *SyRB* for BLs and 2.0% for CBs also increases costs, the loss in the transaction rate of houses from the base scenario cannot be fully compensated, but is, at least, greatly reduced. Due to their special regulatory requirements, BLs still align their business activities on housing financing and are thus able to cushion activities in the housing market.

The same holds true for the rate of homeownership. In the baseline scenario, it measures 0.157. A 2.0% sectoral *SyRB* for all bank types pushes the ratio down to 0.134. More severe financing conditions prevent potential buyers from obtaining real estate financing. Although more severe financing conditions build a more profound borrower base, it reduces housing affordability. An additional sectoral buffer limits homeownership to more prosperous borrowers, i. e., borrowers with higher initial equity and lower LTVs. The homeownership rate recovers almost completely to 0,150 if BLs are exclusively subject to a lower *SyRB*. This is induced by two effects. First, the lower interest rate level initiated by stronger BLs dampens expenditure for housing investment. This is also confirmed by the lower mean price of houses. Second, BLs decide in favor of mortgage granting not only according to initial equity or LTV levels. Instead, they

[14] Note: Operational costs of granting mortgages are not considered in this model. Thus, mortgage interest rates indicate bank returns.

also account for borrower information obtained during the customer relationship. On this informational basis, BLs expand access to real estate financing and enable homeownership for a broader share of the population.

Just like the transaction and homeownership rate, the construction rate decreases if a 2.0% sectoral buffer is introduced. It amounts to 0.058 in the base scenario and 0.048 in the 2.0% / 2.0% – scenario. Higher expenditures for housing investment lower the demand for residential property. As a result, construction firms curb housing construction. Unlike the transaction rate and the homeownership rate, the construction rate in the 2.0% / 0.5% – scenario, with 0.59, even exceeds that of the other two scenarios. Thus, the stable housing market situation and moderate market activities boost construction in the 2.0% / 0.5% – scenario.

The loan amount as well as the number of granted mortgages confirm the preceding results. Compared to the *SyRB* – scenarios, banks accept mortgages most generously when they do not have to comply with a sectoral *SyRB*. The mean value of the offered loan amount as well as the number of accepted loans exceed those of the other two scenarios. When an additional buffer is introduced, banks reduce lending for acquiring a residential property, either because there are more profitable investment options or because they are forced to do so in order to comply with the regulatory requirements. Since the relative importance of the mortgage exposure of BLs exceeds this of CBs, BLs are particularly affected by tightened *CAR* for this business area. As a result, they need to reduce their exposure considerably, thereby sacrificing market shares. A lower *SyRB* for BLs limits their business activities to a lesser extent and cushions the demand for real estate financing. This, in turn, positively affects housing market stability and macroeconomic activities.

The mean value of the Z-score in a regulatory environment without sectoral *SyRB* reaches 2.307. In the 2.0% / 2.0% *SyRB* – scenario it amounts to 2.748. Higher Z-scores imply a lower probability of banks' insolvency (*Hesse* and *Čihák* 2007; *Lepetit* and *Strobel* 2015). Thus, our result unsurprisingly indicates a more stable banking sector if banks are required to maintain a higher equity base. The extension of *CAR* increases banks' loss absorbency capacity and thus improves the resilience of the banking sector. This stability-enhancing effect, however, comes at an expense. It constrains market interactions and restricts potential home buyers' accessibility to mortgage lending. Furthermore, it coincides with a limited possibility of acquiring residential property, and it mitigates macroeconomic stability.

Subjecting BLs exclusively to a lower *SyRB*, in our computational environment to 0.5%, further increases banking soundness, with a Z-score of 2.836. A high additional sectoral buffer restricts BLs from conducting their traditional banking business, which is inherently more stable than this of CBs (*Braun* 2023;

Molterer 2019). As a result of their forfeited market penetration, the stability of the housing market as well as this of the banking sector is lower. In contrast to this, lower *CAR* for BLs lead to a higher mortgage market penetration that positively affects micro- and macroprudential solidity.

Figure 2 illustrates the distribution of Z-scores in all simulation scenarios. It reveals that the mean in the base scenario is positively influenced by a few very stable institutions that are presented as outliers. As BLs' specific regulation creates a concentrated business model which is more solid than this of CBs and more persistent in times of crisis (*Braun* 2023; *Molterer* 2019), it can be assumed that these are BLs. Most of the banks are systematically worth-off than in the other two scenarios. The sectoral *SyRB* in the 2.0% / 2.0% – scenario boosts the mean Z-score to a higher level. A higher share of BLs interacting in the 2.0% / 0.5% – scenario stabilizes the overall banking sector and creates the highest Z-score level of all simulation scenarios. In both latter scenarios, a hypothetical regulator might be troubled by a set of negative outliers, but less so in the third scenario.

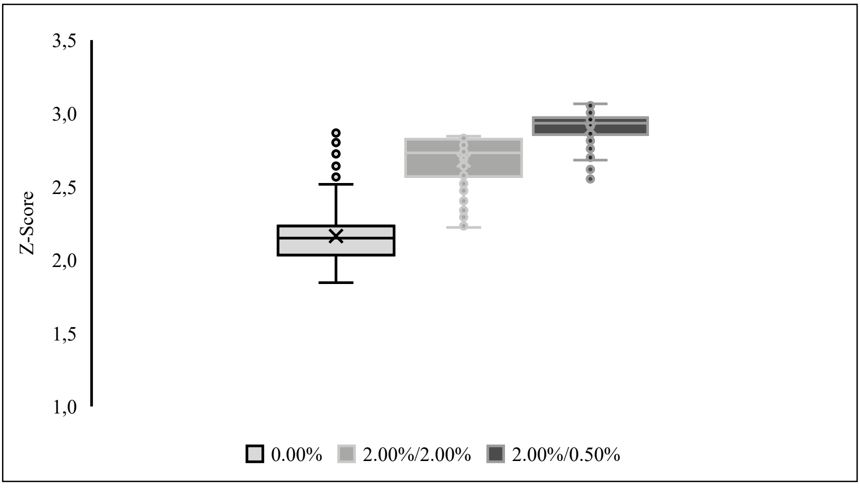

Figure 2: Z-scores of the simulation scenarios[15]

Figure 3 displays the evolution of the mean Z-scores of the three simulation scenarios over time. In all of the scenarios, the Z-scores reach a peak close to the starting point of the simulation. This corresponds to rising house prices from period 7 and an associated rise of the *CCyB*. In times of highly appreciating price dynamics and excessive growth in credit exposures, banks need to raise

[15] *Note*: The figure shows the distribution of Z-scores of one exemplary simulation run.

capital buffers. In the ensuing downturn, the buffer is released, which leads the Z-scores to a stable level in all computational environments. They develop steadily over time while the mean value of the Z-score in the 2.0% / 0.5% – scenario exceeds this of the other scenarios over the whole simulation period. In the base scenario, after the initial peak, the mean Z-score displays the lowest values of all three scenarios.

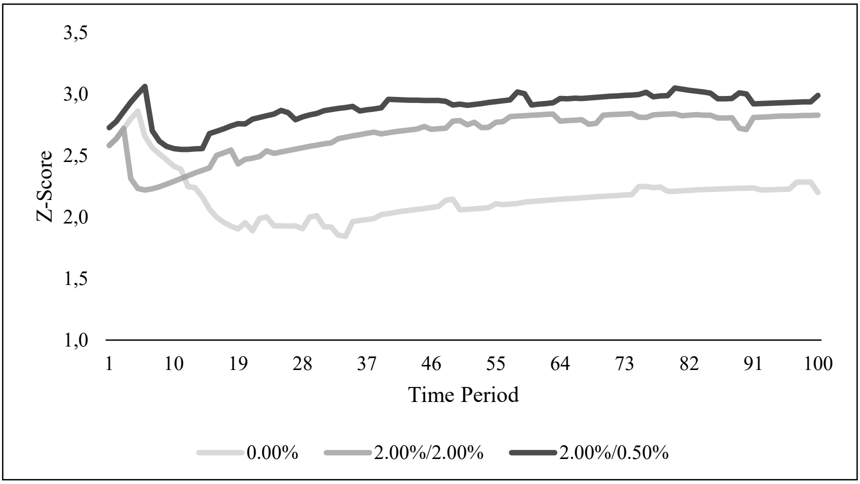

Figure 3: Development of Z-score means in the simulation scenarios[16]

IV. Conclusions

In the aftermath of the financial crisis, existing banking regulation was highly criticized. Prevailing regulatory rules were not able to prevent or mitigate the extent of the crisis that lead to global economic downturns. In response to that, the BCBS passed the Basel III Accords. The revised rules on banking supervision introduce a diverse set of micro- and macroprudential measures that aim to strengthen the regulation and risk management of banks. One particular tool of the post-crisis reform of Basel III is the *SyRB*. It can be introduced by national authorities to counteract systemic risk that is not addressed by the prevailing *CAR* and the *CCyB*. In the context of steadily rising real estate prices during the last decade, the German authority decided to implement a sectoral *SyRB* that specifically addresses the real estate market. From February 1st, 2023, every bank is obliged to maintain an additional 2.0% of equity for exposures that are secured by residential property.

[16] *Note*: The figure shows the development of Z-score means of one exemplary simulation run.

In this paper, we extend the model of *Braun* (2023) and investigate the effectiveness of a sectoral equity buffer designed according to German conditions to mitigate sectoral risk arising in the housing market. The model constitutes a housing and a financial market. The housing market is populated by potential home buyers and sellers. According to individual conditions and expectations, they decide whether they want to acquire or sell residential property. The financial market consists of two types of financial intermediaries, CBs and BLs. Incorporating two bank types, the model creates a diverse financial market that reflects the banking sector in Germany. Banks either hold cash, finance housing, or invest in an alternative investment portfolio. They are constrained in conducting business by the regulatory rules of Basel III. We extend the underlying model by an obligatory *SyRB* of 2.0% that complements the already existing *CAR* and the *CCyB*. Through financing housing investments, banks highly affect the housing market. All agents in this model are characterized by heterogeneous features that influence their decisions. By interacting with each other, they create endogenous housing market cycles.

To study the impact of a sectoral *SyRB* on the housing and the financial market, we conduct several computational experiments that are examined individually and compared to each other. The first simulation scenario presents market conditions without a *SyRB*. Banks are only subjected to the *CAR* and the *CCyB* according to Basel III. This regulatory environment serves as a base scenario. In the second scenario, we introduce the sectoral buffer of 2.0% and investigate how market developments change. As a third environment, we create heterogeneous obligations for the two interacting bank types. Due to their special legal and regulatory setting, BLs' business model is highly concentrated on the financing of housing investment. Thus, a sectoral *SyRB* that addresses the real estate market particularly affects their business activities. We lower BLs' *SyRB* -obligation to 0.5%. This is an interesting scenario to investigate, as previous studies reveal that BLs' business model is inherently stable and able to stabilize housing market volatility (*Braun* 2023; *Braun* et al. 2022; *Molterer* et al. 2017).

The experiments reveal that a sectoral *SyRB* that is introduced to all types of financial intermediaries equally misses its regulatory aim. The risk arising from the housing market, measured by the standard deviation of housing prices, cannot be mitigated. Instead, it is slightly increased. The higher capital requirement increases the cost of financing residential property. This induces banks to raise mortgage interest rates. Increased expenditures for housing investment limit the possibility of potential buyers to acquire housing. This dampens housing demand and depresses macroeconomic activities in the housing market. The *SyRB* constrains housing transactions and constructions and restricts homeownership. As BLs are particularly affected by a sectoral *SyRB*, they are, to some degree, squeezed out of the mortgage market and forfeit market shares. However, the *SyRB* performs well with regard to banking soundness. The strengthened equity base provides capital to absorb potential losses and thus reduces the risk of bank insolvencies. This advantage, however, comes at the expense of adverse macroprudential effects in the housing market.

Exclusively reducing the *SyRB*-level of BLs to 0.5% while holding this for CBs fixed shows that the new regulatory measure can be able to fulfill its aim with regard to the housing market. If the amount of *SyRB* is lowered for BLs, the volatility of housing prices is reduced and housing market cycles are more stable. BLs can expand market shares. This lowers mortgage interest rates, which positively affects housing demand due to decreased expenditures for buying a home. Housing transactions and constructions pick up, and the ratio of homeowners reaches a higher level than in the 2.0% / 2.0% – environment. The increased mortgage lending by BLs positively affects housing market price stability while protecting the general activity level in the real estate market that is endangered by the introduction of a respective sectoral *SyRB*. At the same time, it also enhances the solidity of the banking sector. The Z-score of the 2.0% / 0.5% – scenario exceeds the level of the other simulation scenarios and verifies that BLs' business practices elevate the solidity of the financial sector.

This case study of a sectoral *SyRB* on housing financing provides insights into its impact on the housing market and the financial market. The findings reveal that it is possible to dampen systemic risk and stabilize the financial market while at the same time ensuring macroeconomic activities if the *SyRB* is properly designed, i.e., if it is applied on different types of financial intermediaries with explicit regard to their specific characteristics and ensuing business models, and, consequently, at different rates. This result has a political implication that can be useful in future discussions about the design of regulatory capital adequacy requirements.

Appendix

Table 4 summarizes the requested risk weights of LTV levels according to the BCBS (BCBS, 2017b).

Table 4

Risk weight table for residential real estate exposure

	LTV ≤ 50 %	60 % < LTV ≤ 80 %	80 % < LTV ≤ 90 %	90 % < LTV ≤ 100 %	LTV > 100 %
Risk weight	20 %	25 %	30 %	40 %	70 %

References

Ackerman, F. (2002): Still dead after all these years: interpreting the failure of general equilibrium theory. Journal of economic methodology, 9(2), 119 – 139.

BaFin (2022a): Allgemeinverfügung zur Anordnung eines Kapitalpuffers für systemische Risiken nach § 10e KWG. URL https://www.bafin.de/SharedDocs/Veroeffentlichungen/DE/Aufsichtsrecht/Verfuegung/vf_220331_allgvfg_systemrisikopuffer.html.

BaFin (2022b): Antizyklischer Kapitalpuffer: BaFin erlässt Allgemeinverfügung zur Anhebung auf 0,75 Prozent. URL https://www.bafin.de/SharedDocs/Veroeffentlichungen/DE/Meldung/2022/meldung_2022_01_31_Antizyklischer_Kapitalpuffer.html.

BCBS (2011): Basel III: A global framework for more resilient banks and banking systems. Bank for International Settlements. URL https://www.bis.org/publ/bcbs189.pdf.

BCBS (2017a): High level summary of Basel III reforms. Bank for International Settlements. URL https://www.bis.org/bcbs/publ/d424_hlsummary.pdf.

BCBS (2017b): Basel III: Finalising post-crisis reforms. Bank for International Settlements. URL https://www.bis.org/bcbs/publ/d424.htm.

BCBS (2019a): Risk-based Capital requirements – Calculation of minimum risk-based capital requirements. Bank for International Settlements. URL https://www.bis.org/basel_framework/standard/RBC.htm.

BCBS (2019b): Risk-based Capital requirements – Buffers above the regulatory minimum. Bank for International Settlements. URL https://www.bis.org/basel_framework/chapter/RBC/30.htm?inforce=20191215&published=20191215.

Bernanke, B. S./*Gertler*, M. (1995): Inside the black box: the credit channel of monetary policy transmission. Journal of Economic Perspectives. 9(4). 27 – 48.

Bernanke, B. S./*Gertler*. M./*Gilchrist*, S. (1999): The financial accelerator in a quantitative business cycle framework. In: Taylor. J. B., Woodford. M. (Eds.). Handbook of Macroeconomics. Vol. 1.

Blundell-Wignall, A./*Atkinson*, P. (2010): Thinking beyond Basel III: Necessary solutions for capital and liquidity. OECD Journal: Financial Market Trends, 2010(1), 9 – 33.

Boyd, J. H./*Runkle*, D. E. (1993): Size and performance of banking firms: Testing the predictions of theory. Journal of monetary economics. 31(1). 47 – 67.

Braun, J (2023): Taming Housing and Financial Market Instability: The Effect of Heterogeneous Banking Regulations. Journal of Real Estate Research, 45:4, 511 – 544, https://doi.org/10.1080/08965803.2023.2206284.

Braun, J./*Burghof*, H.-P., *Langer*, J./*Sommervoll*, D. E. (2022): The Volatility of Housing Prices: Do Different Types of Financial Intermediaries Affect Housing Market Cycles Differently? Journal of Real Estate Finance and Economics. https://doi.org/10.1007/s11146-022-09907-y.

Collyns, C./*Senhadji*, A. (2003): Lending booms, real estate bubbles, and the Asian crisis. Asset price bubbles: the implication for monetary, regulatory and international policies. MIT Press, Cambridge and London, 101 – 25.

Deutsche Bundesbank (2022): Macroprudential measures. URL https://www.bundesbank.de/en/tasks/banking-supervision/individual-aspects/macroprudential-measures/macroprudential-measures-622910.

Dosi, G. (2012): Economic Coordination and Dynamics: Some Elements of an Alternative 'Evolutionary' Paradigm, Economic Organization, Industrial Dynamics and Development. Selected Essays, 2.

European Systemic Risk Board (2023): Systemic risk buffer. URL https://www.esrb.europa.eu/national_policy/systemic/html/index.en.html.

Farmer, J. D./*Foley*, D. (2009): The economy needs agent-based modelling. Nature, 460(7256), 685 – 686.

Filatova, T./*Parker*. D. C./*Van der Veen*, A. (2007): Agent-based land markets: heterogeneous agents, land prices and urban land use change. Proceedings of the 4th Conference of the European Social Simulation Association (ESSA'07).

Freund, J./*Curry*, T./*Hirsch*, P./*Kelly*, T. (1998): Commercial real estate and the banking crises of the 1980s and early 1990s. History of the eighties: Lessons for the future (an examination of the banking crises of the 1980s and early 1990s) 1, 137 – 165.

Gaffeo, E./*Delli Gatti*, D./*Desiderio*, S./*Gallegati*, M. (2008): Adaptive microfoundations for emergent macroeconomics. Eastern Economic Journal, 34(4), 441 – 463.

German Central Bank (2019): The Role of the Real Estate Sector in Financial Stability. URL https://www.bundesbank.de/de/presse/reden/die-rolle-des-immobiliensektors-fuer-die-finanzstabilitaet-814682.

Goodhart, C./*Hofmann*, B. (2007): House Prices and the Macroeconomy – Implications for Banking and Price Stability. Oxford University Press.

Hammersland, R./*Jacobsen*, D. H. (2008): The financial accelerator: Evidence using a procedure of structural model design. (No. 569). Discussion Papers.

Herring, R. J./*Wachter*, S. M. (1999): Real estate booms and banking busts: An international perspective. Wharton School Center for Financial Institutions, Working Paper 99 – 27.

Hesse, H./*Čihák*, M. (2007): Cooperative banks and financial stability. International Monetary Fund.

Hilbers, P./*Lei*, Q./*Zacho*, L. (2001): Real estate market developments and financial sector soundness. Working paper 01/129, IMF.

IMF, Monetary and Capital Markets Department (2011): Macroprudential Policy: An Organizing Framework. IMF: Washington D.C. URL https://www.imf.org/external/np/pp/eng/2011/ 031411.pdf.

Kirman, A. (2016): Ants and nonoptimal self-organization: Lessons for macroeconomics. Macroeconomic Dynamics, 20(2), 601 – 621.

Kirsch, S./*Burghof*, H.-P. (2018): The Efficiency of Savings-Linked Relationship Lending for Housing Finance. Journal of Housing Economics, 42, Dec., 55 – 68.

Kiyotaki, N./*Moore*, J. (1997): Credit cycles. Journal of political economy. 105(2), 211 – 248.

Kowalik, M. (2011): Countercyclical capital regulation: should bank regulators use rules or discretion? Economic Review, Federal Reserve Bank of Kansas City, 63.

Lepetit. L./*Strobel*, F. (2015): Bank insolvency risk and Z-score measures: A refinement. Finance Research Letters, 13, 214 – 224.

Molterer, M. (2019): Tougher than the rest? The resilience of specialized financial intermediation to macroeconomic shocks. The Quarterly Review of Economics and Finance, 74, 163 – 174.

Molterer, M./*Amon*, J./*Tyrell*, M. (2017): Specialized Financial Intermediaries and the Impact of Savings and Loan Contracts on Real Estate Finance. Available at SSRN 2873919.

Müller, M. L. (1999): Bausparen in Deutschland zwischen Inflation und Währungsreform 1924 – 1948. C. H. Beck, München. http://dx.doi.org/10.2139/ssrn.2873919.

Niinimäki, J. P. (2009): Does collateral fuel moral hazard in banking? Journal of Banking & Finance, 33(3), 514 – 521.

Roy, A. D. (1952): Safety first and the holding of assets. Econometrica 20, 431 – 449.

Statista (2023a): S&P/Case-Shiller Häuserpreisindex für die USA in den Jahren von 1987 bis 2021. URL https://de.statista.com/statistik/daten/studie/427276/umfrage/sundp-case-shiller-haeuserpreisindex-fuer-die-usa/#:~:text=Ausgehend%20vom%20Januar%202000%20(Index,bei%20etwa%20278%2C52%20Punkten.

Statista (2023b): Entwicklung der Immobilienpreise in Deutschland von 2004 bis zum 4. Quartal 2022. URL https://de.statista.com/statistik/daten/studie/597304/umfrage/immobilienpreise-alle-baujahre-in-deutschland/.