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REGULATION

The unintended consequences of macroprudential regulation in insurance and banking: Endogenous financial system instability induced by regulatory capital standards

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THE UNINTENDED CONSEQUENCES OF MACROPRUDENTIAL REGULATION IN INSURANCE AND BANKING: ENDOGENOUS FINANCIAL SYSTEM INSTABILITY INDUCED BY REGULATORY CAPITAL STANDARDS

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ABSTRACT

Unlike microprudential regulation that focuses on the stability of individual institutions, macroprudential regulation focuses on the stability of the financial system as a whole. However, despite the increased interest in a system-wide lens, our empirical research indicates that the design of the Solvency II and Basel II/III frameworks, while intended to strengthen the stability of each sector individually, may be the source of endogenous destabilizing effects across the financial system, due to incentives for increased asset concentration and capital standard procyclicality. The support for the capital arbitraging hypothesis was weaker.

1. INTRODUCTION: THE DIMENSIONS OF MACROPRUDENTIAL POLICIES

Macroprudential regulation is intended to reduce systemic risk and ensure financial system stability by addressing a number of dimensions, namely time, size, cross-sectoral, and structural [BIS (2010), Borio and Drehmann (2009)].

The time dimension aims to prevent the excessive build-up of risk, resulting from external factors and market failures, with the goal of smoothing the financial cycle. The policy tools employed to address this dimension primarily focus on the offsetting behavior of prudential cushions [Borio (2004)], as well as the extension of the risk management time horizon [Borio and Drehmann (2009)].

The size dimension focuses on the potential reduction of negative externalities associated with institutions that are perceived as too-big-to-fail due to their balance sheet size and interconnectedness [BCBS (2013a)]. The prudential measures adopted aim at increasing the loss absorbing capacity of systemically significant institutions, as well as the going-concern loss absorbency pertaining to them [FSB (2010), BCBS (2013a)].

Third, the cross-section dimension is concerned with how aggregate risk is distributed in the financial system at any point in time and aims to limit contagion effects, thereby making the financial system more resilient. From a policy perspective, the main tools employed to limit cross-sectional effects have been capital requirements and insurance schemes [Borio (2009)].

Lastly, the structural dimension aims to encourage a system-wide perspective on financial regulation to create the right set of incentives for market participants. Employing macroprudential lens, there is "the possibility that actions that are optimal from the perspective of individual institutions may result in undesirable outcomes for the system as a whole, through adverse feedback effects" [Borio (2009)].

2. REGULATORY CAPITAL INDUCED SOURCES OF FINANCIAL SYSTEM INSTABILITY

There are two different approaches to identifying sources of financial instability: one approach defines financial system stability in terms of its robustness to exogenous shocks [Allen and Wood (2006)], whereas a second approach focuses on "a notion of risk that stresses the potentially destabilizing effects of the collective behavior of economic agents, i.e., what might be termed the 'endogenous' nature of risk." [Borio and Drehmann (2009)].

Under the second approach, financial system instability is the result of moral hazard, whereby the consequences of an individual actor's behavior are borne by the financial system as a whole [Acharya (2003), Borio and Drehmann (2009)]. In other words, although insurance and banking capital requirements are intended to maintain the solvency of the respective financial sectors, the incentives they create may come at the expense of sector-wide systemic risk [Acharya (2009), Borio (2009)].

The extant literature has identified a number of non-mutually exclusive endogenous sources of financial system instability, nurtured by the regulatory capital frameworks: (i) asset concentration; (ii) capital arbitraging, and (iii) pro-cyclicality. This article extends the industry-specific (insurance or banking) analyses of such capital-induced incentives [Borio (2003), Acharya (2009), Christophersen and Zschiesche (2015)] to the financial system as a whole (insurance and banking).

Table 1: Differences between Basel II/III and Solvency II

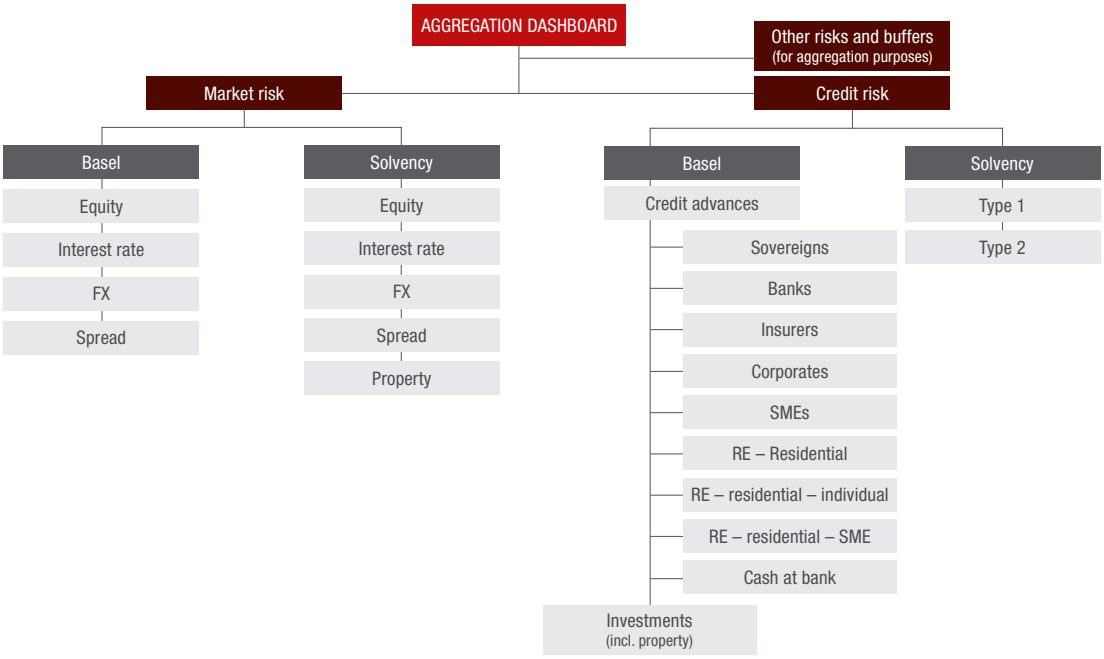
	BASEL II / III	SOLVENCY II
SCOPE	Banking operations excluding insurance and other financial subsidiaries	Insurance (life and non-life) and re-insurance undertakings
APPLICATION	A framework with no legal force but potentially global application	A legal directive (binding in the European Economic Area)
REGULATORY FOCUS	Individual banking institutions	Individual policyholder
STRUCTURE	3 pillars – quantitative requirements come first	3 "pillars" – quantitative requirements come last
APPROACH	Mixture of fair value and amortized cost	Total balance sheet (fair valued assets and liabilities)
QUANTITATIVE RISK COVERAGE	Credit, operational, market Liquidity principles	Insurance, credit, operational, market
CONFIDENCE INTERVAL	Credit and operational: 99.9%; Market: 99%	All: 99.5%
DIVERSIFICATION ACROSS RISK TYPES	None	Across all BSCR risk types, plus loss absorbing capacity of technical provisions and deferred taxes
DIVERSIFICATION WITHIN RISK TYPES	Market risk only	Market and counterparty risk
CAPITAL BUFFERS	Capital conservation buffer Countercyclical buffer G-SIB	None
CAPITAL ELIGIBILITY	Common equity tier 1, additional tier 1 and tier 2	Basic own funds, ancillary own funds
LEVERAGE	Risk-insensitive leverage ratio	Embedded in capital requirement
FUNDING LIQUIDITY STANDARDS	Explicit (non-capital based)	Embedded in overall risk management system
TIME PERSPECTIVE	Retrospective across risk types	Prospective: existing and new business within next 12 months (Article 101)
RISK MEASUREMENT TYPOLOGY	Rules-based for credit (AIRB approach is also based on a pre-calibrated formula with internal modeling of PD, EAD, and LGD only)	Standard formula: several more internally estimated parameters; IM: principles-based

- **Asset concentration:** studies have indicated that existing regulatory requirements can lead to increased demand for liquid assets [BCBS (2013b)] including sovereign paper, which is preferentially treated across the banking and insurance capital frameworks [BCBS (2017a, 2006), EU (2015)]. Consequently, capital standards may be a source of endogenously generated financial system instability by means of incentivizing increased diversification within institutions, yet simultaneously concentration across the financial system [BIS (2003)].
- **Capital arbitraging:** the inconsistent treatment of similar assets across insurance and banking may result in regulatory capital arbitraging across the financial system [Merton (1994), Ambrose et al. (2005), Calem and Follain (2007), Jones (2000)]. Financial assets may be shifted between the different sectors in order to exploit regulatory differences, while formally meeting prudential requirements [Dierick (2004)].
- **Pro-cyclicality:** in the context of financial stability, procyclicality refers to the extent that capital requirements fluctuate with the business cycle, thus amplifying swings in the real economy. Given that insurance and banking regulatory capital requirements are based on exposure to common risk drivers, individually rational responses to changes in risk over time – based on the regulatory capital incentives provided by the frameworks' structure – may result in cyclical upswings or reductions in regulatory capital requirements and capitalization ratios across the financial system without a corresponding reduction in the underlying risks [Dierick (2004), Freixas et al. (2007)], thus exacerbating procyclicality [Nijathaworn (2009)].

3. CAPITAL REGULATORY FRAMEWORKS IN BANKING AND INSURANCE

The analysis presented in this article uses as its basis the insurance regulatory framework commonly referred to as Solvency II [EU (2015, 2014, 2009)] and the banking regulatory frameworks commonly referred to as Basel II and Basel III [BCBS (2017a, 2006, 2019)].[1] While both frameworks have been characterized as mostly microprudential in nature [Hanson et al. (2010)], they also contain macroprudential elements introduced since the 2008 financial crisis [BCBS (2011), EU (2015), Christophersen and Zschiesche (2015)]. The most important differences between the respective capital frameworks are summarized in Table 1.

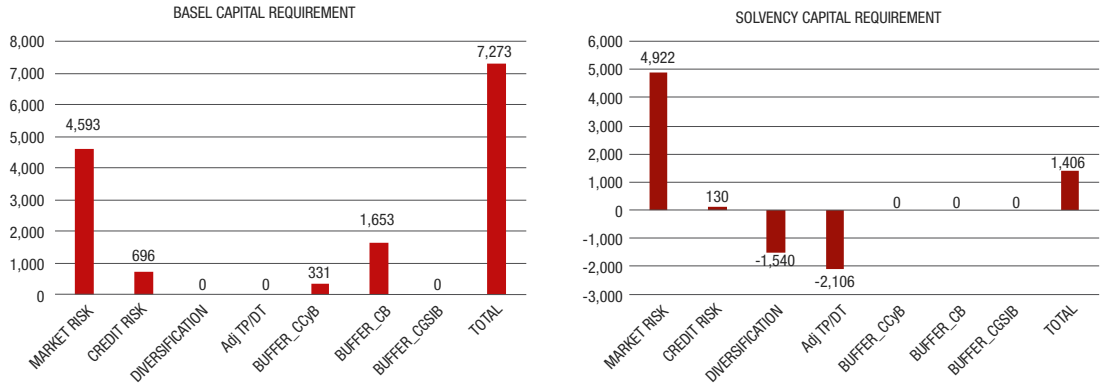
Figure 1: Framework for the regulatory capital estimates in insurance and banking



[1] Please note that unlike Basel I, which was mostly replaced by the introduction of Basel II, Basel II and Basel III are complementary frameworks and as such will be jointly referred to as the banking regulatory frameworks or the Basel framework. The 2017 finalization of the Basel III standards [BCBS (2017a)] is euphemistically termed as "Basel IV".

[2] Non-life and health insurance institutions have not been included due to the fundamentally different composition of their balance sheets (liabilities and assets), as well as due to the differences in the underlying business models.

Figure 2: Aggregate capital requirements for stylized balance sheet under the Basel and Solvency frameworks



4. FRAMEWORK FOR THE SIMULATION ANALYSIS OF REGULATORY CAPITAL-INDUCED DESTABILIZING EFFECTS

We restricted the analysis to the regulated banking and life insurance sectors,[2] and focused on the asset-related risks embedded in the credit risk and market risk capital frameworks, consistently with Acharya (2009), Froot and Stein (1998), Laas and Siegel (2017), and Thibeault and Wambeke (2014). These two financial risks are found across banks and life insurers, and make up at least 85% of the total capital requirement for banks [EBA (2015)] and 75% for solo life insurers [EIOPA (2011)]. Figure 1 provides an outline of the approach used to analyze the regulatory capital requirements in both industries.

For the purposes of our research, the regulatory standard frameworks have been selected as they provide the most harmonized approach to evaluating and comparing capital requirements across institutions [Laas and Siegel (2017)]. Unlike internal model approaches, standard frameworks provide an overall consistent calibration within each industry and are in line with the move towards standardized capital floors [BCBS (2019, 2017a, 2017b), EIOPA (2014)].

4.1 Assets and weights of the portfolio of banks and insurers

To estimate capital requirements for both sectors, we use a stylized balance sheet of insurance and banking, in line with prevailing academic research [Höring (2013), Laas and Siegel (2017), Thibeault and Wambeke (2014), Braun et al. (2017)].

Consistent with our asset side scope, we incorporate only asset classes that are shared across banking and insurance institutions. We use the median E.U. insurer investment portfolio based on data from EIOPA (2016a), namely €50,800 mln.[3] The distribution of the assets in the portfolio is outlined in Table A1 in the Appendix.

4.2 Capital requirements estimates

We estimate the capital requirements per risk type in scope, as well as the aggregate figures considering the diversification and the application of capital buffers, for both banking and life insurance industry. As previously mentioned, all data inputs, associated parameters, assumptions, and calibrations, are as per the regulatory standard frameworks. Results are summarized in Table A2 in the Appendix and Figure 2.

While at the standalone, risk type level, Solvency II capital requirements appear slightly more punitive based on our stylized balance sheet, the overall capital requirement of insurance institutions is mediated by the diversification effects allowed in the Solvency capital requirements calculations, as well as the adjustments permitted for the loss absorbing capacity of technical provisions and deferred taxes. These two effects make the Solvency capital requirement comparatively lower to the respective Basel one, based on the portfolio and assumptions employed.[4]

In summary, the quantitative differences across capital requirements for both banks and life insurers can be attributed to the following factors: the difference in the scope of each

[3] The use of a stylized balance sheet based on data from the banking sector can be an area for further research. One needs to note that, given the comparability constraints, the composition of participating asset classes would likely remain the same, with higher allocations expected primarily in real estate and structured notes.

[4] For a discussion and criticism of the structure and underlying adjustments to the capital formulas, please refer to Christiansen et al. (2012), Eling and Pankoke (2014), Repullo and Saurina Sallas (2011), and Angelini et al. (2011).

risk module, the difference in the structure of the capital calculation per asset class and risk type, and the difference in the aggregation mechanisms and buffers.

5. MAIN FINDINGS: SOURCES OF FINANCIAL SYSTEM DESTABILIZATION STEMMING FROM CAPITAL REQUIREMENTS

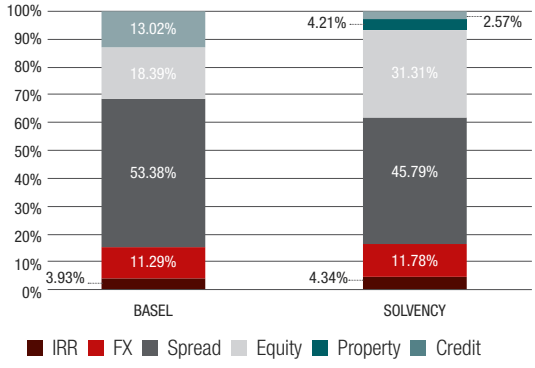
Using the afore-discussed estimates as a basis, our analysis evaluates the extent to which regulatory capital standards provide behavioral incentives detrimental to the financial system, even though individually rational for each market participant. We have evaluated these endogenous incentives along the three dimensions identified by the literature mentioned previously in this article: (i) asset concentration, (ii) capital arbitraging, and (iii) procyclicality.

5.1 Increased asset concentration

Despite the differences in capital requirements for the stylized balance sheet across the two regulatory capital frameworks, the results show a comparable rank order of capital charges and proportionate fully allocated capital amounts within each capital framework. The similarity in the rank ordering and the fully allocated capital amounts per asset class are illustrated in Figure 3.

High quality sovereign paper issued by governments domiciled in the EEA attracts the lowest capital charges and consequently becomes an investment of choice where yields are not the primary investment factor. The desirability of such assets is further augmented by the non-capital related regulatory standards for liquidity management imposed by the Basel framework [BCBS (2013b, 2010)], which necessitate a minimum level of liquid asset holdings covering cash outflows. Similarly, highly rated non-financial bonds (including the ones issued by insurers and covered bonds) also attract proportionately low capital charges and constitute desirable

Figure 3: Fully allocated capital amounts per asset class



assets from a capital perspective. On the contrary, equity investments (and alternative investments) attract significantly higher capital.

The consistency of capital charges within the two frameworks has the potential to increase asset concentrations in the same securities across the banking and insurance industries, providing an endogenous source of financial system instability. This is due to the common exposure effect, whereby "selling off assets can lead to mark-to-market losses for all market participants who hold a similar exposure" [Adrian and Brunnermeier (2011)]. Freixas et al. (2007) echo this view by stressing that "the endogeneity of risk selection [...] reverses the standard assumption that diversification has a stabilizing effect in economic downturns."

Furthermore, the consistency of capital charges within the regulated banking and insurance sectors can provide incentives for the shifting of riskier financial activity to the non-regulated sectors [Wehinger (2012)]. As Begenau and Landvoigt (2016) point out, if "regulated financial firms are competing with unregulated financial firms that provide similar services or products, then tighter regulation can cause a shift to the unregulated sector and thus potentially cause more financial instability."

Naturally, there are several factors that compensate the tendency for increased asset concentration across the financial system. The scarcity of available assets in a competitive market will inevitably reduce allocation in specific securities, and the ensuing price increases and associated yield depression [Tasca and Battiston (2012)] will also play a role in the investment decision beyond the incentives provided by capital requirements [BCBS (2001)]. The diversification factors embedded in the Solvency BSCR (Basic Solvency Capital Requirement) calculation also provide disincentives towards increased concentration in specific assets and associated risk types, however such diversification is not present in Basel's portfolio invariant assumptions [Gordy (2003)]. Lastly, the non-risk sensitive leverage ratio in Basel creates a floor to capital levels based on gross exposures [BCBS (2014)].

Instability due to asset concentration was acutely observed during the 2008 financial crisis, initially in highly rated structured notes and subsequently in sovereign paper issued by high debt countries such as Greece, Italy, and Portugal. The capital incentives created an environment where market, credit, and liquidity risks were converted to sovereign risks [BCBS (2017c)], with the repercussions extending beyond institution and financial sector risk to overall macroeconomic and financial stability [IMF (2011)].

Consequently, notwithstanding the disincentives towards asset concentration and despite the underlying differences in business models and associated risk taking activities, banking and insurance institutions are incentivized to undertake correlated asset positions, which constitutes an endogenous source of financial system instability.

5.2 Regulatory capital arbitraging

Differences in capital standards may provide incentives for regulatory capital arbitrage when the same asset attracts lower capital charges in one industry than another [Merton (1994), Ambrose et al. (2005), Calem and Follain (2007), Jones (2000)]. Regulatory capital arbitrage may be the cause of endogenously generated financial system instability because the shifting of assets from one industry sector to the other may result in a reduction of the overall capital levels in the financial system without a corresponding reduction in their overall risks [BCBS (2001), Dierick (2004), Freixas et al. (2007)].

To empirically evaluate the potential for regulatory capital arbitraging, we performed sensitivity analyses for the most material risk sub-types (equity and spread risks), illustrating the change in the previously calculated aggregate capital requirements per sector due to the shifting of assets from one regulated industry to the other. The analysis demonstrates that the incentives for arbitraging are not as straight forward as one may think.

5.2.1 EQUITY RISK

Equities constitute the most material risk class in our stylized balance sheet, and they attract the highest capitalization ratios across the Basel and Solvency frameworks. We modeled the shifting of equity assets in increments of 1% from the regulated insurance to the regulated banking sector and have quantified the capital charges for the asset class alone, as well as for total (diversified) market risk and total balance sheet on aggregate.[5] When all equities are held in the insurance sector, the total (undiversified) equity capital requirement is €3,780, while (as expected) the equity risk charge for Basel is 0. Due to the lower capitalization ratio under Basel, the standalone equity capital requirement when all assets are held in the banking sector is €1,966. However, when the sensitivity analyses are extended to the aggregate (diversified) market risk, as well as to total capital requirements, the previously apparent incentive to shift assets from insurance to banking is dampened by the countervailing forces between stand-alone and aggregate capital requirements, as the reduction of market risk under Solvency is offset by the reduction of diversification benefits for life insurers and the simultaneous increase in capital buffers for banks.

5.2.2 SPREAD RISK

Similar to the equity sensitivity analysis discussed above, we quantified the capital charges for spread risk standalone, for total (diversified) market risk, and on aggregate, assuming that assets attracting spread risk are shifting in increments of 1% from the regulated insurance to the regulated banking sector. When all spread risk assets are held in the insurance sector, the total (undiversified) spread risk capital requirement for the insurance balance sheet is €3,840, while for banking is naturally 0. When all spread risk assets have been shifted to the banking sector, the total spread risk capital requirement is €10,090. We observed the same pattern for the total capital requirements, post capital buffers, and diversification effects.

While at first sight there is an apparent capital incentive to shift spread risk assets from the banking to the insurance sector, there are a number of counterbalancing factors that would offset the overall incentives for such an activity:

- Sovereign, financial, and corporate bonds are fundamental constituents of any banking institution's balance sheet. The holding of such assets is essential for asset liability matching, fixed income flow, and, importantly, for liquidity risk management. Spread risk attracting bonds are an essential component of the required stock of "high quality liquid assets" (HQLA) and a complete removal would almost certainly result in a regulatory breach [BCBS (2013b)].
- In addition, counterparties in the scope of the European Market Infrastructure Regulation (EMIR) [EU (2012)] are obliged to post variation margins as collateral for uncleared derivatives, resulting in additional demand for government bonds in particular [Cœuré (2017)]. Additional regulations, such as for central counterparties (CCPs) have also resulted in liquid, spread risk-bearing assets, being pledged as collateral for meeting initial margins [BIS and IOSCO (2017)].

In other words, while a strict reading of the empirical results would indicate regulatory capital incentives for shifting spread risk bearing assets from the banking to the insurance industry, such a shift is moderated by a number of additional considerations that constrain the amount of liquid assets that banking institutions can shed off their balance sheet.

[5] When the split between the two sectors is 50-50, the comparative capital requirements equal the base case figures.

5.3 Procyclicality of capital standards

We have defined procyclicality as the extent to which capital requirements fluctuate consistently across the financial system (insurance and banking) due to exposure to common risk drivers, in the face of uncertainty to changes in risk over time and the incentives provided by the respective regulatory capital frameworks. The extant literature has demonstrated that there is a visceral link between procyclicality and financial stability [Borio et al. (2001), Gordy and Howells (2006), Freixas et al. (2007), Repullo and Saurina (2011), Andersen (2011), Kashyap and Stein (2004)].

Bank business models are inherently cyclical [FSB (2009)]. The two primary risk drivers of the banking business model (credit risk and market risk) are highly exposed to cyclical influences. Market risks and (to a lesser extent) credit risks are also material in the insurance sector. The underwriting component of insurance firms' business model is less cyclically affected; however, investment decisions are impacted by cyclical trends. In addition, even though the contribution of life insurers to systemic risk remains below that of banks, it has increased in recent years across advanced economies [IMF (2016)]. To the extent that banking and insurance regulatory capital requirements and associated capitalization ratios are synchronized, such procyclical behavior may endogenously undermine financial system stability.

For the purposes of this empirical analysis we focus on market risk, the biggest contributor to the overall capital requirement for our stylized portfolio. Procyclical effects have been evaluated by calculating the changes in regulatory capital requirements, eligible exposure (equity valuations), and – primarily – capitalization ratios (capital over assets) across both sectors given the EIOPA (2016b) "double hit" scenario from the insurance stress test technical specifications. The scenario represents a rapid increase of sovereign bond yields for E.U. countries complemented by a drop in the risk-free rate. We further assume that financial institutions are not able to raise new capital during a downturn [Andersen (2011), Peura and Jokivuolle (2004)]. All repricing and capital requirement assumptions have been held consistent with the base case empirical model. Consistently with the scenario, we do not assume changes in external ratings. The results are included in Table A2 in the Appendix.

Eligible exposures for equities have dropped consistently across the Basel and the Solvency calculators, given the consistent application of the stock market shock, with a proportionate drop in the undiversified equity capital requirement. Eligible exposures for interest rate risk have increased from 15,823 to 16,401 under Basel and from 40,640 to 42,199 under Solvency due to the decline in yields. Undiversified interest rate risk capital requirements for Basel have increased by 1.38% due to the higher eligible exposure base, and by 3.64% for Solvency, reflective of the incorporation of both interest rate sensitive assets and liabilities with differing weighted durations. Stress spreads have dropped the value of spread assets under Basel from 15,823 to 13,203 and under Solvency from 40,640 to 28,300, primarily driven by longer duration bonds. FX, commodity, and property figures have remained unchanged, as they were not part of the scope of the scenario.

As expected, capitalization ratios decline under the scenario for both the Basel (-19.37%; from 14.32% in the base case to 11.54% under stress) and Solvency models (-30.13%; from 2.77% in the base case to 1.93% under stress) at the aggregate level. The Basel capital requirement changes -20.61% for an asset value reduction of -1.53% while the Solvency capital requirement changes -29.97% for a +0.24% increase in asset valuations. The shifts in asset values are the combined outcome of the increase in the yields and credit spreads of the assets, and the drop in equity prices. As observed at the aggregate level, the diversification structure of the Solvency framework dampens the overall reduction in capitalization levels due to the changes in market risk capital requirements, while the capital buffers applied as part of Basel provide a similar effect for the respective capital estimates, given their linear (RWA based) impact on the final result.

The joint reduction of capitalization levels under the Basel and Solvency standard frameworks, even though totally explainable based on the structure of the supervisory formulas, echoes the concerns raised by academic commentators on the procyclical impact of regulatory capital standards for the banking and insurance industries [Freixas et al. (2007), Repullo and Saurina Salas (2011), Andersen (2011), Heid (2007), Kashyap and Stein (2004)]. Capital standards are inherently procyclical under both Basel and Solvency and their joint impact has the potential to undermine the ability of financial institutions to absorb additional losses in case of protracted stress, thus endogenously impairing the overall capitalization of the financial system and consequently financial system stability.

A number of factors, which have not been captured by our empirical model, could add to the procyclical concerns. First, as per the assumptions of the EIOPA (2016b) scenario, we have not evaluated the impact of potential external rating downgrades, which would have had a material impact on spread risk capital requirements. From a Basel point of view,

we could also assume that – as a response to such a stress – countercyclical buffers would change, while they are assumed constant in our calculation. In addition, the absence of second order effects as a response to the stress scenario highlights an additional aspect of procyclical behavior not captured by the fixed portfolio assumption of this study: the price depression on riskier assets, due to the selloff expected in order to bolster declining solvency positions [Tasca and Battiston (2012)]. Similarly, the observed reduction in regulatory capital standards, which is larger than the decline in asset valuations, may indicate that the standard formula does not appropriately capture the valuation volatility of market risk portfolios. Practically, in case of a continued downturn, the ability of capital standards to cover further P&L losses may be questioned.

In summary, the empirical evidence indicates that the structure of the respective regulations will generate comparable changes in capital requirements, asset valuations, and capitalization ratios across the stylized portfolio held in the banking and insurance sector. Such procyclical effects further indicate that the design of regulatory capital standards may also be a factor that is endogenously destabilizing the financial system as a whole.

6. CONCLUSION

Having moved beyond previous comparisons of regulatory capital levels across insurance and banking, our empirical research analyzed the capital-induced (endogenous) impact that regulatory capital standards may have on financial system stability:

- First, we observed that the rank order of capital charges as well as the proportionate, fully allocated capital amounts within the Basel and Solvency frameworks are remarkably similar, consequently, potentially providing incentives to increase asset concentrations in the same securities across the two industries. Such system-wide asset concentrations contribute to endogenously generated financial system instability due to common exposure effects across the two sectors, which may amplify the impact of exogenous shocks.
- Similarly, our empirical modeling demonstrated that the consistent application of a stress scenario to both the banking and insurance capital standards leads to material procyclical effects across both sectors, which have also been shown to endogenously undermine financial system stability.
- Our empirical analysis did not provide strong support for the hypothesis that the design of regulatory capital standards may incentivize regulatory capital arbitrage across the industries. Even though the overall capitalization levels for the financial system can be arbitraged based on the incentives provided by the respective capital frameworks, the overall structure of capital requirements – taking into account diversification and capital buffers – dampens such incentives. In addition, several other, non-capital related factors come into play that also partially mitigate the incentives and scope for arbitraging activity. We propose that capital arbitraging behavior should be studied between the regulated and non-regulated financial sectors instead.

Naturally, the expected impact of the Basel and Solvency frameworks cannot be evaluated in isolation but must rather be studied holistically, in the context of the continuously evolving insurance and banking business models and associated business objectives. Capital frameworks may undermine financial system stability due to perceived disincentives towards appropriate asset-liability matching [EC (2017), Al-Darwish et al. (2011)], the shifting of bank business activities towards non-interest income [Brunnermeier et al. (2012), Stiroh (2004)], and the effects on financial stability and economic growth of liquidity standards [Gobat et al. (2014)] and risk insensitive leverage ratios [Kiema and Jokivuolle (2014)].

The practical contributions of this study aid three distinct yet related groups of stakeholders: regulators, policymakers, and financial managers. From a regulatory point of view, "both insurance supervisors and banking supervisors are becoming increasingly aware of the need to address risks also on a system-wide, sometimes referred to as 'macroprudential', basis" [Knight (2004)]. Yet again, despite the senior calls for "a regulatory approach that is consistent across the main jurisdictions and sectors" [Caruana (2013)], regulatory capital frameworks focus on the banking or insurance sectors alone. Consequently, macroprudential approaches can benefit from our extension of stability analyses from a single industry to the financial system as a whole.

More practically, our study highlights the need for evaluating the impact of exogenous shocks across the banking and insurance industries. The results of such sector-wide stress tests can help with better calibrating capital requirements within and across the banking and insurance frameworks, and provide guidance with regards to financial system-wide recovery and resolution plans.

From a policymaker point of view, the further development of capital standards will benefit from a solid theoretical basis on which future macroprudential frameworks can be designed

[Gauthier et al. (2010), Hanson et al. (2010)]. The study of cross industry effects using an endogenous lens [Borio and Drehmann (2009)] can assist with preventing the build-up of instabilities by creating the right sets of incentives for market participants, hence better supporting the ultimate objective of macroprudential regulation, which is the strengthening of stability across the financial system as a whole.

Consistent with the literature highlighting the differences between the underlying business models of insurance and banking [Gatzert and Wesker (2012), Lehmann and Hofmann (2010)], we do not propose enacting policy changes that may lead to greater convergence of capital standards across the two sectors. Instead, by taking into account the endogenous nature of financial system instability, policymakers can focus on developing appropriate macroprudential overlays that address the interdependencies across the financial system along the dimensions of time, size, cross-section, and structure. Such policy frameworks need to focus on mitigating the procyclical impact of regulatory capital standards and the capital incentives for increased asset concentration by providing appropriate, long-term prudential cushions and self-adjusting mechanisms that minimize the behavioral incentives for destabilizing actions over a long-term window of time [Borio (2009), Borio and Drehmann (2009)].

Lastly, for bank and insurance managers, shareholder value maximization is dependent on an understanding of the intended and unintended consequences of capital standards. Beyond the narrow objective of regulatory capital arbitraging, the more efficient deployment of scarce capital resources across the banking and insurance industries can provide better returns to shareholders and spill-over effects to the wider economy.

APPENDIX 1

Table A1 – Stylized portfolio composition

CATEGORY	% OF TOTAL	TOTAL VALUE OF CATEGORY	RATING	% OF CATEGORY	BANKING BOOK VALUE	TRADING BOOK VALUE
Government bonds – E.U.	22.40%	11,379.20				
			AAA	58.8%	5,540.12	1,150.85
			AA	20.6%	1,940.93	403.19
			A	18.1%	1,705.38	354.26
			BBB	0.6%	56.53	11.74
			BB	1.9%	179.02	37.19
			B or lower	0.0%	0.00	0.00
			Unrated	0.0%	0.00	0.00
Government bonds – U.S.	5.60%	2,844.80				
			AAA	65.0%	1,531.07	318.05
			AA	17.5%	412.21	85.63
			A	2.5%	58.89	12.23
			BBB	10.0%	235.55	48.93
			BB	0.0%	0.00	0.00
			B or lower	3.0%	70.66	14.68
			Unrated	2.0%	47.11	9.79
Bonds – financials	17.00%	8,636.00				
			AAA	17.5%	1,251.36	259.94
			AA	15.0%	1,072.59	222.81
			A	40.0%	2,860.24	594.16
			BBB	20.0%	1,430.12	297.08
			BB	2.0%	143.01	29.71
			B or lower	0.5%	35.75	7.43
			Unrated	5.0%	357.53	74.27

CATEGORY	% OF TOTAL	TOTAL VALUE OF CATEGORY	RATING	% OF CATEGORY	BANKING BOOK VALUE	TRADING BOOK VALUE
Bonds – non financials	14.00%	7,112.00				
			AAA	17.5%	1,030.53	214.07
			AA	15.0%	883.31	183.49
			A	40.0%	2,355.49	489.31
			BBB	20.0%	1,177.75	244.65
			BB	2.0%	117.77	24.47
			B or lower	0.5%	29.44	6.12
			Unrated	5.0%	294.44	61.16
Collective investments	20.00%	10,160.00				
Government bonds – E.U.			AAA	23.5%	0.00	2,390.94
Government bonds – E.U.			AA	8.2%	0.00	837.64
Government bonds – E.U.			A	7.2%	0.00	735.99
Government bonds – E.U.			BBB	0.2%	0.00	24.40
Government bonds – E.U.			AAA	6.5%	0.00	660.76
Government bonds – U.S.			AA	1.8%	0.00	177.90
Government bonds – U.S.			A	0.3%	0.00	25.41
Government bonds – U.S.			BBB	1.0%	0.00	101.66
Bonds – financials			AAA	5.3%	0.00	540.05
Bonds – financials			AA	4.6%	0.00	462.90
Bonds – financials			A	12.1%	0.00	1,234.39
Bonds – financials			BBB	6.1%	0.00	617.19
Equities	8.00%	4,064.00				
Mortgages – residential	7.00%	3,556.00				
Property – commercial	2.00%	1,016.00				
SMEs	0.00%	0.00				
Cash and deposits	3.00%	1,524.00				
Structured notes	0.00%	0.00				
Covered bonds	1.00%	508.00				
			AAA	94.3%	0.00	478.85
			AA	3.3%	0.00	16.66
			A	2.5%	0.00	12.49
			BBB	0.0%	0.00	0.00
			BB	0.0%	0.00	0.00
			B or lower	0.0%	0.00	0.00
			Unrated	0.0%	0.00	0.00
TOTAL	**100%**	**50,800.00**				

Note: The Basel Committee [BCBS (2019)] defines the trading book as instruments comprising of financial instruments, foreign exchange, and commodities that have no legal impediment against selling or fully hedging them, are fair valued daily, and valuation changes are recognized in the profit and loss account. All other banking assets are part of the banking book. The Solvency II framework employs a "total balance sheet" approach and, therefore, there is no distinction between banking and trading books.

Table A2 – Comparative capital, eligible exposure, and capitalization ratios across frameworks (base, stress, and delta)

	BASEL			SOLVENCY		
	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS
BASE						
Market diversified	4,593	19,887	23.10%	4,922	45,720	10.77%
Equities	983	4,064	24.19%	1,890	4,064	46.50%
Interest rate	179	15,823	1.13%	262	40,640	0.64%
FX	603	2,845	21.21%	711	2,845	25.00%
Spread	2,827	15,823	17.87%	2,764	40,640	6.80%
Property				254	1,016	25.00%
Credit diversified	696	30,913	2.25%	130	5,080	2.56%
Sovereigns	64	11,777	0.54%			
Banks	237	7,151	3.32%			
Insurers	144	4,323	3.32%			
Corporates	55	1,566	3.52%			
SMEs	0	0				
Mortgages	108	3,556	3.04%			
Property	88	1,016	8.67%			
Cash at bank	0	0				
Deposits	0	1,524	0.00%			
Type 1				112	1,524	7.32%
Type 2				23	3,556	0.65%
Diversification				-1,540		
Adj TP / DT				-2,106		
CCYB	331					
CB	1,653					
CG-SIB	0					
TOTAL	7,273	50,800	14.32%	1,406	50,800	2.77%

	BASEL			SOLVENCY		
	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS
STRESS						
Market diversified	3,503	19,107	18.33%	3,395	45,841	7.41%
Equities	655	2,707	24.19%	1,259	2,707	46.50%
Interest rate	182	16,401	1.11%	274	42,119	0.65%
Fx	603	2,845	21.21%	711	2,845	25.00%
Spread	2,063	13,203	15.63%	1,726	28,300	6.10%
Property				254	1,016	25.00%
Credit diversified	696	30,913	2.25%	130	5,080	2.56%
Diversification				-1,079		
Adj TP / DT				-1,461		
CCYB	262					
CB	1,312					
CG-SIB	0					
TOTAL	5,774	50,020	11.54%	985	50,921	1.93%
DELTA (stress/base)						
Market diversified	-23.73%	-3.92%	-20.62%	-31.03%	0.27%	-31.21%
Equities	-33.40%	-33.40%	0.00%	-33.40%	-33.40%	0.00%
Interest rate	1.38%	3.65%	-2.19%	4.74%	3.64%	1.06%
FX	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Spread	-27.03%	-16.56%	-12.55%	-37.54%	-30.36%	-10.30%
Property				0.00%	0.00%	0.00%
Credit diversified	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Diversification				-29.91%		
Adj TP/DT				-30.65%		
CCYB	-20.61%					
CB	-20.61%					
CG-SIB	0.00%					
TOTAL	-20.61%	-1.53%	-19.37%	-29.97%	0.24%	-30.13%

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