EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 1698 / JULY 2014

MARGIN REGULATION AND VOLATILITY

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In 2014 all ECB publications feature a motif taken from the €20 banknote.

Acknowledgements
We thank audiences at the IMF, the 2013 CEF conference in Vancouver, the University of Zurich, the Macroeconomic Financial Modelling (MFM) and Macroeconomic Fragility conference in Cambridge, MA, the University of Berne, and in particular our discussants Andrea Vedolin and Jianju Miao for helpful comments. We are grateful to Chris Carroll, Lars Hansen, Ken Judd, Nobuhiro Kiyotaki and Blake LeBaron for helpful discussions on the subject and to Antoine Camous for comments on an earlier version of this paper. Felix Kubler and Karl Schmedders gratefully acknowledge financial support from the Swiss Finance Institute and NCCR--FINRISK. Johannes Brumm and Felix Kubler acknowledge support from the ERC. The opinions expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank or the Eurosystem.

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ISSN	1725-2806 (online)
ISBN	978-92-899-1106-1 (online)
EU Catalogue No	QB-AR-14-072-EN-N (online)

Table IX: Average conditional asset price and portfolio holdings under countercyclical regulation

m	s	1	2	3	4	5	6
0.6	$p\|s$	2.1616	2.5554	2.9403	3.2043	3.3798	3.4584
	$\theta^1\|s$	0.0970	0.7115	0.9235	0.9757	0.9716	0.9728
	$\phi^1\|s$	-0.1019	-0.8877	-1.1765	-1.2434	-1.2287	-1.1941
0.7	$p\|s$	2.2876	2.6280	3.0601	3.2283	3.2810	3.4068
	$\theta^1\|s$	0.5972	0.9604	0.9944	0.9962	0.9836	0.9873
	$\phi^1\|s$	-0.6662	-1.1664	-1.1241	-1.0494	-0.9605	-0.9582
0.8	$p\|s$	2.7285	2.8737	2.9971	3.0842	3.0563	3.1735
	$\theta^1\|s$	0.9943	0.9990	0.9999	0.9999	0.9886	0.9935
	$\phi^1\|s$	-1.0325	-0.8473	-0.7298	-0.6755	-0.5931	-0.6076
0.9	$p\|s$	2.7045	2.7338	2.7569	2.7716	2.6208	2.6935
	$\theta^1\|s$	1.0000	1.0000	1.0000	1.0000	0.9888	0.9919
	$\phi^1\|s$	-0.4965	-0.4113	-0.3546	-0.3275	-0.2501	-0.2607

Average asset price and average holdings of agent 1 conditional on the state s. m = regulated margin level on both assets in growth states 5 and 6, $p|s$ = average conditional price of the aggregated long-lived asset, $\theta^1|s$ = agent 1's average holding of the two assets, $\phi^1|s$ = agent 1's average holding of the risk-free bond.

First, for margin levels $m \in \{0.8, 0.9\}$ the average conditional price of the aggregated long-lived asset does not increase from (the recession) state 4 to (the normal-growth) state 5 but instead decreases. Second, for each margin level m, agent 1's average holding of the long-lived asset in state 4 is larger than her average holding in the growth states 5 and 6. Moreover, for $m \in \{0.8, 0.9\}$ her average holding of the long-lived asset in all four negative-growth states exceeds her average holding in the normal-growth state 5. Third, for each margin level m, agent 1's average short position in the bond in state 4 is larger than in states 5 and 6. In fact, for $m \in \{0.7, 0.8, 0.9\}$, her average short position in states 2, 3, and 4 exceeds those in states 5 and 6. These three pattern, which are not at all present for uniform regulation, reveal the critical impact of countercyclical margins on the economy.

In response to larger margin requirements in the good states, agent 1 must reduce her leverage. For this purpose, she must even sell a small portion of the long-lived asset; selling the risky asset to the risk-averse agent 2 dampens the increase in the conditional price that naturally occurs when agent 1's relative wealth increases in response to a good shock 5 or 6. In fact, for margin levels $m \in \{0.8, 0.9\}$ the conditional normalized price in state 5 is even smaller than in state 4. This dampening effect on the asset price in the positive-growth states reduces the asset return volatility. Conversely, in response to smaller margin requirements in negative-growth states, agent 1 can actually increase her leverage compared to good states. In particular for $m \in \{0.8, 0.9\}$, both her average holding of the aggregated long-lived asset and her short position in the bond are larger in the four negative-growth states than in the two positive-growth states. So, on average, agent 1 buys the long-lived asset in response to a bad shock. As a result, the relative asset price does not decrease as much as it would have otherwise because agent 1's relative wealth decreases in response to a bad shock $s = 1, 2, 3, 4$. This buffer effect on the asset price in the negative-growth states also reduces the asset return volatility. And so, the dampening effect in the good states and the buffer effect in bad states together lead to the drastic decrease in the asset return volatility apparent in the solid line in Figure V.

In sum, equilibrium portfolios and prices exhibit qualitatively different features in an economy with countercyclical margins on all assets than in an economy with uniform margins on all assets or in an economy with an unregulated asset. For sufficiently large margin requirements in the positive-growth states, the much less risk-averse agent 1 reduces leverage in positive-growth states and increases leverage in negative-growth states. A reduction of leverage in good times and increase of leverage in bad times greatly reduces asset return volatility compared to uniform regulation. The countercyclicality of leverage dampens or even reverses those movements in the conditional price that lead to large excess volatility under constant regulation.

6 Discussion

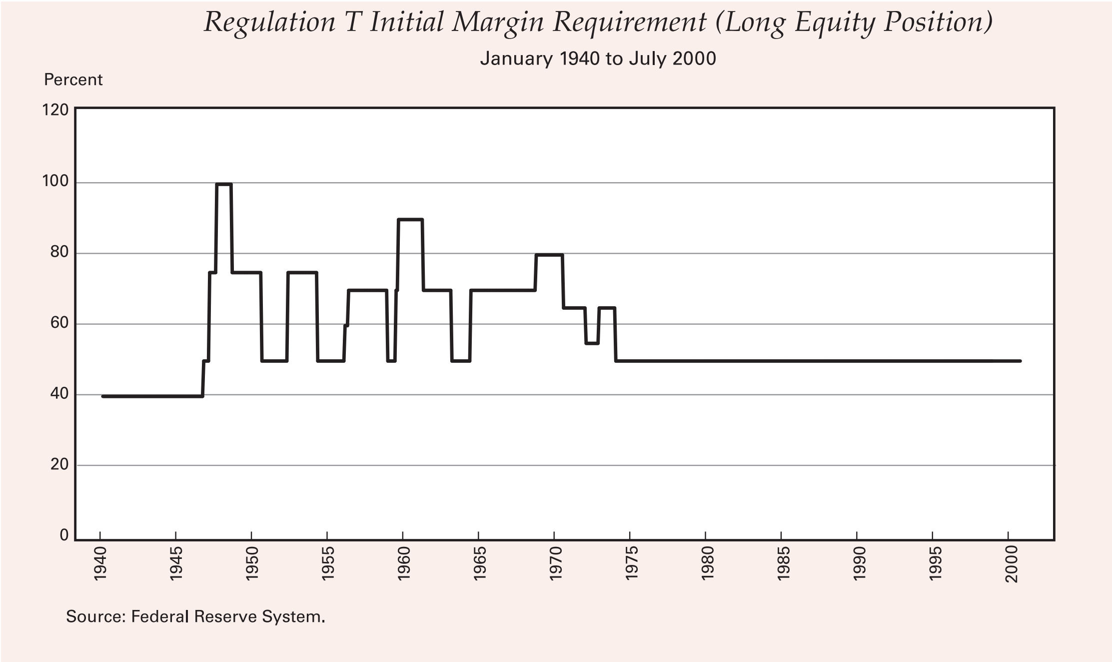
The numerical analysis (in the two previous sections) of margin regulation in the framework of a general equilibrium model has delivered numerous insights. We now want to argue that these insights bear fundamental significance for margin policy. For this purpose, we first explain that the findings on the effects of U.S. Regulation T in the empirical literature are in line with the predictions of the general equilibrium model. Second, we relate the current policy discussion on margin regulation in securities lending and repo markets to the model predictions. Finally, we discuss the assumptions and limitations of our general equilibrium analysis.

6.1 Regulation T

In response to the speculative stock market bubble of 1927–1929 and the subsequent "great crash" of 1929, the United States Congress passed the Securities Exchange Act of 1934 which granted the Federal Reserve Board (FRB) the power to set initial margin requirements on national exchanges. The introduction of this law had three major purposes: the reduction of "excessive" credit in securities transactions, the protection of buyers from too much leverage, and the reduction of stock market volatility, see, for example, Kupiec (1998). Under the mandate of this law, the FRB established Regulation T to set minimum equity positions on partially loan-financed transactions of exchange-traded securities. Figure VI from Fortune (2000) shows the Regulation T margin requirements between 1940 and 2000. While the initial margin ratio has been held constant at 50 percent since 1974 (until today), the FRB frequently changed initial margin requirements in the range of 50 to 100 percent from 1947 until 1974.[9]

[9]While the Securities Exchange Act of 1934 also granted the Federal Reserve Board to set maintenance margins (see Kupiec (1998)), Regulation T governs initial margin requirements only. Maintenance margins are generally set by security exchanges and broker-dealers.

Figure VI: Historical Levels of Margin Requirements, Fortune (2000)



Required margin ratio: minimum equity per dollar of securities traded.

The introduction and frequent adjustments of the initial margin ratio prompted the development of a sizable empirical literature on the effects of Regulation T. Already Moore (1966) claimed that the establishment of margin requirements had failed to satisfy any of its objectives. He argued that a major reason for the regulation's failure was that investors could avoid the regulation by substituting margin loans through other forms of borrowing. Kupiec (1998) provides a comprehensive review of the empirical literature; in particular, he extends the scope of his analysis to account for margin constraints on equity derivative markets. He finds that "there is no substantial body of scientific evidence that supports the hypothesis that margin requirements can be systematically altered to manage the volatility in stock markets. The empirical evidence shows that, while high Reg T margin requirements may reduce the volume of securities credit lending and high futures margins do appear to reduce the open interest in futures markets, neither of these measurable effects appears to be systematically associated with lower stock return volatility." Furthermore, Kupiec (1998) quotes from an internal 1984 FRB study that "margin requirements were ineffective as selective credit controls, inappropriate as rules for investor protection, and were unlikely to be useful in controlling stock price volatility." Similarly, Fortune (2001) concludes after a review of 18 papers in the literature as well as some additional analysis that "the literature does provide some evidence that margin requirements affect stock price performance, but the evidence is mixed and it is not clear that the statistical significance found translates to an economically significant case for an active margin policy." In particular, Fortune (2001) argues that even though some studies suggest that the effect of margin loans on stock return volatility is statistically significant, such effects are much too small to be of economic significance. He also recalls the popular sentiment, see Moore (1966), that investors may substitute between margin loans and other debt: "If an investor views margin debt as a close substitute for other forms of debt, changes in margin requirements will shift the type of debt used to finance stock purchases without changing the investors total debt. The investors leverage will be unchanged but altered in form. The risks faced, and the risk exposure of creditors, will be unchanged. Little will be changed but the name of the paper."

The empirical analysis of Regulation T in Hardouvelis and Theodossiou (2002) provides a notable exception from the mainstream opinion and finds that increasing margin requirements in normal and bull periods significantly lowers stock market volatility and that no relationship can be established during bear periods. The authors' policy conclusion is to set margin requirements in a countercyclical fashion as to stabilize stock markets.

The main predictions of our general equilibrium analysis of margin requirements are in consonance with the empirical evidence on Regulation T. The model predictions in Sections 5.1 and 5.2 that, in the presence of unregulated asset classes, changes in the margin requirement of a regulated asset (class) have a non-monotone and only weak impact on that asset's return volatility coincides with the results reported in Kupiec (1998) and Fortune (2001). Also, in consonance with the findings of Kupiec (1998), we do find that the average amount of lending decreases as regulated margin levels increase. Moreover, as the margin requirement on the regulated asset increases, the leveraged agent holds a larger fraction of her wealth in the unregulated asset. That is, she borrows relatively more against the unregulated asset than against the regulated asset, just as argued by Moore (1966) and Fortune (2001). The general equilibrium analysis in Section 5.2 also suggests that countercyclical regulation may have a somewhat larger albeit still small effect on return volatility and thus may provide some support for the suggestion of Hardouvelis and Theodossiou (2002).

6.2 Current Policy Discussion

This section relates our theoretical findings to the current debate on the regulation of margin requirements in repo and securities lending markets. In the aftermath of the financial crisis of 2007–2009, it has been argued that excessively low margin requirements led to a build-up of collateralized borrowing thus exacerbating the subsequent downturn (see, for example, CGFS (2010)). As a consequence, the Financial Stability Board launched a public consultation on a policy framework for addressing risks in securities lending and repo markets (see FSB (2012) or FSB (2013)). Among other things, it explicitly includes a policy proposal to introduce minimum haircuts on collateral for securities financing transactions. On page 12 of FSB (2012), the motivation for regulating margins or haircuts is summarized as follows: "Such a framework would be intended to set a floor on the cost of secured borrowing against risky asset in order to limit the build-up of excessive leverage."Though our model is foremost suited for the analysis of stock market margin regulation (like Regulation T), we believe that the underlying economic mechanisms yielding our key results also play a major role for margin regulation in other markets featuring collateralized borrowing. In particular, our analysis suggests the following three implications for the ongoing policy debate in repo and securities lending markets:

First, a countercyclical regulation of margin requirements is more effective than a simple constant margin regulation. Our analysis of margin regulation for all asset classes has shown that countercyclical regulation decreases stock market volatility substantially, in strong contrast to uniform regulation. Hence, competent authorities should be given the power to require higher margin requirements in good times.

Second, our analysis shows that only a regulation of all asset classes leads to a quantitatively significant decrease in volatility: if not all collateralizable assets are subject to regulation, our model predicts that the ability to take up leverage with other, unregulated assets would strongly limit the impact of regulation. This suggests that margin regulation should be applied with a very broad scope as to ensure maximal impact on volatility. In other words, "carve-outs" for specific asset classes would be counterproductive and should be largely avoided.

Finally, our general equilibrium analysis also reveals that there might be unintended consequences of margin regulation on other, unregulated asset classes. As the analysis in Section 5 has shown, the volatility of the unregulated asset decreases monotonically as the margin requirement on the other asset is increased. Thus, the effect on the volatility of other assets turns out to be stronger and monotone.[10] So, there are strong spillover effects from the margin regulation of the regulated asset on the return volatility of the unregulated asset. Hence, the lesson is that for any quantitative impact study done for margin regulation the effects on similar asset markets have to be considered.

While the regulation of asset markets that we consider is very different from the regulation of capital requirements for banks, these two regulatory tools share a common economic motivation. Therefore, we briefly want to discuss the countercyclical nature of margin regulation in light of the Countercyclical Capital Buffer (CCB) as introduced in the Basel III accord. Remember that the primary goal of setting higher margins in good times is to lean against the build-up of leverage via borrowing against collateral. To have a significant effect on volatility, our analysis has shown that high margins in good times need to be complemented with low regulated margins in bad times. The goals of the CCB are similar, but the ordering is reversed: the main objective of the CCB is to ensure that in bad times "the banking sector in aggregate has the capital on hand to help maintain the flow of credit in the economy without its solvency being questioned"(BIS (2010), p.8). Only as a secondary goal, the CCB is supposed to have a moderating effect on the build-up of excessive credit in good times.

6.3 Discussion of Assumptions and Limitations

The general equilibrium analysis of regulated and endogenous margin requirements in this paper rests on a number of strong assumptions. We now critically review the most important assumptions and the resulting limitations of our analysis.

[10]To understand this result we have to recall the mechanisms that are at work when margins on stocks are changed. First, as the margin for the regulated asset increases, the unregulated asset becomes, in relative terms, even better collateral for agent 1. Thus, she now has an even stronger motive to hold on to the unregulated asset after a bad shock. This stabilizes the price of this asset. Second, as agent 1's ability to leverage decreases deleveraging episodes become less severe which further reduces the volatility of the unregulated asset. Thus, both effects work in the same direction for the unregulated asset.

Our general equilibrium economy is a grossly simplified model of modern markets. The focus on only two asset classes completely ignores the presence of a huge number of security markets with very different features. In particular, contrary to some microeconomic studies of specific markets or sectors such as, for example, repo markets or the banking industry, the GE model ignores institutional details. The model takes a very high-level view and considers financial markets only in an aggregated fashion. Clearly, specific market structure can have a strong impact on market outcomes. Another oversimplification is the restriction to two agents; we consider neither implications of non-participation nor the fact that only agents with margin accounts can buy stocks on margin. Therefore, our model does not consider the many different types of trading restrictions that perhaps could be modeled via many agents with different budget restrictions. Instead, our general equilibrium analysis is meant as a transparent macro-finance study of margin regulation in an economy. In particular, we want to analyze general equilibrium effects of margin regulation. For that reason, we believe that our abstraction from many specific market features and the restriction to two agents facing collateral constraints is justified by the transparent insights into the economic mechanism that we obtain from a general equilibrium analysis.

For the general equilibrium model to be numerically tractable, we have to limit the possible trades that agents can enter into. In the economy, short-sales of the long-lived assets are not permitted. Clearly, this assumption is not satisfied in practice. Investors can enter short positions in the stock market and secure such short sales by holding bonds as collateral. Allowing for such 'reversed' portfolios of long bond and short stock positions is certainly important but would render the model (at least currently) intractable. We believe that an important area of future research in financial economics will be the examination of bond-secured short positions in long-lived financial assets or other financial securities. At the same time, we believe that, despite this limitation, our analysis in this paper contributes to the understanding of margin regulation.

As in any quantitative study, our numerical results hinge on the parametrization of the economy. Our parametrization exhibits several special features that are somewhat unrealistic. In the analysis of countercyclical margins, we assume that the regulator chooses the margin level depending on the present growth rate. That appears likely to be unrealistic because the regulating agency may not know the current growth rate; instead it appears to be more likely that regulators would make margins depend on price levels, particularly on the price-dividend ratio, or on total leverage in the economy. With such a regulator in the general equilibrium economy, the margin levels would become dependent on the endogenous state variable. Such a model is much more difficult if not impossible to solve. Another unattractive feature of our model parametrization is that the growth shocks are i.i.d. Certainly it may be more realistic to consider Markovian shocks; particularly after a sharp economic downturn we may expect a higher probability of a strong "recovery", that is, a higher probability for the good states after a very bad state. And we could certainly include Markovian shocks in our analysis. However, we deliberately chose i.i.d. shocks so that the transition probabilities would not impact the equilibrium and thereby obscure our analysis of the features of margin regulation.

We also assume that labor endowments of the two agents and the dividends paid by the two assets are all collinear with aggregate endowments, and consequently with each other. This assumption is, of course, also unrealistic. In particular, dividends in our model are less volatile than in the data. This is one reason why return volatility in our simulations is substantially lower than in the data, even though collateralized borrowing causes substantial excess volatility in our model. Despite this drawback, we assume collinearity because it ensures that the differing statistics for the two assets are not driven by their dividend dynamics, but only by their different margins (and to a much smaller extent their different size). It also ensures that the behavior of the two agents is only driven by their different risk aversion and income share, not the hedging demand resulting form a non-trivial correlation structure between labor endowments and dividends. Thus, the collinearity assumption allows for a more transparent analysis of the dynamics within the model and in particular of the effect of margin regulation.

In sum, while our general equilibrium analysis ignores many institutional details, it allows us to examine general equilibrium effects of margin regulation. Moreover, for technical reasons we must impose short-sale constraints on the long-lived assets and let countercyclical margin levels depend on the exogenous shock. Furthermore, for a transparent analysis we choose a rather special model specifications. Undoubtedly, all these assumptions influence the quantitative results. However, the described qualitative effects of margin requirements and regulation are likely to be present in models far beyond the scope of ours.

As a final comment on the limitations of our analysis, we emphasize again that the motivation for this study has been the question whether Regulation T enabled the FRB to reach the aforementioned third goal of the Securities and Exchange Act of 1934, namely the reduction of stock market volatility. Therefore, we focus almost exclusively on asset market volatility in our analysis. In particular, we do not report results on the welfare effects of margin regulation. Such a welfare study would face serious obstacles in our model. First, it is unclear which welfare metric would be most appropriate for an economy with heterogeneous preferences. Second, Epstein et al. (2012) casts serious doubt on the usefulness of Epstein-Zin utility for the study of normative issues.

7 Conclusion

In this paper, we have analyzed the quantitative effects of margin regulation on asset return volatility in the framework of a general equilibrium infinite-horizon economy with heterogeneous agents and collateral constraints. There are two assets in the economy which can be used as collateral for short-term loans. We have first analyzed an economy in which a regulating agency imposes a margin requirement on the first asset while the margin requirement for the second asset is determined endogenously in equilibrium. We have shown that the presence of collateral constraints leads to strong excess volatility and a regulation of margin requirements potentially has stabilizing effects. However, we have seen that changes in the regulation of a class of assets may have only small effects on the assets' return volatility if investors have access to another (unregulated) class of collateralizable assets to take up leverage. Therefore, the predictions of the general equilibrium model are in consonance with the findings of the empirical literature on U.S. Regulation T. In fact, the regulatory changes in the regulated market have much stronger effects on the return volatility of the unregulated asset. We have also shown that margin regulation has a much stronger impact on asset return volatility if all long-lived assets in the economy are regulated. In such an economy, countercyclical regulation that imposes sufficiently large macroprudential add-ons on margin levels in high-growth states can lead to drastic reductions in asset return volatility.

Appendix

A Sensitivity Analysis

As in any quantitative study, our results above hinge on the parametrization of the economy. In this appendix, we discuss how our results depend on the preferences of the two types of agents. We also check how the presence of disaster risk influences our results. These robustness checks further deepen our understanding of the mechanisms of the model.

A.1 Preferences

As a robustness check for the results on the effectiveness of the various forms of regulations presented in Sections 5, we consider different specifications for the IES, the coefficients of risk aversion, and the discount factor, β. Obviously, changes in the IES and the risk aversion coefficients affect the risk-free rate. For each specification, we recalibrate β to get a risk-free rate of 1.0% for the case of a constant margin of 60 percent. Table X reports changes in stock market volatility for several different combinations of these parameters. For each combination of parameters, we report three numbers: First, the change in stock market volatility if the constant regulation of stock margins is changed from 60 percent to 90 percent. Second, the change in stock market volatility if the countercyclical regulation of stock margins is changed from 60 percent to 90 percent in boom periods. As in Section 5, the margin in shocks 1-4 is set to 50 percent. Finally, we report changes in volatility for countercyclical margin regulation of all assets. We consider a change of boom margins from 60 percent to 90 percent. Note that for this case the reported change in volatility corresponds both to the stock market volatility and the aggregate volatility, as the two assets are now identical. For convenience, we repeat the results for our baseline model, $(IES, RA, \beta) = ((2,2),(0.5,7),(0.942,0.942))$, and report them as the case (P1).

$(IES^1, IES^2),(RA^1, RA^2),(\beta^1, \beta^2)$	Constant	Countercyclical	Full market (countercyclical)
(P1): (2,2),(0.5,7),(0.942,0.942)	2.5	-5.3	-35.6
(P2): (2,2),(0.5,9),(0.880,0.880)	-3.2	-5.9	-35.5
(P3): (2,2),(0.5,5),(0.975,0.975)	7.7	5.7	-23.5
(P4): (2,2),(0.1,7),(0.942,0.942)	1.6	-6.5	-36.1
(P5): (2,2),(1,7),(0.941,0.941)	6.9	-1.4	-33.8
(P6): (0.75,0.75),(0.5,7),(0.945,0.945)	-11.2	-10.3	-38.4
(P7): (1.5,1.5),(0.5,7),(0.943,0.943)	1.6	-5.4	-42.4

Table X: Sensitivity analysis for preferences (percentage change in volatility)

We find that the effect of a change in the constant regulation of stock margins is relatively small for all different preference specifications. The same is true for countercyclical regulation. However, as in the baseline, countercyclical regulation tends to be more effective in reducing stock market volatility. Finally, a countercyclical regulation of all assets substantially reduces volatility across all specifications considered.

A.2 Disaster Shocks

Disaster shocks are a central feature of our calibration. Naturally the question arises how much the reported qualitative and quantitative economic consequences of margin regulation depend on these extreme shocks. To answer this question, we conduct two analyses. We first report results for a model with disaster shocks that are only half as severe (D2) and demonstrate that the results remain qualitatively the same. Second, we scale down the probability of disasters (D3) and find the effect of margin regulation in the case of constant or countercyclical regulation is even quantitatively almost the same as in the baseline model. However, the effect of regulating the full market turns out to be only half as strong.

	Constant	Countercyclical	Full market (countercyclical)
(D1): Baseline	2.1	-5.3	-35.6
(D2): Half-Sized Disaster	2.1	-1.4	-11.5
(D3): Half-Probability of Disaster	1.0	-6.1	-17.6

Table XI: Sensitivity analysis for preferences (percentage change in volatility)

B Details on Computations

The algorithm used to solve all versions of the model is based on Brumm and Grill (2014). Equilibrium policy functions are computed by iterating on the per-period equilibrium conditions, which are transformed into a system of equations which we solve at each grid point. Policy functions are approximated by piecewise linear functions. By using fractions of financial wealth as the endogenous state variables, the dimension of the state space is equal to the number of agents minus one. Hence with two agents, the model has an endogenous state space of one dimension only. This makes computations much easier than in Brumm and Grill (2014), where two- and three-dimensional problems are solved. In particular, in one dimension reasonable accuracy may be achieved without adapting the grid to the kinks. For the reported results we used 160 grid points. If the number of grid points is increased to a few thousands, then the moments under consideration only change by about 0.1 percent. Hence, using 160 points provides a solution which is precise enough for our purposes. The moments reported in the paper are averages of 50 different simulations with a length of 10,000 periods each (of which the first 100 are dropped). This is enough to let the law of large numbers do its job, even for the rare disasters.

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