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COLLATERAL IMPACT

Unintended Consequences of Collateral Requirements in Over-the-Counter Derivatives Markets

Research Note

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Introduction

The reform program for the over-the-counter (OTC) derivatives market launched by the G-20 nations in 2009 seeks to reduce systemic risk from OTC derivatives. The reforms require that: (i) standardized OTC derivatives be cleared through central counterparties (CCPs), and (ii) they set higher collateral and capital requirements for non-centrally cleared derivatives. According to the international banking and securities markets standard setting bodies BCBS-IOSCO (2019),[1] an important motivation for the second element of the reforms is to create a cost incentive in favor of central clearing, (Ghamami and Glasserman (2017)).

In this note, we discuss potential unintended consequences of collateral requirements in OTC derivatives markets. These potential consequences are important in part because derivatives can facilitate managing risk in the economy and large banks, including the members of the Financial Services Forum, play a key role in providing derivatives to companies that need to manage risk. While our main focus is on collateral requirements in OTC derivatives markets, we note that the use of collateral has also been expanded in lending. Unsecured interbank lending is far lower than its pre-crisis levels and has largely been replaced by collateralized lending through repurchase agreements.

After providing a brief overview of collateral rules in OTC markets, we show that collateral requirements may increase systemic risk. Specifically, using the results of Ghamami, Glasserman, and Young (2019), we demonstrate that collateral, in the form of initial margin (IM), can lead to the inefficient allocation of banks' assets and, in turn, can increase risks to financial stability.

Next, using the results of Brunnermeier and Pedersen (2008) and Andersen, Duffie, and Song (2019), we discuss the potential impact of collateral on market liquidity and OTC market intermediation. We highlight the well-known fact that collateral can be destabilizing in that it can intensify the link between dealer banks' funding illiquidity and market illiquidity. Collateral requirements may also disincentivize dealer banks' OTC market intermediation.

Our analysis also directly applies to inter-affiliate (IA) initial margin requirements in the U.S., where the prudential banking regulators require large U.S. banks to exchange IM among their affiliates under certain conditions.[2] Put simply, IA IM rules may reinforce the link between banks' asset allocation inefficiencies and systemic risk, which we will introduce later in the note.

As we will discuss in the last section, some of the reduction in trading and market making activities by the Financial Services Forum members in the past eight years can be viewed as a consequence of OTC derivatives reforms, (Figure 4). If designed and used prudently, and if intermediated by regulated firms with robust risk management frameworks, derivatives can add value to the real economy. Previous research at the Financial Services Forum by Campbell (2019) summarizes the rationale for derivatives usage by companies in the Dow Jones Industrial Average, and Figure 2 shows that Forum members are the main liquidity providers in the U.S. derivatives markets. Given that OTC market intermediation below certain levels may harm the real economy, we believe that levels of liquidity provision and market making need to be monitored in parallel with the regulation of these markets and their intermediaries. Some of these regulations can then be revisited to promote both the safety and soundness of the financial system and economic growth.

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[1] The Basel Committee on Banking Supervision (BCBS) is the international standard setting committee of banking supervisory authorities. The International Organization of Securities Commissions (IOSCO) is the international setting body for securities markets regulation.

[2] See Davis Polk (2016) for background, and SIFMA (2019) for renewed debate on the topic.

Collateral Requirements

Prior to the introduction of the 2009 reforms, the OTC derivatives market was not subject to regulations requiring the exchange of margin between counterparties. The market developed its own practices regarding the exchange of variation margin (VM), often at a weekly frequency, and an independent amount at trade inception similar to IM. After the financial crisis, regulators introduced VM and IM requirements in non-centrally clearing OTC markets in a way that closely resembles VM and IM requirements at CCPs.[3] Margin requirements in non-centrally clearing OTC markets came into effect on September 2016.

To avoid a buildup of large exposures, an OTC derivatives market participant, e.g. a dealer bank, exchanges VM on a daily (or intraday) basis with its counterparties. VM reflects marking-to-market of a counterparty's portfolio with the dealer. Depending on the direction of the market, VM is posted by the counterparty to the dealer or credited to the counterparty by the dealer. IM provides an additional layer of credit risk protection beyond VM. IM is based on potential price changes to which the dealer will be exposed following the default of a counterparty. IM associated with non-centrally cleared derivatives is set to cover potential losses over a ten-day period with 99 percent or higher confidence. The ten-day interval, known as the margin period of risk (MPOR), is intended to be an estimate of the time needed to replace the contracts of a failed counterparty.[4] MPOR of centrally cleared IM is set to five days, half of the MPOR associated with bilateral IM. This is to incentivize derivatives central clearing, (Ghamami and Glasserman (2017)).

According to Key Principle 5 of the BCBS-IOSCO (p.19), *Initial margin collected should be held in such a way as to ensure that (i) the margin collected is immediately available to the collecting party in the event of the counterparty's default, and (ii) the collected margin must be subject to arrangements that protect the posting party to the extent possible under applicable law in the event that the collecting party enters bankruptcy.* Initial margin is often segregated and held in a bankruptcy remote way at third-party custodians.

Using the analysis and results of Ghamami et al. (2019), Table 1 presents information on derivatives collateral. In the "Total" column, the table shows the collateral received by each bank from other banks and securities firms, as disclosed in each bank's FR Y-9C report. The total amount is broken down into cash collateral and all other types of collateral; most of the collateral is held in cash. The last column shows cash collateral posted by each bank, as reported in each bank's 10-K filing. The values in the table indicate that the collateral amounts posted by each bank are roughly similar to the amounts received by each bank from other banks.

[3] See Cont (2015) and Ghamami (2015) and the reference therein for background on derivatives central clearing.

[4] The ten-day MPOR is not grounded on finance theory Cont (2018).

Table 1: Derivative collateral

2019	Collateral from Banks and Securities Firms			Cash Collateral
	Cash	Other	Total	Posted
Bank of America	27.9	9.0	36.9	34.0
BNY Mellon	1.3	0.1	1.4	0.6
Citigroup	29.3	12.2	41.5	38.0
Goldman Sachs	51.4	16.0	67.4	43.2
JPMorgan Chase	41.9	9.9	51.8	53.3
Morgan Stanley	30.8	2.4	33.2	34.1
State Street	1.5	0.3	1.7	0.6
Wells Fargo	3.0	1.9	4.8	6.6

Shown are derivative collateral received (cash, other, and total) and derivative cash posted by each bank, as reported at the end of Q2 2019, in billions of dollars. Source: Federal Reserve Y-9C reports, company 10-k reports, Ghamami et al. (2019) and Forum's analysis.

Collateral mitigates counterparty credit risk and provides a buffer against the spread of losses in the financial system: if one party to a contract defaults on a payment obligation, its counterparty can seize the available IM to offset the loss. In this sense collateral can support financial stability. But, as will be shown in this research note, this is not the whole story. Collateral, particularly in the form of initial margin, can have unintended consequences.

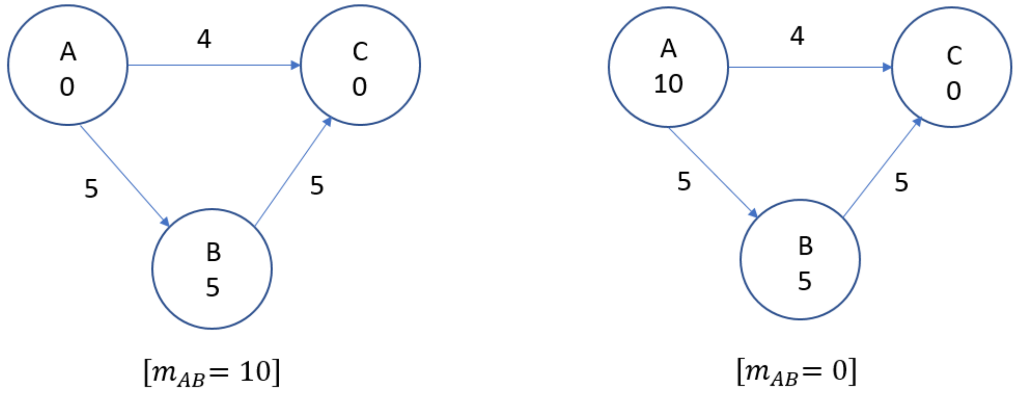
Before discussing potential shortcomings of collateral, we briefly return to the second element of the reforms mentioned earlier. We note that risk-based credit (counterparty credit) capital and collateral requirements cannot be increased at the same time. This is because a bank's counterparty risk capital depends on its counterparty exposures, the bank's counterparty risk capital increases as its counterparty exposures increase. Collateral reduces these exposures and so subsequently reduces risk-based capital levels. Indeed, Ghamami and Glasserman (2017) show that collateral requirements lead to substantial reduction in banks' counterparty risk capital levels.

Does Collateral Reduce Systemic Risk?

Measuring systemic risk often requires modeling and analyzing contagion by which we mean the spread of losses and defaults through financial networks. Ghamami et al. (2019) have recently introduced a network model under collateral requirements. We use some of their results to discuss the impact of collateral on contagion.

It is not difficult to see that committing collateral to specific contracts and counterparties can lead to an inefficient allocation of a bank's assets, a bank may find itself unable to make a *current payment obligation* on one contract despite having posted collateral to protect *potential future obligations* on other contracts. Consider the stylized network illustrated in Figure 1

Figure 1: Collateral may increase contagion



with nodes A, B, and C representing banks in a hypothetical financial network. The number inside each circle indicates the node's available cash or liquid assets on its balance sheet. The arrows indicate the directions of nominal payment obligations, and the labels on the arrows indicate the amounts due. The label in the square bracket shows posted IM. Specifically, $[m_{AB} = 10]$ indicates that node A has posted IM worth 10 to node B. In the first network, node A defaults as its available liquid assets fall below its liabilities, node B seizes collateral to cover missed payments from A, and excess collateral is returned to A, allowing A to ultimately pay C. The default of node A can be viewed as a liquidity-driven default, or more precisely, a funding liquidity -driven default in the sense of Drehmann and Nikolaou (2013) who define *funding liquidity as the ability to settle obligations with immediacy*.[5] In the second network, instead of posting and committing collateral to B, node A holds cash worth 10 on its balance sheet. Consequently, it does not default as it can instantly fulfill its obligations to nodes B and C.

Collateral versus Capital Requirements

In the first network of Figure 1, node A defaults because collateral is tied up in the "wrong" place. This default could be avoided if node A can hold on to its collateral as cash, as illustrated in the second network of Figure 1, rather than commit it to counterparty B. This tradeoff is similar to the tradeoff between capital requirements and collateral requirements: *collateral provides a buffer against specific losses, whereas capital absorbs any type of loss.*

In its comparison of margin requirements and capital requirements, BCBS-IOSCO (p.4) writes that, *margin can be seen as offering enhanced protection [in comparison with capital] against counterparty credit risk provided that it is effectively implemented. In order for margin to act as an effective risk mitigant, it must be (i) accessible when needed and (ii) provided in a form that can be liquidated rapidly and at a predictable price even in a time of financial stress*.

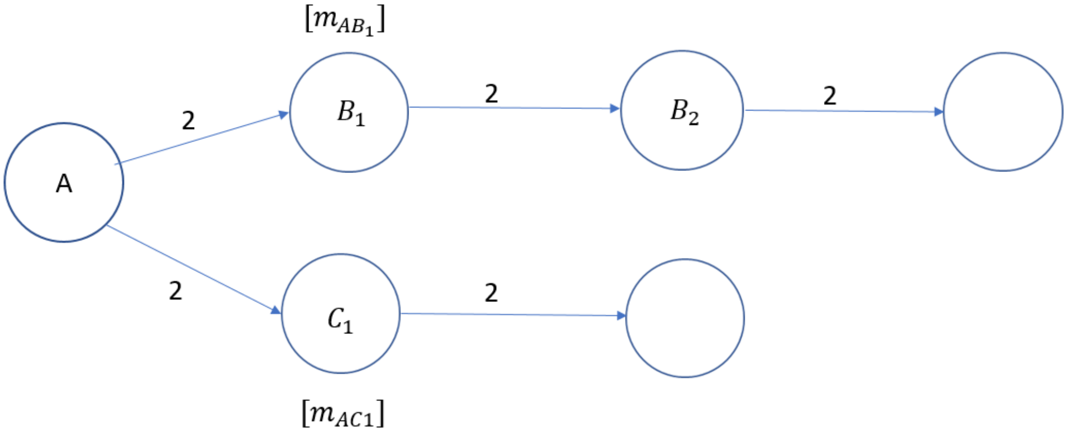
Ghamami et al. (2019) show that even when (i) and (ii) hold, collateral is not guaranteed to improve financial stability. Depending on how collateral is allocated to counterparties, it can increase or decrease the spread of losses and defaults.

[5] Alternative definitions of funding liquidity exist in the finance and economics literature as we will briefly mention in the next section of the note.

Suppose that contagion is measured by two metrics: the number of defaults, and *systemwide payment shortfalls*. Consider the set of banks that default in a network model. For each member of this set, payment shortfall is defined as the difference between the defaulter's nominal payment obligations to its counterparties and the defaulter's actual payments to them. The systemwide payment shortfalls, which we denote by L, is then the sum of payment shortfalls associated with all defaulting banks.

Now, consider Figure 2, which is based on Figure 4 of Ghamami et al. (2019). We compare defaults and total payment shortfalls in three scenarios. In the first scenario, collateral is committed to node C1. Holding the collateral as cash instead, as indicated in the second scenario, results in a payment of 1 to each of B1 and C1. This increases the number of defaults but it reduces systemwide payment shortfalls, which argues in favor of pooling. The third scenario, with collateral committed to node B1, yields the fewest defaults and the smallest shortfall. As this example illustrates, committing collateral to specific counterparties is not unambiguously better or worse than pooling it. The comparison depends on the network and cannot be resolved by considering banks in isolation.

Figure 2: Collateral may increase contagion



Sceanrio 1: $C_A = 0,\ m_{AB_1} = 0,\ m_{AC1} = 2:\quad D = \{A, B_1, B_2\},\ \ L = 6$

Scenario 2: $C_A = 2,\ m_{AB_1} = 0,\ m_{AC1} = 0:\quad D = \{A, B_1, B_2, C_1\},\ \ L = 5$

Scenario 3: $C_A = 0,\ m_{AB_1} = 2,\ m_{AC1} = 0:\quad D = \{A, C_1\},\ \ L = 4$

Source: Ghamami et al. (2019)

Excess Collateral

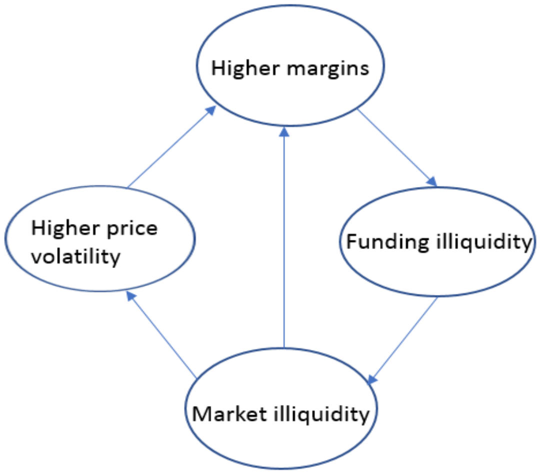
As indicated earlier, collateral in the form of initial margin is set to cover potential future exposures. As the MPOR and confidence level associated with IM increase, higher levels of collateral will be committed to specific counterparties. This can lead to excess collateral (collateral in excess of current payment obligations) being “trapped” in the “wrong” places, which can in turn result in increasing contagion. For instance, it is not difficult to see that the results of the previous example will change under excess collateral. Suppose that node A posts collateral worth 4 to nodes C1 and B1 in scenarios 1 and 3. Also, suppose that in scenario 2, collateral worth 4 is held as cash on A’s balance sheet. Then, while there won’t be any defaults or payment shortfalls in the second scenario, the default set associated with the first and third scenarios will remain unchanged. The analysis of Ghamami et al. (2019) indicates that excess collateral can increase the risk of contagion under different network configurations and collateral allocation regimes.

Collateral Can Affect Liquidity and Financial Intermediation

There has been a growing body of work on the impact of financial intermediaries’ capital structure on asset prices. In what follows, we briefly draw the results of Brunnermeier and Pedersen (2008) and Andersen et al. (2019) to highlight the potential impact of collateral on dealers’ funding liquidity, market liquidity, and OTC market intermediation.

The model introduced by Brunnermeier and Pedersen (2008) shows how intermediaries’ funding liquidity (the ease with which they can obtain funding) can affect and be affected by market liquidity (the ease with which assets are traded). The authors show that under certain conditions, margin requirements can be destabilizing. This is in part because margins can increase in price volatility, and market illiquidity can increase margins. Increasing margins affect intermediaries’ funding liquidity, which subsequently, can lead to market illiquidity as dealers cut back on their market making and liquidity provisions under funding pressures. This can be roughly summarized in Figure 3.

Figure 3: The Link between Intermediaries funding conditions, and market liquidity and price volatility can be reinforced by margins



Funding Costs Affect OTC Derivatives Valuation

Due to the imperfect nature of OTC markets, the same asset can be traded at different prices roughly at the same time as dealers can offer distinct bids and offers reflecting differences in the structures of their balance sheets. Over the past eight years, major dealer banks have included funding costs in the form of funding value adjustments (FVAs) in their balance sheets. The funding cost associated with initial margin is known as margin value adjustment (MVA) and is often considered independently from FVA.

It is now well-known that dealers' bid-ask spreads are in part driven by FVAs and MVAs. Introducing a structural model of a dealer's balance sheet and using a general reduced-form swap valuation framework, Andersen et al. (2019) show that in order to maximize its equity value, dealer bid and ask quotes must incorporate these funding costs. This is because FVAs and MVAs can be viewed as debt-overhang costs to the dealer's shareholders.

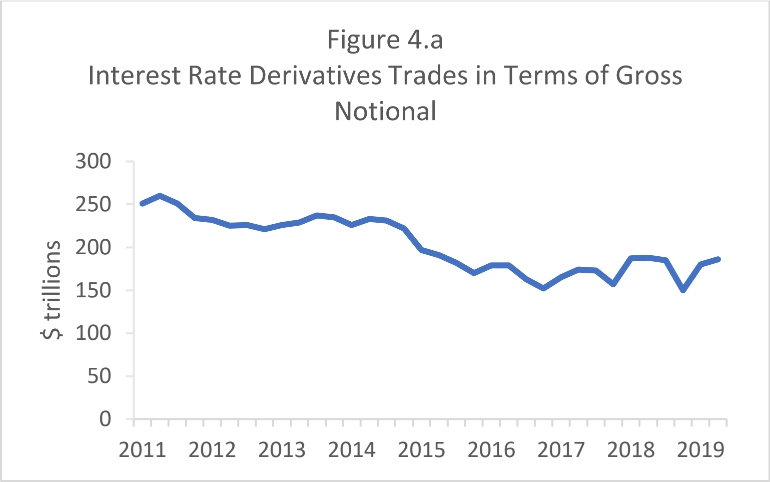
Consider the valuation of an unsecured, semi-annual-coupon, plain-vanilla interest rate swap from a dealer's perspective. Suppose that the swap between the dealer and its client is unsecured, and assume that the dealer hedges the unsecured swap with a fully collateralized offsetting swap that requires initial margin. The "hedge swap" can be with another dealer or a CCP. Dealers often combine their unsecured client swaps with risk mitigating hedges with other dealers or CCPs. Suppose that the unsecured swap is executed at an upfront payment equal to the swap's default-free fair market value denoted by V_0 .

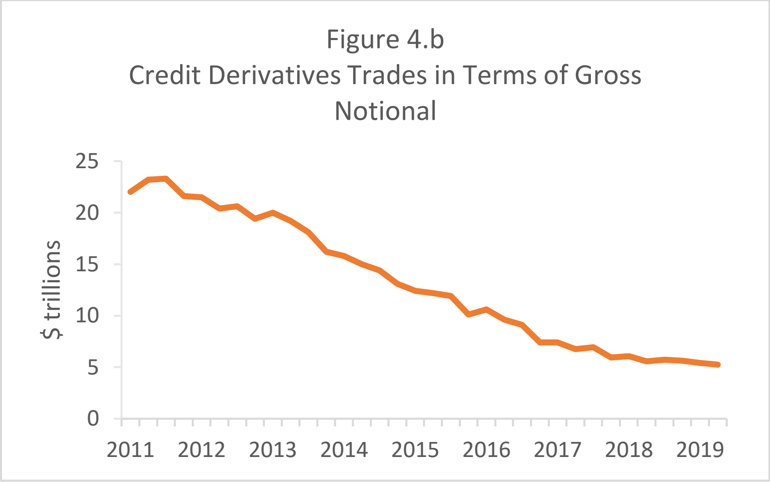
Using the results of Andersen et al. (2019), the *shareholder breakeven value* of the swap, which we denote by V, can be approximated by $V \approx V_0 - CVA - FVA - MVA$. In this formulation, CVA or credit value adjustment Carr and Ghamami (2017) represents the dealer's expected loss due to the possibility of the client defaulting prior to the maturity of the contract. FVA and MVA are both increasing functions of the dealer's credit spread. Additionally, FVA depends on the default-free market values of the swap up to its maturity, and MVA depends on IM values associated with the offsetting hedge swap up to the maturity. As noted earlier, IM at any point in time depends on swap values over MPOR. Put simply, the above formulation indicates that clients of dealers must on average pay above the market values of their swap positions by compensating dealers in the form of funding-driven pricing terms. Otherwise, dealers may not be incentivized to perform swap market making. In sum, collateral requirements can reinforce market illiquidity and can lead to reduction in dealers' OTC market intermediation.

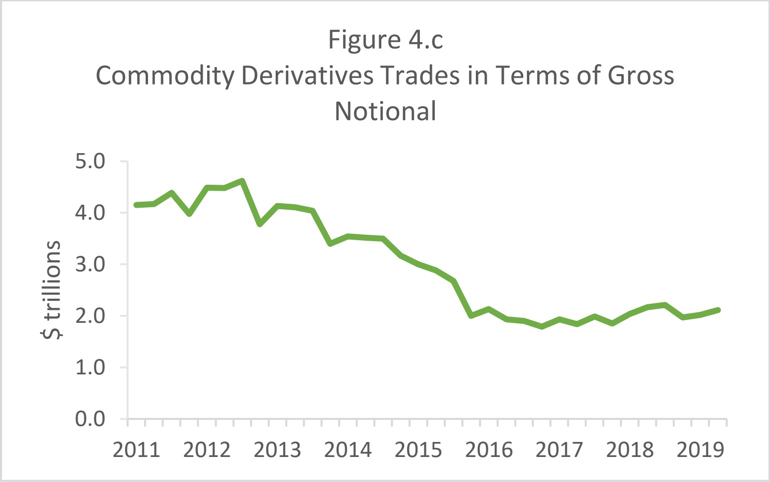
Section 4.B of Andersen et al. (2019) gives a numerical example for the valuation of the above-mentioned swap with 10-year maturity and notional size of $100 million, where the dealer quotes both the payer and receiver versions of the swap. Their example indicates that in the absence of funding costs, the bid-ask spreads would be under .2 basis points while including FVA and MVA results in an upper bound of 11.1 basis points for the bid-ask spread. Removing MVA impacts would result in a bid-ask spread of around 8.7 basis points. The example illustrates a substantial widening of unsecured dealer-client bid-ask spreads due to FVA and MVA effects.

Concluding Remarks

The financial crisis of 2007-2009 revealed deficiencies of microprudential regulation and called for a macroprudential approach to financial regulation that focuses on maintaining the stability of the financial system as a whole, (Bernanke (2008) and Hansen, Kashyap, and Stein (2011)).







Source: Federal Reserve Y-9C and Forum's analysis

Narrowly focusing on designing risk-based collateral rules to safeguard specific counterparties of a bank under distress is a myopic and microprudential approach to supervision that can be in tension with macroprudential regulation.

While increasing the MPOR or confidence level associated with IM and incorporating add-on type components into it to capture derivatives portfolio concentration or liquidity characteristics can ensure the stability of specific counterparties in isolation, it may also increase systemic risk. Our analysis shows that collateral, particularly collateral in excess of banks' *current* payment obligations or exposures, can lead to inefficient allocation of banks' assets and can make the financial system vulnerable to liquidity shocks.

Ghamami et al. (2019) show that collateral fire sales can further increase the spread of losses and defaults in financial networks when collateral is held in illiquid assets, Table 1 shows that collateral can also be held in non-cash assets. The tradeoff between capital requirements and collateral requirements and the optimal distribution of collateral need to be further analyzed, we leave these to future work.

Researchers have shown that risk-based collateral requirements are procyclical, margins can be destabilizing and can intensify the link between funding illiquidity and market illiquidity, (Figure 3). Collateral increases frictions associated with OTC markets. In fact, funding and collateral costs are the main determinants of bid-ask spreads in these markets. OTC markets rely heavily on intermediation by dealers, inter-dealer collateral requirements in excess of current exposures can disincentivize OTC market intermediation.

OTC derivatives reform FSB (2017)[6] has had positive effects but also some unintended consequences. One consequence, intended or not, is a decline in the largest banks' positions in OTC interest rate, credit, and commodity derivatives. Figures 4.a, 4.b, and 4.c show the total interest rate, credit, and commodity derivatives trades at the Financial Services Forum member banks in terms of gross notional from 2011 to 2019 using FR Y-9C reports. We note that OTC interest rate derivatives dominate other product types in OTC markets in terms of notional and accounting values. According to Figures 4.a-c, since 2011, banks have reduced their trading and market making activities in interest rate, credit, and commodity derivatives by around 26 percent, 76 percent, and 49 percent, respectively. We note that part of this decline, but certainly not all of it, in the past few years can be attributed to the increasing compression and netting efficiencies achieved through services provided by third-party firms in the inter-dealer and centrally cleared OTC markets.

[6] The Financial Stability Board (FSB) is an international body that monitors and makes recommendations about the global financial system.

About the Author

Samim Ghamami is the Senior Economist and Vice President at the Financial Services Forum. He joined the Forum in August 2019 from Goldman Sachs, where he was a senior financial economist and a senior vice president. Ghamami is also an adjunct professor of finance at New York University, an adjunct associate professor of economics at Columbia University, and a senior researcher at UC Berkeley Center for Risk Management Research.

Dr. Ghamami has also been an acting associate director and a senior economist at the Office of Financial Research at the U.S. Department of the Treasury, and an economist at the Federal Reserve Board. Ghamami's research has broadly focused on financial economics and more recently on the interplay between finance and macroeconomics. His work on banking and central clearing has been presented and discussed at central banks. Ghamami has been an advisor to the Bank for International Settlements and has also worked as an expert with the Financial Stability Board on post-financial crisis reforms. He served on the National Science Foundation's panel on Financial Mathematics in 2017 and 2018.

Ghamami has also been a visiting scholar at the Department of Economics at UC Berkeley, a quantitative researcher at Barclays Capital, an adjunct professor at the University of Southern California, and a post-doctoral researcher at CREATE Homeland Security Center.

Ghamami received his Ph.D. in Mathematical Finance and Operations Research from the University of Southern California in 2009. His publications have appeared in different journals including the *Journal of Financial Intermediation*, *Management Science*, the *Journal of Derivatives*, *Quantitative Finance, Mathematics of Operations Research, and* the *Journal of Applied Probability*.

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