Volume Title: Risk Topography: Systemic Risk and Macro Modeling

Volume Author/Editor: Markus Brunnermeier and Arvind Krishnamurthy, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-07773-X (cloth); 978-0-226-07773-4 (cloth); 978-0-226-09264-5 (eISBN)

Volume URL: http://www.nber.org/books/brun11-1

Conference Date: April 28, 2011

Publication Date: August 2014

Chapter Title: Measuring Margin

Chapter Author(s): Robert L. McDonald

Chapter URL: http://www.nber.org/chapters/c12510

Chapter pages in book: (p. 65 - 82)

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Measuring Margin

Robert L. McDonald

5.1 Introduction

In discussions related to derivatives and regulatory policy, three questions often arise:

- Across the economy, how exposed are firms to derivatives?
- How is this exposure split across different asset classes?
- How sensitive is the magnitude of exposure to economic shocks?

Margin—collateral that protects the counterparty against losses from failure to pay—is an economic measure of exposure that differs by asset and by the topography of risk. In this chapter I discuss the idea that reporting of margin, disaggregated by product class and by entity, would provide a standardized measure of the specific net risks being borne with derivatives, and provide information about entity vulnerabilities to specific market shocks, along with sector concentrations in particular derivative asset classes.[1] The future configuration of contracts, institutions, trading, and market practices is difficult to forecast. As markets evolve, routine margin reporting would provide information about risks that would be potentially helpful to policymakers, analysts, and market participants.

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Prepared for the NBER Initiative on Systemic Risk and Macro Modeling. I am grateful to Markus Brunnermeier, Arvind Krishnamurthy, Richard Heckinger, John McPartland, and Robert Steigerwald for helpful discussions and comments, but of course errors are my own. For acknowledgments, sources of research support, and disclosure of the author's material financial relationships, if any, please see http://www.nber.org/chapters/c12510.ack.

1. Acharya (chapter 6, this volume) suggests even more detailed reporting on derivatives. Whereas I emphasize reporting of existing margins, Acharya emphasizes reporting of what he calls "potential exposure," including additional margin calls due to credit downgrades.

The Bank of International Settlements (BIS) estimates that at year-end 2010, the outstanding notional amount of over-the-counter (OTC) derivatives was $601 trillion (BIS 2011). According to the BIS, the vast majority (77 percent) of these contracts are interest rate derivatives (with over 10 percent of this amount as options), with foreign exchange derivatives second at 9.6 percent, and credit default swaps (CDS) third at about 5 percent. Equity contracts represent about 1 percent and commodity contracts about 0.5 percent. The BIS obtained this estimate by surveying market participants and eliminating the double counting that results from both A and B reporting the same derivative contract between A and B.

The BIS estimate is difficult to interpret for several reasons.[2] First, by definition the count includes positions that are effectively offsets. For example, if two dealers in the ordinary course of business enter into a series of nonidentical but functionally similar swaps, there are likely to be significant economic offsets, so that the net exposure of one dealer in the event of bankruptcy by the other dealer is small. How overstated is the notional amount reported by BIS?

Second, the number includes derivatives based on interest rates, equity, credit, foreign exchange, and commodities. A swap of a given notional amount will embody different risks depending on the underlying asset, maturity, and structure of the product. A $1 million vanilla equity swap will typically be riskier than a $1 million vanilla interest-rate swap. However, swaps, including interest-rate swaps, can be designed to have additional layers of leverage and thus be substantially riskier than vanilla swaps per dollar of notional value. A famous example of this is the Procter and Gamble swap (McDonald 2013, 253).

In section 5.2 I discuss the economic interpretation of margin for individual contracts and for portfolios of contracts. I present examples showing how margin is assessed in practice for different kinds of underlying assets. In section 5.3, I discuss different margin practices in centrally cleared and OTC markets. Depending upon whether the margining system is gross or

2. ISDA (2011) makes two additional adjustments to the BIS number. First, it eliminates foreign exchange swaps. Second, it reduces the BIS estimate for double counting of interest rate swaps cleared at LCH Clearnet. Regarding the treatment of foreign exchange swaps, ISDA subtracts the value of FX swaps on the grounds that these are short term and, bizarrely, that they are "older products." Duffie (2011), in a comment on the Treasury proposal to exempt FX swaps from clearing requirements, expresses skepticism that foreign exchange swaps should be treated differently than other derivatives. Regarding the treatment of cleared swaps, the adjustment for double counting arises from the observation that a single swap presented to a clearinghouse becomes two swaps, one each between the original counterparties and the clearinghouse. Clearing, therefore, leads to an increase in the measured notional value of swaps. This is correct, but it is also true that the use of a clearinghouse does create new counterparty relationships for a given contract. Both the FX and clearing adjustments illustrate the limited usefulness of aggregate numbers. Disaggregated statistics permit the statistical consumer to make whatever adjustments seem appropriate for the analysis at hand.

net, margin may be held by different parties. Section 5.4 presents several examples illustrating different margin calculations for cleared and noncleared transactions. Using these examples, I contrast margin with notional amount and VaR (value at risk) as measures of risk. In section 5.5, I discuss a controversial feature of Dodd-Frank, the end-user exemption. I show that this feature can be seen as creating implicit off-balance sheet borrowing by the exempt end user. Section 5.6 concludes.

5.2 Understanding Margin

Derivatives contracts have future settlement based on a reference price, but it is common to settle the contracts on an ongoing mark-to-market basis as prices change prior to contract maturity. The term "margin" encompasses at least two different kinds of payments related to this settlement in advance: the maintenance margin, which is referred to in the OTC market as the "independent amount," and the variation margin.[3] The maintenance margin, which is the focus of this chapter, is an amount that provides collateral against possible future loss before the next marking to market of the contract. Depending upon the context, market participants under current rules may or may not post maintenance margin. The variation margin, by contrast, is a payment that covers realized loss, thereby resetting the value of the derivative to zero, and preventing losses from cumulating.

Margin is collateral for a contractual obligation, and as such reflects the riskiness of the contract. Although the notional amount of a position can be difficult to interpret, the margin on a position is an economically meaningful value, routinely computed and used by market participants as a protection against counterparty default. Margin thus provides a common denominator with which to compare the risk of different contracts and positions. In this section I provide some examples to illustrate margin practices in several different contexts.

Throughout this discussion we will be assuming that the derivative contract under discussion resembles a futures contract or swap, in that it has no initial premium (i.e., no payment from one party to the other, distinct from margin), there is futurity, that is, the contract will require future performance, and at the future settlement date there is a possibility of payments from either one of the two parties to the other. Credit risk is therefore two sided. Contracts for which the buyer fully pays (such as options) are different because the buyer has no further obligation, and thus credit risk is one sided.

3. The CME also distinguishes between *initial margin* and *maintenance margin*. Initial margin is the amount a trader must provide at the initiation of a position, while maintenance margin is the amount below which the trader must provide additional margin. We will focus on maintenance margin in this discussion.

5.2.1 Margin in Theory

Assume that there are two firms, A and B, that enter into a derivative contract such as a vanilla swap. A firm posts margin to protect the counterparty against the failure of the other to make a required payment on the derivative. In practice, margin is often computed as the expected loss on the position that occurs with some probability. The amount of margin will depend upon the frequency with which the position value is measured and settled.

Various methods can be used to compute the margin amount, but it is helpful to think of margin as a tail VaR, which is the conditional expectation of a position value if it falls below a certain level. Let V_t be the value of the derivative for A, so that $-V_t$ is the value for B. Assuming that A is long, so that $V_{t+1} < V_t$ represents a loss, margin for A is

$$(1) \qquad M_t^A = -E_t[V_{t+1} - V_t | V_{t+1} < V_{t+1}^p, V_t],$$

where V_t is the value of the derivative position at time t (it can be positive or negative), V_{t+1}^p is the value of the claim such that

$$\Pr(V_{t+1} < V_{t+1}^p | V_t) = p,$$

V_{t+1}^p is exceeded with probability p, and M_t is margin at time t. For example, margin might be computed based on a value that is exceeded with 1 percent probability. Note that there is a time period implicit in the calculation of M_t^A. For exchanges, the time period is typically a day. In OTC markets, the time period can be several days, in which case margin will be correspondingly greater, other things being equal.

Margin for B, who is short, is

$$(2) \qquad M_t^B = E_t[V_{t+1} - V_t \mid V_{t+1} > V_{t+1}^{1-p}, V_t].$$

We define V_{t+1}^{1-p} as

$$\Pr(V_{t+1} > V_{t+1}^{1-p} | V_t) = p.$$

In practice, for futures traded at exchanges, margin is set symmetrically so that $M_t^A = M_t^B$. Symmetry is not necessary, however. For options, margin applies only to levered or written positions. Equations (1) and (2) provide a rough conceptual description of the margin calculations of many derivatives clearinghouses.

Equations (1) and (2) are statistical definitions of margin. These measures are not based on an economic theory of optimal margin, which would require modeling default and systemic risk.[4] The margin calculations also make no adjustment for the risk of the specific counterparty. Nevertheless, M_t^A and M_t^B correspond conceptually to clearinghouse practice.

4. Bolton and Oehmke (2011) develop a model of optimal derivatives use and collateral in a context where hedging has value for firms but entails real costs, and there is credit risk.

In this discussion we have not specified the time horizon over which marking to market occurs. In practice, clearinghouses compute margin with respect to daily price moves. In the OTC market, revaluations may occur only weekly, in which case margins are larger due to less frequent marking to market. Margin is often approximated as a multiple of the asset standard deviation. A weekly return standard deviation will be approximately $\sqrt{5}$ times the daily standard deviation. If margin were being used to compare exposures across classes of derivatives, it would be necessary to know the mark-to-market horizon in order to compare the underlying positions.

5.2.2 Netting and Portfolio Margining

The preceding discussion defined margin for a single asset. For a portfolio of assets, margin can be computed in the same way. Suppose there are two derivatives with values V_t and Q_t held in quantities α_v and α_q. Let $W_t = \alpha_v V_t + \alpha_q Q_t$ denote the value of the portfolio. (Buyers and sellers can be distinguished by setting α_v and α_q appropriately.) The tail VaR for this portfolio is

$$M_t^P = -E_t[W_{t+1} - W_t \mid W_{t+1} < W_{t+1}^p, W_t], \tag{3}$$

where $M_t(W)$ denotes the margin for asset W. By the Cauchy-Schwarz inequality,

$$\alpha_v M_t(V) + \alpha_q M_t(Q) \geq M_t(W). \tag{4}$$

Setting margin for the position W using equation (3) is called *portfolio margining*, with the margin based on the aggregate risk of the portfolio components rather than the individual risks.[5]

The calculation in equation (4) depends upon the return correlations of V and Q. Correlations may vary over time and increase across asset classes in times of stress. As a result, portfolio margining is generally used only within specific asset classes, where correlations are likely to be high and relatively stable.

5.2.3 Margin Examples

The economic risk, and thus the margin, associated with a given notional amount differs by asset class and other characteristics, including maturity

5. Suppose that V and Q are marked to market over different horizons, which we will call 1 period and V periods. To understand portfolio margining in this case, let σ_v and σ_q represent the two 1-period standard deviations (corresponding to the more frequent mark-to-market interval) and ρ the return correlation. Suppose that Q is marked to market every $T > 1$ periods. The variance of the portfolio over T periods will be $\sigma^2 = \alpha_v^2\sigma_v^2 + \alpha_q^2\sigma_q^2 T + 2\rho\alpha_v\alpha_q\sigma_v\sigma_q\sqrt{T}$. The horizon T does not affect the variance of V in this calculation because the position is refreshed every period and there is never more than one period of exposure. As we vary T, we have

$$\frac{\partial\sigma}{\partial T} = \frac{1}{2\sigma}\left(\alpha_q^2\sigma_q^2 + \rho\alpha_v\alpha_q\sigma_v\sigma_q\frac{1}{\sqrt{T}}\right).$$

As T increases, margin increases due to the risk of Q.

and the structure of the contract. In the following we use CME Group margin levels to illustrate possible differences in margin amount for a $100 million notional position in different assets.

Consider a contract to hedge a future $100 million ninety-day loan with a rate that will be linked to LIBOR on the lending date. One way to hedge this loan is by entering into a Eurodollar futures contract, which is an exchange-traded contract. The notional value of the contract is $1 million, so hedging the loan requires a position in 100 contracts.[6]

For each exchange-traded contract, the CME Group website reports the initial margin—the amount that must be posted to enter into an outright position (long or short) in one contract—and the maintenance margin, which is the minimum amount permitted in the margin account. Exchange-traded contracts are marked to market daily. In June 2011, the CME Group website reported that initial margin and maintenance margin for the Eurodollar contract was $608/$450 for contracts with an expiration date of less than one year, $743/$550 for contracts with an expiration date between one and three years, and $1,013/$750 for longer-dated contracts. In all three cases the maintenance margin is 74 percent of the initial margin, which in turn is less than 0.1 percent of the notional amount of $1 million. For our purposes, maintenance margin is the required minimum and thus corresponds most closely to equations (1) and (2).

Thus, hedging the $100 million loan would require that traders on each side of the contract maintain a margin balance of between $45,000 and $75,000, depending on the maturity of the contracts. In this example, we would observe open interest of 100 contracts and, because there is both a long and a short, total margin of roughly $90,000 to $150,000, depending upon maturity.

There are trading strategies such as spreads that would result in different margin amounts. For example, consider a trader who goes long fifty Eurodollar contracts expiring in one month and short fifty Eurodollar contracts expiring in a later month. The risk of a spread is lower than the risk of an outright position, so the spread—which also generates open interest of 100 contracts—would require initial margin of between $23,600 and $57,400, depending on maturity. This is about half the margin for a 100 contract outright position.

Some trading strategies require substantially smaller margin amounts per contract. For example, going long one December 2012 contract, long three June 2013 contracts, short three March 2013 contracts, and short one September 2013 contract—a so-called condor—would have initial margin of $68. If a trader entered into twelve such positions, there would be open

6. In this example it is irrelevant whether or not the party is hedging a lending or borrowing position. However, hedging a loan would entail going long Eurodollar futures, which are designed to behave like a bond, making money when the interest rate goes down. A short position would hedge borrowing.

Table 5.1 **Maintenance margin for different representative futures at CME Group exchanges, assuming a $100 million notional amount in the case of outright trades and a $100 million notional amount on each side in the case of spread trades (this is twice the number of contracts)**

			Margins	
Asset	Ticker	Number of contracts	Outright ($)	Spread ($)
Eurodollar	ED	100	45,000	20,000
Treasury bond	US	1,000	2,000,000	300,000
S&P 500 index	SP	320	6,400,000	80,000
Crude oil (WTI)	CL	1,000	5,250,000	300,000
Natural gas (Henry Hub)	NG	2,174	4,347,826	869,565
Gold	GC	667	3,000,000	54,667
Copper	HG	1,000	4,250,000	225,000
Corn	C	3,077	5,384,615	2,307,692

Source: CMEGroup.com.
Note: The "Number of contracts" column reports the number of contracts with a $100 million notional amount.

interest of ninety-six contracts and total margin of $816. Depending on the spread strategy, required margin can vary by a factor of ten.

5.2.4 Margin for Different Assets

Table 5.1 shows representative margin levels for positions with a notional value of $100,000,000 for different contracts.[7] The main point of table 5.1 is that for a given notional amount, the risk of a position, as measured by margin, can vary significantly.[8] Even ignoring the Eurodollar contract, margin can vary by a factor of three (T-bonds vs. the S&P 500 index), and margin on spread positions can vary still more widely. For some assets, spreads are low risk (the S&P 500 index and gold, for example), while for others, spreads are relatively risky (corn and natural gas).

7. Table 5.1 is intended only to be illustrative, but it is worth noting that there can be a great deal of contract-to-contract variation in margin characteristics, even holding fixed the underlying asset or commodity. The table emphasizes differences across assets, but the differences in margin for a given asset, across different expirations, can also be considerable. For example, crude oil maintenance margins on outright positions start at $6,250 for the near months, and decline to $5,000 for contracts more distant than twenty months. Corn spread margins are $750/contract for spreads that cross harvests (e. g., summer against winter months), and $300/contract for spreads in the same season. The examples in table 5.1 are necessarily somewhat arbitrary.

8. The Eurodollar contract has a deceptively low margin. A common use of the contract is the hedging of swaps. The equivalent of a ten-year swap would be a set of Eurodollar contracts with forty different maturities. Multiplying the Eurodollar margin by forty yields a margin of $1.8 million, close to that of Treasury bonds.

5.3 Margin in Practice

In this section I discuss how margin is handled at a central clearinghouse and in the OTC market. It is important to keep in mind that all derivatives are in zero net supply. Also, for futures and swaps with zero value, both the buyer and seller post margin because either could experience a loss.

5.3.1 Clearinghouse Margin Practice

A typical clearinghouse becomes the counterparty for all traders: the seller to all buyers and the buyer to all sellers. This process by which the clearinghouse substitutes itself as counterparty is called *novation*. A clearinghouse does not novate all counterparty relationships, but typically deals directly only with clearing members, who in turn have obligations to the clearinghouse.[9] Other traders interact with the clearinghouse through clearing members.

A clearinghouse will have procedures and safeguards to protect clearing members against default by other clearing members. One common practice is for the clearinghouse to hold margin. For example, the CME Group in 2010 (CME Group, Inc. 2010) reported holding $82 billion of performance bonds. Depending upon the requirements of the clearinghouse and regulators, this reported margin number can have different interpretations. The following discussion is intended to outline the possible practices concerning margin, rather than the specific practices of any particular exchange.

Outright Positions

Consider the left-hand side of figure 5.1, in which there are two clearing members, and clearing member 1 has two customer accounts. Suppose that customer A is long two contracts, customer B is short one contract, and clearing member 2 is short one contract. Margin is M per contract, so total margin deposited by customers at clearing member 1 is $3M$, and clearing member 2 must deposit M. The disposition of the margin depends on clearinghouse rules, but the important point is that the total margin of $4M$ on deposit from customers measures their one-period economic exposure resulting from their derivatives positions.[10]

What happens to the $4M$ on deposit? The clearinghouse could mandate that clearing members post with the clearinghouse all margin received, in which case the clearinghouse would show performance bond holdings of

9. Clearing members will contribute to a clearinghouse guarantee fund, must be in financial good standing, and may have an obligation to contribute further to the clearinghouse in the event another clearing member defaults.

10. Note that there are credit relationships in the clearinghouse model that do not involve payment of margin. Generally, clearing member 1, not the clearinghouse, is the counterparty for customers A and B. If clearing member 1 were to fail, the clearinghouse would protect other clearing members against losses, but customers of clearing member 1 could potentially suffer losses, depending upon the precise legal obligation of the clearinghouse.

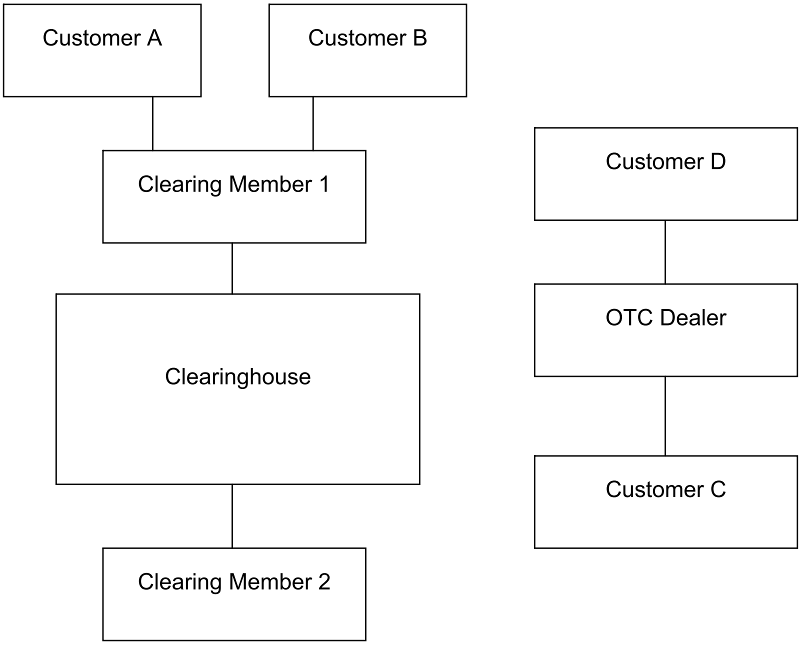

Fig. 5.1 Derivatives counterparties with and without a clearinghouse

$4M$. This treatment of margin by the clearinghouse is referred to as *gross margining*. Alternatively, rules could be such that the clearinghouse would, in the event of a failure, have a net obligation of one contract to clearing member 1, and the clearinghouse could then require a deposit only of M, the margin on one contract, from each clearing member. Clearing member 1 would continue to hold the remaining $2M$. This is a *net margining* system.

Thus, depending upon its rules, the clearinghouse could hold two units of margin, four units of margin, or something in between. In a net margin system, clearing member 1 would hold the two units of margin that are not held by the clearinghouse. The specific rights and obligations of customers, clearing members, and the clearinghouse under the two systems are potentially quite complicated and are beyond the scope of this discussion. The point is that the margin held by the clearinghouse provides different measures under the two systems.

Cross-Margined Positions

As discussed previously, margin can be based on a total portfolio position, taking into account diversification. Clearinghouses routinely use portfolio margining for calendar spreads (e.g., long September and short October in the same asset or commodity) and spread positions in different equity indexes (e.g., long Dow-Jones and short the S&P 500). Going long and short the same contract is a limiting case of portfolio margining (the two positions are perfectly negatively correlated). Portfolio margining is generally *not* used across asset classes, although this could change.

Once margin is computed for a position, margin can be held by the broker or clearinghouse depending upon whether there is gross or net margining.

5.3.2 OTC Margin Practice

Under Dodd-Frank, margin treatment in the OTC market should closely resemble that for clearinghouses, with the dealer bank serving as the clearing entity. Prior to Dodd-Frank, however, margin practice in the OTC market typically differed from that in clearinghouses.[11]

The OTC market is illustrated on the right-hand side of figure 5.1. Suppose that customers C and D enter into offsetting positions in an OTC version of the same contract that A and B are holding. The OTC dealer is counterparty to each, effectively serving the same role as the clearinghouse. The customers are exposed to the dealer, and the dealer is exposed to each customer. Prior to Dodd-Frank, it would have been possible that none of the participants in figure 5.1 would have posted maintenance margin.[12] Typically, the dealer would compute the independent amount (analogous to maintenance margin) for a counterparty and then the party with the larger independent amount (typically the customer) would post collateral equal to the difference in the independent amounts. This is in contrast with the situation at a clearinghouse, where the two clearing members would both post margin for their positions. Another difference is that OTC margin calculations for different asset classes may cover different horizons: several days, for example, rather than one day.

As with a clearinghouse, OTC dealers make use of portfolio margining but only for closely related assets.

5.4 Using Margin to Assess Risk

Margin requirements attempt to measure risk in a precise way, so systematic reporting of margin, broken down by asset class, reported by market participants, would provide potentially valuable information to regulators, analysts, and other market participants. One could imagine a reporting scheme in which derivatives would be broken out into standard asset class categories; for example, equity, index, fixed income, energy, agricultural

11. OTC margining is discussed in detail in appendix A of Brunnermeier and Pedersen (2009). One issue pertaining to OTC margining that I do not address is the effect of nonstandardized contracts and illiquid markets for the underlying asset.

12. Under proposed rules, the SEC and CFTC would designate large dealer firms as "covered swap entities." These firms would be required to collect margin from one another.

commodities, metals, and foreign exchange. Derivative margin by such categories would be reported by clearinghouses, swap clearing entities, dealers, and corporate end users.

Major market participants such as clearinghouses and swap clearing entities could report margin broken down by asset class, with and without incorporating the effects of cross margining. This number could be divided by two in order to compare directly to open interest.

- Clearinghouse rules might leave substantial customer margin held by clearing members (for example, if the clearinghouse uses net margining). In this case, the margin in the custody of clearing members could be reported as well.
- Covered swap entities could report margin, by asset class, for non-cleared swaps.
- For users subject to the end-user exemption, margin that would have been otherwise required would be reported by asset class.

To illustrate the role of margin in measuring economic exposure, table 5.2 summarizes a series of transactions undertaken by different entities. The transactions illustrate three issues in assessing derivatives risk:

1. The existence of partial offsetting positions between two counterparties (transactions 1 and 2, group A)
2. Cyclical transactions, where individual firms face exposure that could be netted, but is not (transactions 3, 4, and 5, group B)
3. Nonstandard derivatives (transactions 6 and 7, group C)

Note that none of the positions in table 5.2 are exactly offsetting with respect to both the contract and the counterparty. The notional amounts for oil swaps in the table are based upon a price of $100 per barrel and settlement

Table 5.2 **Hypothetical oil derivatives positions among six dealers (D1–D6) and one customer (C)**

			Outright		
Group	Item	Description	Long	Short	Margin ($)
A	1	$125 1.25-year swap	D1	D2	6.25
	2	$150 1.5-year swap	D2	D1	7.50
B	3	$100 1-year swap	D3	D4	5.00
	4	$100 1-year swap	D4	D5	5.00
	5	$100 1-year swap	D5	D3	5.00
C	6	$100 1-year exotic levered swap	C	D6	20.00
	7	$100 1-year swap	D6	C	5.00

Notes: All swaps are based on 83,333 barrels per month, and outright margin is assumed to be 5 percent of notional for standard swaps. All dollar amounts are millions.

based on 83,333 barrels per month. The stated notional amount is the total barrels over the life of the swap times price. We assume that the margin is $5 per barrel or $5 million on a $100 million swap and $20 million for the exotic swap. The measured total notional derivatives positions implied by table 5.2, as well as the amount and location of risk exposures, will depend upon whether the trades are cleared.

5.4.1 Clearinghouse Treatment

Suppose first that trades are centrally cleared. Table 5.2 illustrates the original trades, but assume that the ordinary swaps have been presented to the clearinghouse and novated. For the purpose of this discussion it does not matter whether the dealers are clearing members.

In transactions 1 and 2, D1 and D2 have partially offsetting positions in swaps. Because each party is both long and short closely related contracts, margin on the net position is that of a spread, reflecting the remaining exposure in months sixteen through eighteen. The margin in this example would be about $1.25 million for each counterparty.[13]

Transactions 3, 4, and 5 illustrate the netting function of a clearinghouse. Each dealer is both long and short the same contract, albeit with a different counterparty. Novation of the contracts makes the clearinghouse a counterparty to all three contracts, eliminating the positions and therefore the exposure of the dealers.

Finally, transactions 6 and 7 again represent partial offsets for the customer, who is long oil via an exotic swap and short oil with an ordinary swap, with dealer 1. Assuming the exotic swap cannot be cleared, the customer owes $5 million margin to the clearinghouse for the ordinary swap and $20 million margin to the dealer for the exotic swap. The ordinary swap is novated, resulting in the dealer and customer both having a standard cleared contract.

Summarizing, with a clearinghouse, the transactions in table 5.2 would result in reported notional amounts of $475 million (transactions 3, 4, and 5 vanish due to novation) and margins of $1.25 million for transactions 1 and 2 (counting one firm's margin) and $25 million for transactions 6 and 7.

Margins thus reveal low risk associated with the $275 million notional amount of transactions 1 and 2, and the very high risk associated with the $200 million notional of transactions 6 and 7. Transactions 3, 4, and 5 do not exist.

13. Margin in this case would reflect the different notional amounts and also the different maturities. Presumably there would be a positive but small margin for equal notional amounts in the two contracts, and an additional margin for the residual $25 million, whence the assertion that margin would be "about" $1.25 million.

5.4.2 OTC Treatment

Suppose now that all of the transactions in table 5.2 are OTC, and therefore not centrally cleared.[14] Both open interest and margins are different due to differences in netting with and without central clearing.

Transactions 1 and 2 should result in the same margin as with central clearing. As the counterparties are the same, only net exposure matters and both sides are margined.

Transactions 3 to 5 are treated quite differently with and without central clearing. In the OTC market there is no novation; all bilateral transactions remain in place with the original counterparties. Therefore the transactions, which net to zero with central clearing, will remain outstanding. This increases total notional amounts by $300 million. Further, under Dodd-Frank, all dealers will post margin with their counterparties. (This creates a powerful incentive to identify and unwind such transactions, achieving the same outcome as novation.)

Finally, with the standard swap receiving OTC treatment, it is possible for dealer 1 and the customer to net the exotic and ordinary swap, transactions 6 and 7. The same notional amounts would be outstanding for these transactions, but the amount of margin is reduced from $25 million when cleared to $15 million when the exotic and ordinary swaps are not cleared.

Without clearing, notional amounts outstanding increase to $775 million and required margins increase by approximately $5 million. This takes account of the increase of $15 million from transactions 3 to 5 and the reduction of $10 million from transactions 6 and 7. The increase in OTC margin relative to clearinghouse margin in this example reflects the increase in counterparty credit risk from the inability to novate in an OTC setting.

5.4.3 Discussion

The examples illustrate how margin measures the net exposure to a given counterparty, providing a convenient and consistent measure of exposure to a given asset class. The aggregate notional amount of derivatives outstanding is quite different in the cleared and uncleared case, but margin is almost the same. The examples illustrate one case where margin is the same in a cleared and noncleared system (transactions 1 and 2), one case where margin and risk are both reduced in the cleared system (transactions 3, 4, and 5)—albeit because derivatives positions are eliminated by clearing—and one case where margin declines in the uncleared system (transactions 6 and 7). In each case, margin shows who is bearing risk and how it is distributed.

14. The examples here would also apply if there were multiple clearinghouses for the same product. The examples illustrate the incentive to consolidate trades in an asset class at a single clearinghouse.

Note that it would be difficult to obtain this risk exposure information in other ways. One possibility would be to acquire precise information about the terms and counterparties of derivatives claims outstanding, but assessing risk would require valuing these claims and computing net exposure to each counterparty. With margin, the counterparties have performed this calculation. The requirement of consistent margin reporting is thus a decentralized form of regulation: margin is computed by agents with economic stakes, rather than by a central entity.

In addition to margin, there are at least two other leading natural measures of derivatives usage and exposure applicable both to OTC and cleared positions.

- *Notional amount* measures the notional dollar value of contracts outstanding, with no adjustment for risk or offsetting positions. In table 5.2, notional amounts with clearing are \$475 and without clearing \$775, but the aggregate margin is almost the same. As discussed in the introduction, notional amount takes no account of the different risks of positions or whether there are offsetting positions. It is inherently difficult to interpret the economic significance of notional amounts.
- *Value at risk (VaR)* measures the firm's specific exposure. As discussed in section 5.2, margin is conceptually similar to value at risk. The difference is that value at risk may be zero in circumstances where margin would be positive. For example, in Group B without clearing, each of the three firms would show zero VaR, whereas under the rules proposed by Dodd-Frank, each would post margin for both positions. The positive margin amount would indicate that there is a chain of uncleared obligations, which is indicative of systemic risk.

The implementation questions for a margin reporting system include the following:

- How finely should asset classes be subdivided? It is common to subdivide products as equity, interest rates, credit, foreign exchange, and commodities. Finer subdivisions would include splitting equity and interest rates by currency of denomination, and commodities into agriculture, energy, and metals.
- How fine grained should entity-level reporting be? Two objections to fine-grained reporting by dealer banks would be the costs of reporting and the possibility of releasing proprietary information. Presumably regulators will be receiving detailed information, so the issue of cost should be moot. The issue of proprietary information is potentially more problematic.
- How frequent should reporting be? Under Dodd-Frank, OTC derivatives trades are to be publicly reported on a near real-time basis, and

dealers presumably will be performing margin calculations at least daily. Daily or weekly margin reporting should be feasible.

- Does portfolio margining raise special issues? If portfolio margins were sensitive to correlation assumptions, margins could change abruptly at the onset of a crisis. One could require reporting of margins with and without portfolio margining. This is probably not important with current practice, but could be a significant issue if the scope of portfolio margining were to increase.

5.5 The End-User Exemption

The exception to the requirement to post margin under Dodd-Frank is the proposed "end-user exemption" for nonfinancial firms. Specifically, under the Treasury's proposed margin and capital requirements for covered swap entities (Department of the Treasury et al. 2011),

> a covered swap entity would not be required to collect initial or variation margin from a nonfinancial end-user counterparty as long as the covered swap entity's exposures to the nonfinancial end-user were below the credit exposure limits that the covered swap entity has established. (25)

Note that under this proposed rule, because the trigger is credit exposure to the dealer, an exempt end user could avoid posting margin by splitting positions among multiple dealers.

The end-user exemption has been controversial because it exempts a large class of traders from the requirement to post explicit margin. Large end users lobbied for the exemption on the grounds that their hedging transactions are implicitly offsetting risk on nonfinancial assets and the margin requirement would make such transactions more costly. Nevertheless, large derivative positions would expose counterparties to credit risk. Large firms would take derivatives positions correlated with their business, so failure of the end user would be correlated with failure to pay on the contract. If failure occurs due to losses in the line of business associated with the hedged asset, this correlation would be negative. But if failure occurred due to systemic stresses, it is possible that failure of the business and failure to pay on the contract could occur simultaneously. In any event, the end-user exemption creates the economic equivalent of an off-balance sheet transaction between the dealer and end user. The exemption also creates an incentive for end users to use noncleared, nonstandard contracts in order to obtain the exemption.

Suppose an end user enters into an exchange-traded contract. The resulting hypothetical balance sheet, including margin and financing, is depicted in table 5.3. Margin posted by the end user, M_E, is assumed to be debt financed. This captures the idea that a failure to pay variation margin trig-

Table 5.3 Hypothetical balance sheets for a firm transacting in a derivatives contract via a clearinghouse and posting margin for derivatives transaction that has a zero initial value

End user			
Assets		Liabilities	
Risky asset	A	Financing	A
Derivative	0	—	—
Cash (margin)	M_E	Debt	M_E

Notes: Firm has preexisting assets and financing of A. Assumes that margin is debt financed.

gers default. For example, suppose the firm has A of assets and financing, and posts margin of M_E. If the firm suffers a loss on the position of λM_E, it is obligated to pay that amount, or else it is in default. Entering into a derivative is analogous to a firm issuing short-term debt of M_E and investing the proceeds in a risky asset. Any failure to pay the loan due to a loss on the invested value would trigger default.

Table 5.4 generalizes table 5.3 to the case where there is an OTC contract and both the firm and dealer post margin. Both issue debt to finance margin. Each has an off-balance sheet asset, margin posted by the other, to offset exposure to the other. The resulting conceptual balance sheet is in table 5.4.

Finally, consider the case whether neither firm posts margin. Each has credit exposure to the other and thus, implicitly, each has made a loan to the other. The end-user exemption, by allowing firms to avoid posting margin, effectively permits off-balance sheet financing of the margin amount. (See table 5.5.)

The upshot is that the end-user exemption creates an obligation resembling an off-balance sheet loan that finances an implicit margin deposit. Exempt firms could report the amount of margin they would have posted in the absence of the exemption. This would permit consistent analysis of entity exposures and aggregate measures of derivatives activity.

5.6 Conclusion

The Dodd-Frank Act was intended to reduce systemic risks. A central goal of the legislation was to increase clearing of derivatives transactions, but at this point no one knows the consequences of new rules. In particular, we do not know

- how large clearinghouses will be,
- how many clearinghouses there will be,
- how international integration and resolution will function,
- how empirically important the end-user exemption will be, and

Table 5.4 **Hypothetical balance sheets for a firm and dealer transacting in an OTC derivatives contract, with both posting margin for a derivatives transaction that has a zero initial value**

Assets		Liabilities	
	End user		
Risky asset	A	Financing	A
Derivative	0	—	—
Cash (margin)	M_E	Debt (3rd party)	M_E
Dealer margin	M_D	*Exposure to dealer*	M_D
	Dealer		
—	—	Derivative	0
Cash (margin)	M_D	Debt (3rd party)	M_D
End-user margin	M_E	*Exposure to end user*	M_E

Note: Assumes that margin is debt financed.

Table 5.5 **Hypothetical balance sheets for a firm and dealer transacting in an OTC derivatives contract, with neither posting margin for a derivatives transaction.**

Assets		Liabilities	
	End user		
Risky asset	A	Financing	A
Derivative	0	—	—
Margin	M_E	*Debt (from dealer)*	M_E
Loan to dealer (margin)	M_D	*Exposure to dealer*	M_D
	Dealer		
—	—	Derivative	0
Margin	M_D	*Debt (from end user)*	M_D
Loan to end user (margin)	M_E	*Exposure to end user*	M_E

Note: Implicitly, each lends to the other.

- how much market-making business will flee traditionally regulated entities (e.g., banks subject to Basel III).

Whatever the new configuration of firms and markets, the push to central clearing will likely create new systemically important clearinghouses or related financial utilities, some of which will be too big or interconnected to fail. A critical question is what information will be useful across different possible future configurations of activity.

Frequent, disaggregated, public reporting of margin provides a mechanism that should help regulators and market participants assess the risk of aggregate positions and the effects of changes in the level of risk. It should help to assess the risks borne by clearinghouses, dealers, and large market participants. Such reporting would reveal which asset classes have the greatest risk exposure and potentially, depending on the level of disaggregation, which sectors have exposure to which risks (e. g., insurance companies writing credit default swaps).

References

Bank for International Settlements (BIS). 2011. "OTC Derivatives Market Activity in the Second Half of 2010." Technical Report. BIS, Monetary and Economics Department. http://www.bis.org/publ/otc_hy1105.htm.

Bolton, P., and M. Oehmke. 2011. "Should Derivatives Be Senior?" Unpublished Manuscript, Columbia University.

Brunnermeier, M. K., and L. H. Pedersen. 2009. "Market Liquidity and Funding Liquidity." *Review of Financial Studies* 22 (6): 2201–38.

CME Group Inc. 2010. "Annual Report." http://www.cmegroup.com/investor-relations/annual-review/2010/.

Department of the Treasury et al. 2011. "Margin and Capital Requirements for Covered Swap Entities (Notice of Proposed Rule-making)." Technical Report. Department of the Treasury.

Duffie, D. 2011. "On the Clearing of Foreign Exchange Derivatives." Working Paper, Graduate School of Business, Stanford University. http://dx.doi.org/10.2139/ssrn.1869065.

International Swap Dealers Association (ISDA). 2011. "OTC Derivatives Market Analysis Year-end 2010." Technical Report. ISDA.

McDonald, R. L. 2013. *Derivatives Markets*, 3rd ed. Boston: Pearson/Addison Wesley.