Macroeconomic Assessment Group on Derivatives

established by the OTC Derivatives Coordination Group

Macroeconomic impact assessment of OTC derivatives regulatory reforms

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A report prepared by the Macroeconomic Assessment Group on Derivatives

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Executive summary

In February 2013, the Over-the-counter Derivatives Coordination Group (ODCG) commissioned a quantitative assessment of the macroeconomic implications of over-the-counter (OTC) derivatives regulatory reforms to be undertaken by the Macroeconomic Assessment Group on Derivatives (MAGD), chaired by Stephen G Cecchetti of the Bank for International Settlements (BIS). The Group comprised 29 member institutions of the Financial Stability Board (FSB), working in close collaboration with the IMF. Guided by academics and other official sector working groups, and in consultation with private sector OTC derivatives users and infrastructure providers, the Group developed and employed models that provide an estimate of the benefits and costs of the proposed reforms. This report presents those findings.

Counterparty exposures related to derivatives traded bilaterally in OTC markets helped propagate and amplify the global financial crisis that erupted in 2008. Many of these exposures were not collateralised, so OTC derivatives users recorded losses as counterparty defaults became more likely or, as in the case of Lehman Brothers, were realised. Furthermore, since third parties had little information about the bilateral exposures among derivatives users, they became less willing to provide credit to institutions that might face such losses.

In response, policymakers have developed and are implementing reforms aimed at reducing counterparty risk in the OTC derivatives market. These include requirements for standardised OTC derivatives to be cleared through central counterparties (CCPs), requirements for collateral to be posted against both current and potential future counterparty exposures, whether centrally cleared or non-centrally cleared, and requirements that banks hold additional capital against their uncollateralised derivative exposures.

While these reforms have clear benefits, they do entail costs. Requiring OTC derivatives users to hold more high-quality, low-yielding assets as collateral lowers their income. Similarly, holding more capital means switching from lower-cost debt to higher-cost equity financing. Although these balance sheet changes reduce risk to debt and equity investors, risk-adjusted returns may still fall. As a consequence, institutions may pass on higher costs to the broader economy in the form of increased prices.

This report assesses and compares the economic benefits and costs of the planned OTC derivatives regulatory reforms. The focus throughout is on the consequences for output in the long run, ie when the reforms have been fully implemented and their full economic effects realised. The main beneficial effect is a reduction in forgone output resulting from a lower frequency of financial crises propagated by OTC derivatives exposures, while the main cost is a reduction in economic activity resulting from higher prices of risk transfer and other financial services.

These long-run benefits and costs depend on how the reforms interact with derivatives portfolios and affect the structure of the derivatives market more broadly, as this can significantly alter the amount of netting obtainable from gross counterparty exposures. In response, the Group analysed three scenarios that differ mainly in terms of the assumed degree of netting. The anticipated economic benefits and costs are summarised in the following table.

Macroeconomic benefits and costs of OTC derivatives regulatory reforms

Change in expected annual GDP after full implementation and effects of reforms; in per cent

	Low-costs scenario (high netting)	Central scenario	High-costs scenario (low netting)
Benefits[1]	+0.16	+0.16	+0.16
Costs[2]	–0.03	–0.04	–0.07
Net benefits	+0.13	+0.12	+0.09

[1] Reduction in output losses from financial crises, computed as the estimated decline in the probability of financial crises propagated by OTC derivatives exposures multiplied by the average cost of past financial crises. [2] Effect on GDP of higher prices of financial services, as evaluated by a range of macroeconomic models. The table reports the GDP-weighted median effect calculated by these models.

Briefly, the main benefit of the reforms arises from reducing counterparty exposures, both through netting as central clearing becomes more widespread and through more comprehensive collateralisation. The Group estimates that in the central scenario this lowers the annual probability of a financial crisis propagated by OTC derivatives by 0.26 percentage points. With the present value of a typical crisis estimated to cost 60% of one year's GDP, this means that the reforms help avoid losses equal to (0.26 x 60% =) 0.16% of GDP per year. The benefit is balanced against the costs to derivatives users of holding more capital and collateral. Assuming this is passed on to the broader economy, the Group estimates that the cost is equivalent to a 0.08 percentage point increase in the cost of outstanding credit. Using a suite of macroeconomic models, the Group estimates that this will lower annual GDP by 0.04%. Taken together, this leads to the Group's primary result: the net benefit of reforms is roughly 0.12% of GDP per year.

As one would expect, for the scenarios with higher and lower netting these net benefits are respectively slightly higher and slightly lower. Importantly, the Group concludes that the economic benefits are essentially constant across scenarios because the reforms demand collateralisation of the vast majority of net counterparty exposures, whatever their size. But shifting between netting and collateralisation does affect the estimated costs and hence the net benefits.

Uncertainties arising from a combination of modelling limitations and data scarcity were handled in a variety of ways. First, examining a variety of macroeconomic models helped the Group to improve the precision of estimates of the impact of the reforms' direct costs on the real economy. Second, by varying the structure of the network of bilateral OTC derivatives exposures within feasible limits as well as the strength of the relationship between losses on these exposures and the creditworthiness of the institution incurring them, the Group managed two other potentially large uncertainties. And finally, while some assumptions bias the results towards higher net benefits, many deliberately bias them in the other direction. For example, the funding costs of increased collateral and capital holdings were based on historical prices, rather than prices that reflect improvements in credit quality associated with these balance sheet changes.

In the course of completing the analysis reported here, the Group encountered a number of technical challenges. One related to a shortage of information about the structure of the OTC derivatives exposure network. In the absence of data on bilateral exposures, these were estimated using aggregate data and distributional assumptions. Conversations with derivatives users, infrastructure providers and regulators then helped to validate the estimated network. More generally, the Group found little prior analysis of how derivatives can affect the economy.

Despite statistical uncertainty and the need to make various modelling assumptions and to employ only the limited data available, the group concludes that the economic benefits of reforms are likely to exceed their costs, especially in the scenarios with more netting. Therefore, to maximise the net benefit of the reforms, regulators and market participants must work to make as many OTC derivatives as possible safely centrally clearable, with either a modest number of central counterparties or with central counterparties that interoperate. This should include efforts to harmonise the rules governing cross-border transactions, so that market participants have equal access to CCPs.

Part I – The macroeconomic impact of OTC derivatives regulatory reforms

1. Introduction

In February 2013, the Over-the-counter Derivatives Coordination Group[1] (ODCG) commissioned a quantitative study of the macroeconomic implications of OTC derivatives regulatory reforms in an effort to evaluate the combined effects of several such reforms developed in the wake of the 2008 global financial crisis. These include: (i) mandatory central clearing of standardised OTC derivatives, (ii) margin requirements for non-centrally cleared OTC derivatives; and (iii) bank capital requirements for derivatives-related exposures.[2]

To conduct the study, the Macroeconomic Assessment Group on Derivatives (MAGD) was formed. Chaired by Stephen G Cecchetti, Economic Adviser and Head of the Monetary and Economic Department at the Bank for International Settlements (BIS), the Group is composed of 29 member institutions of the Financial Stability Board (FSB). A list of those participating is in Annex 4.

The Group focused on the consequences of planned OTC derivatives reforms for output in the long run, ie once the reforms have been fully implemented and their full economic effects realised.

The primary anticipated benefit of the planned reforms is a reduction in forgone output arising from a reduced frequency of financial crises because of reduced counterparty risk, which limits the potential for losses to spread through the network of OTC derivatives exposures. This reduced counterparty risk is expected to follow from better collateralisation of OTC derivatives exposures (either through central clearing or through bilateral credit support agreements).

The main anticipated cost of the planned reforms is an increase in the price of risk transfer and other financial services that support economic activity, as financial institutions seek to recoup some of the direct costs of reforms. These costs include funding more collateral, financing a greater proportion of assets with equity and increased operational outlays, including central clearing fees. Throughout it is assumed that the cost of the bank's debt and equity does not fall as leverage, and hence risk, falls. Hence the cost estimates used in the analysis should be seen as an upper bound.

The scale of these benefits and costs depends on the amount of netting obtainable from gross counterparty exposures. This, in turn, will depend on how the reforms interact with derivatives portfolios and how they affect the structure of the derivatives market more broadly. To address this uncertainty, the Group analysed three scenarios with different degrees of netting. These are described fully in Section 3 below.

1 The ODCG comprises the Chairs of the Basel Committee on Banking Supervision (BCBS), the Committee on the Global Financial System (CGFS), the Committee on Payment and Settlement Systems (CPSS), the Financial Stability Board (FSB) and the International Organization of Securities Commissions (IOSCO).

2 See (i) CPSS-IOSCO (2012), FSB (2013); (ii) BCBS-IOSCO (2013); and (iii) BCBS (2011, 2012).

In identifying and assessing the main benefits and costs of the planned reforms, the Group benefited from consultations with OTC derivatives users and infrastructure providers, as well as academics and related working groups in the official sector. At a meeting at the Bank of England in London on 15 May 2013, members met with major dealers, central counterparties and end users of OTC derivatives, including non-dealer banks, asset managers and non-financial companies. Group members also had ad hoc discussions with individual derivatives dealers, infrastructure providers and end users, as well as with their industry groups. A summary of these discussions is in Annex 3. The Group is also grateful to a number of academics, listed in Annex 5, who provided guidance in the course of the work. Finally, the study benefited from the advice and previous work of other official sector working groups, notably in its analysis of the cost of reforms. In particular, this work drew on that of the BCBS-IOSCO Working Group on Margining Requirements (WGMR) and the Derivatives Assessment Team (DAT), set up by the ODCG.

The remainder of this report is divided into two parts. The first, comprising five sections, presents the analytical approach (Section 2), the impact scenarios (Section 3), the results (Section 4), caveats and impacts that are difficult to quantify using existing techniques (Section 5), and the conclusion (Section 6). This is followed in Part II with three chapters setting out the methods used for computing the benefits (Section 7), costs (Section 8) and macroeconomic modelling (Section 9).

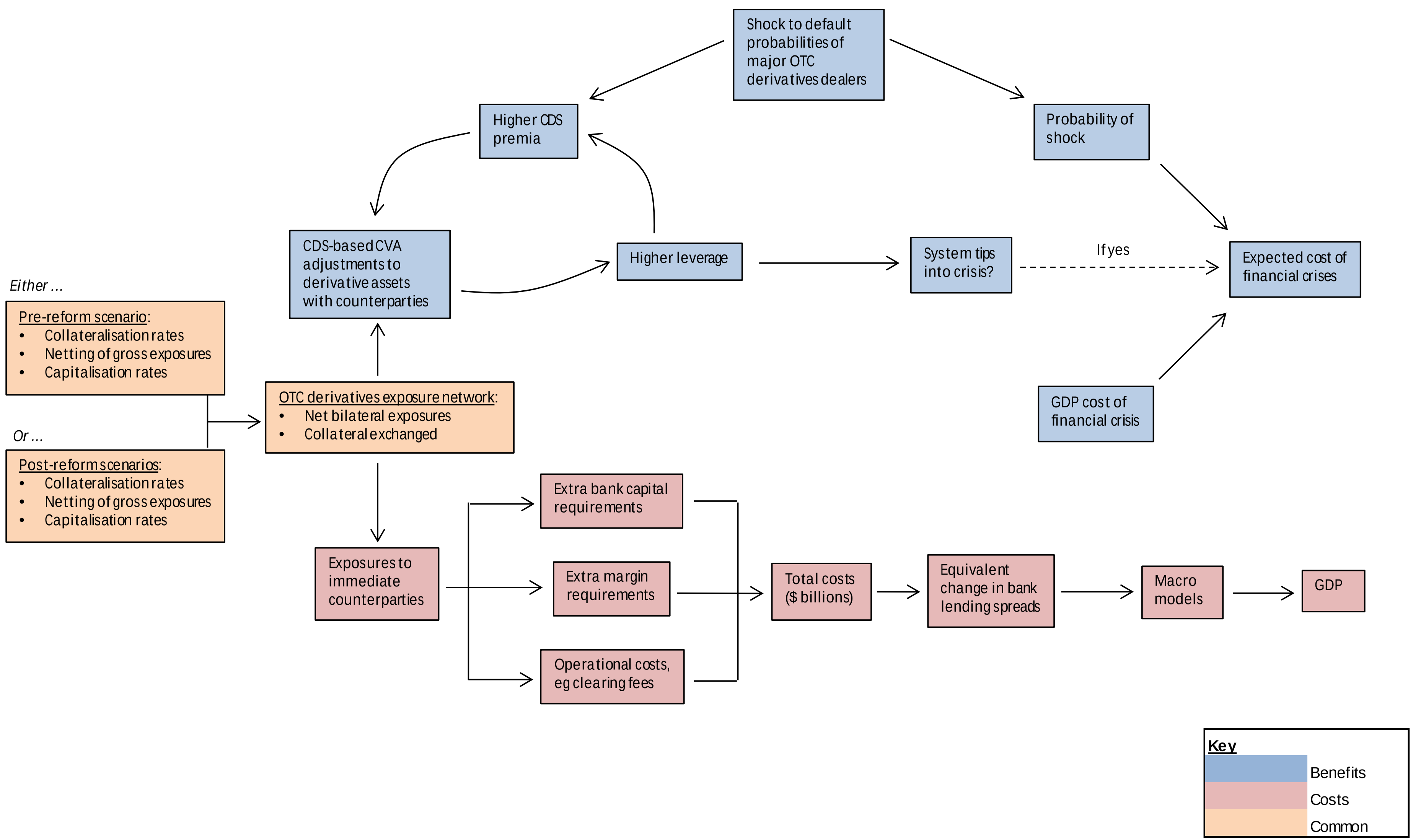
2. Analytical approach

Assessing the main benefits and costs of the planned reforms is best done by examining changes to GDP. With that in mind, the report estimates beneficial and costly changes in GDP that are expected to prevail after the reforms have been fully implemented and once any transitory effects on the structure of the OTC derivatives market and the broader economy have settled down. These long-run consequences are likely to dominate any transitory implications of the reforms for GDP, particularly because the reforms will be phased in gradually.

Graph 1 summarises how the main benefits and costs of reforms are linked to long-run GDP. The main benefit is the reduction in the likelihood of financial crises associated with strengthening the network of OTC derivatives counterparty exposures. Financial crises reduce GDP, so reducing their probability results in a benefit that can be measured as a reduction in expected GDP loss.[3] Section 2.1 describes the analytical approach to quantifying the benefit in more detail.

[3] The reforms may also reduce the severity of any given financial crises, but for simplicity the approach taken is to fix the size of the crises considered and quantify the reduction in probability.

Graph 1: Schematic of the analytical approach



The main costs of the proposed reforms to OTC derivatives markets reflect recurring expenses for users that arise from changes to their assets and liabilities. These include costs of financing a greater share of assets with equity as well as shifting the allocation of these assets more towards high-quality but low-yielding securities that are acceptable as collateral. These costs are subsequently passed on to the broader economy through the prices of financial services provided by these firms. The effect on GDP for a representative economy that is hit by the global average price change is examined in a range of macroeconomic models. Section 2.2 describes the analytical approach to quantifying these costs in more detail.

2.1. Benefits

To analyse the benefits of the reforms, consider an event that increases the default probabilities of several of the major OTC derivatives dealers. If the balance sheet consequences for the affected dealers and other financial OTC derivatives users are severe enough, it will result in a financial crisis. Once the crisis occurs, we know from a previous macroeconomic assessment of regulatory reforms (BCBS (2010)) that the median cost of such a crisis is about 60% of annual GDP.[4] The task at hand is then to estimate the probability that an event is severe enough to trigger a crisis.

The first step in this process is to establish the responses of counterparties to changes in the creditworthiness of the dealers. As the default probability of the directly affected dealers rises, their counterparties will incur mark-to-market losses in the form of an increase to the credit valuation adjustments (CVAs) applied to derivatives exposures. These losses occur even in the absence of an actual default. The losses then reverberate through the network of OTC derivatives exposures as follows: rising default probabilities lead to mark-to-market-losses which drive up leverage, thereby further increasing default probabilities.

As a technical matter, and as described in detail in Section 7, the likelihood of an event that drives up default probabilities in the first place is inferred from CDS premia. The relationship between these CDS premia and leverage is estimated from a regression that controls for other balance sheet characteristics besides leverage and adjusts for the effects on CDS premia of country-specific factors that influence expected credit losses. All of this information is used to help calibrate the cycle of increased default probability, CVA-based losses, rising leverage and increased default probability, which then repeats until the leverage of all institutions in the network converges on new stable values.

The network itself features 41 banks, including the 16 largest derivatives dealers often known as the "G-16 dealers", and is constructed to mimic the structure of the OTC derivatives market, with its highly interconnected "core" and less interconnected "periphery". The approach assumes that the G-16 dealers are exposed to one another with 100% probability, that G-16 dealers are exposed to other banks with 50% probability and that these other banks are exposed to one another with 25% probability. For each of these relationship types, bilateral exposures are spread proportionally across linked counterparties such that the total

[4] This is the median estimate of the present value of the cumulative output losses due to financial crisis from numerous studies reviewed in the BCBS (2010) report, some of which include crises where the level of output never returns to its pre-crisis trajectory.

OTC derivatives exposures of each institution are as reported in their financial accounts or regulatory filings.

Next, the Group has made a judgment about the leverage level of institutions in the OTC derivatives network that would cause a financial crisis. The larger the initial change in G-16 dealer default probability, the more financial institutions end up with leverage ratios above 40. This leverage level has caused financial stress in individual institutions in the past. When a sufficient proportion of institutions in the network have leverage ratios at or above this level, the financial system is assumed to tip into crisis.

Finally, the main effect of reforms is to collateralise the vast majority of exposures in the OTC derivatives network. This happens either as collateral is posted against bilateral exposures or as bilateral positions are shifted to central counterparties, which then demand collateral. Hence, reforms vastly lower CVAs held against these exposures and correspondingly increase the severity of events necessary to drive beyond the tipping point.[5] For a complete description of the analysis of the economic benefits of reforms, see Section 7.

2.2. Costs

The planned reforms will raise costs incurred by financial institutions in several ways. These include the costs of complying with new capital and collateral requirements and increases in operational expenses inherent in central clearing. To compute these costs, they are first aggregated into a total nominal amount for all financial institutions worldwide. The presumption is that these will be passed on to the broader economy in the form of higher bank lending rates relative to deposit rates. Following the methods used by the Macroeconomic Assessment Group (2010), a range of macroeconomic models was used to estimate the GDP consequences of the increase in credit spreads.

Additional bank capital requirements arise from the combination of the new CVA charge that will be levied against uncollateralised bilateral OTC derivatives exposures and the new charges against trade and default fund exposures to CCPs. Where these requirements bind, they will force banks to reduce their leverage and finance more of their assets with equity rather than debt. The Group estimates this additional financing cost as the difference between the cost of equity and the cost of debt, multiplied by the dollar value of the additional equity that will be required to meet the requirements imposed by the reforms. It is important to note that this estimate is an upper bound since it assumes that the cost of the bank's external funding, both for debt and equity, does not fall as leverage, and hence risk, falls.

Additional margin for OTC derivatives, whether because of new requirements for non-centrally cleared trades or reallocation of exposures to CCPs, is a second source of additional expense for financial institutions. The Group estimates this cost as the difference between the cost of funding the purchase of collateral-eligible assets and the interest received when they are posted as collateral, multiplied by the volume of extra collateral that will be needed under the reforms. Again, this estimate is an upper bound because it ignores the improved pricing of OTC

5 The reforms also require banks to hold more capital against potential future OTC derivatives exposures, but this is relatively inconsequential for the benefits analysis given the widespread collateralisation of exposures also introduced.

derivatives that is likely to follow from the reduction in counterparty risk due to increased collateralisation.

The direct cost of central clearing infrastructure is a third source of additional expense for financial institutions. This includes clearing and collateral management fees paid to CCPs. The Group estimates these costs from the known clearing fees and spreads on collateral already levied by major CCPs currently operating.

Summing these three costs – those from holding more capital, posting additional margin and facing additional clearing fees – yields the total nominal cost of the planned regulatory changes. Assuming that this cost is fully recovered from borrowers, it can be mapped into an increase in the lending spread. Using macroeconomic models, this is then converted into an estimate of the reduction in annual GDP.

3. Regulatory reform scenarios

At the time of writing, there remains considerable uncertainty about the way in which the reforms will change both the balance sheet management of financial institutions and the structure of derivatives markets. To reflect this uncertainty, the Group developed a number of scenarios that vary mainly in terms of central clearing and netting. These are summarised in Annex 2.

To formulate these alternative scenarios, a pre-reform baseline is required. This is based on the structure of the OTC derivatives markets as at end-2012. At that time, roughly 40% of the $480 trillion notional amount of outstanding OTC derivatives was cleared centrally.[6] The market value of these contracts was nearly $25 trillion, which generated $3.6 trillion of counterparty exposures. So, netting reduced counterparty exposures to 15% of market values on average. In the pre-reform baseline, it is assumed that multilateral netting associated with central clearing is often more effective at compressing counterparty exposures than bilateral netting. In particular, it is assumed that it is about four times more effective for derivatives dealers and banks, which are counterparties to the majority of outstanding positions.[7] For consistency with the overall compression of counterparty exposures to 15% of market values, this implies centrally-cleared exposures compress by a factor of about 20 while bilateral exposures compress by a factor of about five. As for margining, it is assumed that all current and potential future exposures are collateralised for centrally cleared positions. In contrast, current

6 These figures have been adjusted to reverse the doubling of contracts that occurs with central clearing. When bilateral counterparties, *A* and *B*, centrally clear a contract, this is replaced by an equivalent contract between *A* and a CCP and another equivalent contract between *B* and the same CCP. With double counting, the figures would be 55% and $633 trillion.

7 This is based on the BCBS-IOSCO (2013) QIS, in which respondents estimated that their initial margin requirements would be almost four times lower if their current bilateral positions (composed of multiple types of derivatives) were cleared with one CCP in each of the five broad classes of OTC derivatives, rather than remaining bilateral and paying initial margins on the same terms (10-day closeout period and no threshold).

exposures related to bilateral positions are assumed collateralised in about 60% of cases, while potential future exposures are not generally backed by collateral.[8]

Turning to the scenarios and reflecting the changes currently in train, we assume that central clearing will be much more widespread in the future. In particular, the products identified as clearable in the BCBS-IOSCO (2013) quantitative impact study (QIS) will all be cleared centrally. These include most OTC derivatives that are traded actively as well as those with payoffs that are linear in their reference assets. Compared with the pre-reform baseline, this raises the share of derivatives that will be cleared to about 60%.[9] In the 'low-costs' scenario, this rises further to about 70%, as central clearing expands to cover most remaining OTC derivatives with prices that do not change discretely either because of poor market liquidity or very non-linear payoffs.[10] In both of these scenarios, the gross exposures that shift onto CCPs are assumed to net four times more effectively than they did as bilateral exposures for derivatives dealers and banks and equally effectively for other OTC derivatives users. In the 'high-costs' scenario, the share of derivatives that will be cleared rises to about 60%, as in the central scenario, but the gross exposures that shift onto CCPs are assumed to net no more effectively than they did as bilateral exposures for all market participants.

Collateralisation of exposures is also assumed to rise considerably following the reforms. In part, this reflects the increase in central clearing. However, it also reflects the BCBS-IOSCO (2013) margin requirements for positions that remain non-centrally cleared. Simplifying somewhat, the post-reform scenarios extend requirements for daily variation margining and initial margins that cover potential future exposures (other than the first €50 million of exposure per counterparty) to all financial institutions. Non-financial institutions are assumed to be exempt from all of these requirements, and exposures related to physically settled foreign exchange (FX) forwards and swaps are assumed to be exempt from initial margin requirements.[11] The cost of funding collateral is assumed to vary across the post-reform scenarios. Compared with the baseline, it falls by 15 basis points in the low-costs scenario, is unchanged in the central scenario and rises by 24 basis points in the high-costs scenario.

To compare the baseline and the three scenarios, imagine that a dealer has OTC derivative contracts with a notional amount of $20 billion and a market value of $1 billion. In the baseline, $400 million of this amount is centrally cleared and $600 million remains in bilateral contracts. Across all of the dealer's counterparties, the $1 billion of market value reduces to $150 million of counterparty exposure. Because multilateral netting is assumed to be four times more effective than

8 The 2012 ISDA Margin Survey shows that 71% of OTC derivatives trades were subject to collateral agreements and that 83% of these required collateral to be posted in both directions. Focusing on derivatives dealers and banks, as is done in Section 7, and assuming that in one-way agreements these institutions post collateral (to non-financial companies and sovereigns), rather than receive it, this implies collateral posting in 60% of cases.

9 Or 75% with double-counting (see footnote 5). Separately, some market participants suggested that the OTC derivatives market might shrink somewhat as end users shift to exchange-traded products or hedged fewer risks (see Annex 3). Since the costs of non-hedged risks are not captured explicitly in the quantitative analysis of this report, the size of the market is held constant across its reform scenarios. However, this cost is discussed in qualitative terms in Section 5.

10 Or 80% with double-counting (see footnote 5).

11 While US regulators have exempted FX derivatives, other jurisdictions are still considering this issue.

bilateral netting, the $400 million is reduced by a factor of almost 20 to $21 million, while the $600 million falls by a factor of almost five to $129 million. Given the collateralisation assumptions in the baseline, the dealer receives $99 million ($21 million x 100% + $129 million x 60%) in collateral. Post-reform, the $150 million of counterparty exposure becomes $118 million in the central scenario, $102 in the low-costs scenario and remains unchanged at $150 million in the high-costs scenario.

In addition, the scenarios show the effect of new bank capital requirements relative to the baseline. First, there is the CVA requirement. This requirement demands that banks hold capital against potential falls in the market value of counterparty exposures due to declines in counterparty credit quality that stop short of default. Second, there is a new capital requirement for trade exposures to CCPs. In many cases, banks and CCPs have characteristics that would result in these exposures having a 2% risk weight. As a simplifying approximation, it is assumed that these exposures attract the 2% risk weight in all cases.[12] Third, there is a new capital requirement for exposures to CCP default funds. This requires banks to hold capital equal to their default fund exposures, although this is capped at 20% of their CCP trade exposures. Section 8 provides further detail on these new capital requirements.

4. Results

We now turn to the quantitative results, starting with the benefits, then turning to the costs and finally providing a comparison.

4.1. Estimated economic benefits of reforms

In the pre-reform scenario, it is estimated that an increase in the default probabilities of the G-16 dealers of 240 basis points or more forces at least two institutions into distress, generating a financial crisis. Using CDS spread data, the Group estimates that the annual probability of such an event materialising is 0.26%.[13] Given that the cost of a crisis is assumed to be 60% of annual GDP, the expected cost of OTC derivatives-induced crises in the absence of reforms is 0.16% of GDP.

In all post-reform scenarios, exposures were found to be sufficiently collateralised that no plausible increases in default probabilities could generate a financial crisis through OTC derivatives exposures. From this, the Group concludes that, following the implementation of the reforms, the probability of such a crisis is negligible (absent the remote possibility that a CCP fails), so the expected cost of crises propagated by OTC derivatives exposures is almost zero. Hence, the expected benefit of the reforms is around 0.16% of GDP.

[12] Although it is not yet clear which CCPs will qualify for this risk weight.

[13] The BCBS (2010) finds that across a range of advanced and emerging economies that the average probability of *all types* of financial crises is around 4.5% per year.

The estimated benefits from the regulatory reforms depend on the structure of the network, the sensitivity of bank CDS premia to leverage and the assumed crisis tipping point. As discussed in Section 7, using different networks consistent with available information, the benefits can vary between 0.13 and 0.22% of GDP. Variations in the sensitivity of bank CDS premia to leverage consistent with market prices can also generate different benefit estimates; in this case between 0.11 and 0.33% of GDP – with higher sensitivity resulting in larger benefits. Finally, if we assume that the leverage ratios of two additional G-16 dealers' must exceed the critical value of 40 before a crisis occurs, then the estimated benefits decline to 0.09% of GDP.

4.2. Estimated economic costs of reforms

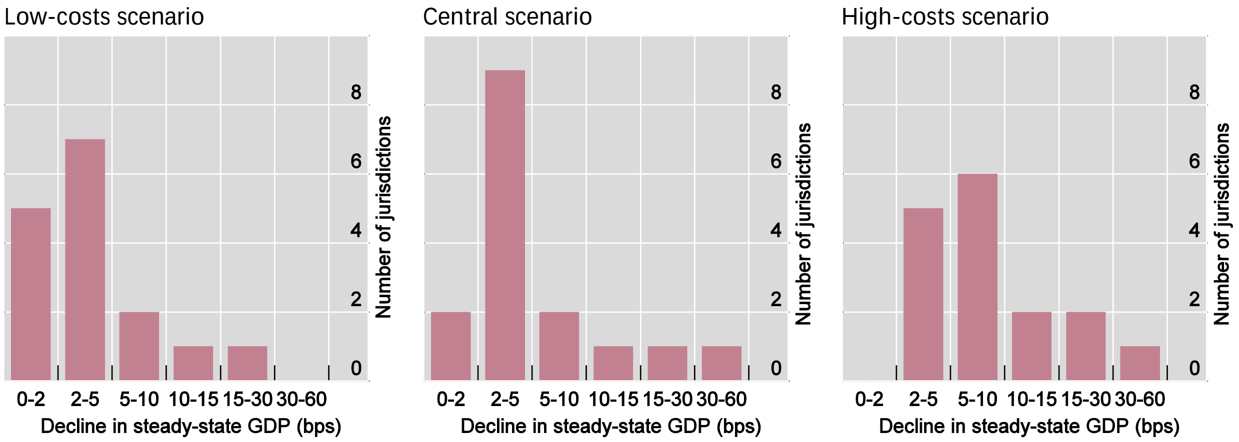
Turning to the costs, in the central scenario costs to institutions of the reforms are estimated to induce an 8 basis point increase in bank lending spreads. By comparison, in the low-costs scenario costs correspond to a 6 basis point increase in bank lending spreads, while in the high-costs scenario the increase in bank lending spreads is 13 basis points.

To assess the broader economic costs, MAGD members used macroeconomic policy models to examine the implications of these higher lending spreads for the steady-state level of GDP. In particular, jurisdictions generally used their main macroeconomic models that they typically employ for policy purposes. Results are presented in Graph 2 as the distribution of the percentage decline in steady-state GDP relative to the pre-reform scenario.

Macroeconomic costs

Decline in steady-state GDP, in basis points

Graph 2



Includes estimates for 16 jurisdictions.

Source: MAGD members.

In the central scenario, the reported declines in GDP in nearly all cases are less than 0.30% per year. In all but two cases the cost estimates are below 0.15%. In the low-costs scenario the declines in GDP are even smaller. Even in the high-costs scenario the cost for all but three cases are less than 0.15%, and most of the cost estimates remain below 0.10%.

4.3. Comparison of benefits and costs

Turning to a comparison of the benefits and the costs, Table 1 provides a summary. On the costs side, the central scenario estimates indicate that the increase in bank lending spreads will result in a median reduction of steady-state GDP of 0.04%. On the benefits side, the estimates indicate that the lower incidence of financial crises propagated by OTC derivatives exposures will lead to an expected increase in the GDP level of around 0.16%. As a result, the net benefit of the regulatory reforms is expected to be about 0.12% of GDP per year.[14]

Some MAGD members provided cost results using different types of macroeconomic models, including ones in which credit supply is very sensitive to lending spread increases. In some cases, these models had steady-state GDP declines in the high-costs scenario that were up to 0.35 percentage points higher than the results from the jurisdiction's standard model. This difference shows that, if credit supply is very sensitive to lending spread changes, the costs of reforms will be higher.

Macroeconomic benefits and costs of OTC derivatives regulatory reforms

Impact on long-run GDP, in per cent Table 1

	Low-costs scenario	Central scenario	High-costs scenario
Benefits[1]	+0.16	+0.16	+0.16
Costs[2]	–0.03	–0.04	–0.07
Net benefits	+0.13	+0.12	+0.09
Memo items:			
Mean costs (GDP weighted)[2]	*–0.05*	*–0.06*	*–0.10*
Mean costs (equal weighted)	*–0.05*	*–0.07*	*–0.12*
Median costs	*–0.03*	*–0.04*	*–0.07*

Based on results from 16 jurisdictions.

[1] Calculated as the impact on GDP due to financial crisis times the reduction of the probability of crisis. The assumed decline in GDP due to crisis is 60%, corresponding to the BCBS (2010) estimates of the present value of output losses due to a financial crisis. [2] Impact on GDP due to higher lending spreads. The GDP-weighted median/mean is calculated based on 2012 GDP in US dollars of the different reporting countries.

The quantified uncertainties with respect to both costs and benefits indicate that in most cases the benefits outweigh the costs. That said, cases can be found where this is not true. For example, if credit is very sensitive to lending spreads, economic activity will experience a larger decline. A second example is that if bank CDS premia are insensitive to changes in leverage, then reforms that reduce leverage will have little impact on counterparty exposures and hence on the probability of crisis. However, even in these cases the net costs are small compared to GDP.

[14] The modelling approach used by the Group is not sufficiently detailed to make macroeconomic impact assessments for specific jurisdictions.

5. Non-quantified consequences of reforms

As with any statistical exercise, especially one focusing on impact assessment, there are a number of uncertainties. In particular, there are a number of factors that may influence the impact of OTC regulatory reforms, but that are impossible to explicitly incorporate into the macroeconomic models used by Group members. The following discussion first describes a series of technical issues associated with netting efficiency, costs of indirect clearing, collateral availability, market liquidity and market volatility. It then turns to how changes in hedging practices, cross-border regulation, transparency and risk-taking behaviour could influence the impact of the reforms.

5.1. Netting efficiency

Central clearing allows CCPs to perform multilateral netting of exposures, thereby facilitating the reduction of counterparty risk. Multilateral netting is maximised when entire portfolios are cleared in a single location. In the analysis it is assumed that there is one CCP for each of the five main asset classes. Portfolio fragmentation, caused by splitting portfolios between centrally cleared and non-centrally cleared transactions or by splitting them between multiple CCPs, will reduce netting and thereby increase collateral costs. Links or interoperability between CCPs could increase the scope for multilateral netting, but may also introduce interconnection risks that could transmit a participant's failure across CCPs (CGFS (2011)).[15] More generally, to achieve the benefits of the regulatory reforms, the probability of CCP defaults must be maintained at essentially zero and hence competition between CCPs must not result in erosion of collateral standards and margining practices.

5.2. Cost of indirect clearing

Indirect clearing can allow access to CCPs for smaller market participants who are unable to meet CCP direct membership criteria (CGFS (2011)). Although clients could avoid the large fixed costs involved in direct clearing, they may face higher margin requirements and clearing fees imposed by the direct clearing member compared to those imposed by the CCP on the direct clearers themselves. These higher costs may deter socially valuable hedging.

5.3. Collateral availability

As the OTC derivatives market reforms are gradually being implemented globally, the imposition of central clearing requirements for standardised OTC derivatives and margin requirements for non-centrally cleared derivatives is expected to increase the demand for high-quality collateral for margining purposes. Any shortages of collateral during times of stress may put pressure on the pricing of high-quality assets and increase the costs of engaging in these transactions.

[15] Although inter-CCP exposures would be collateralised.

The Group's analysis assumes sufficient collateral will be available to fulfil the requirements of all (and not only OTC derivatives-related) regulatory reforms currently planned. This assumption is based on BCBS QIS data and studies and recent work undertaken by the Committee on the Global Financial System (CGFS (2013)), which suggests that concerns that regulation will lead to aggregate collateral scarcity appear unjustified. This does not rule out the possibility of temporary collateral shortages in some jurisdictions or for individual institutions. For example, temporary shortages may arise in countries where the amount of government bonds outstanding is low or when government bonds are perceived as risky.

5.4. Potential impact on market liquidity

The different regulatory requirements and associated compliance costs in different jurisdictions may lead to structural changes in the OTC derivatives activities of dealers, particularly in less liquid markets. Given the high concentration of the market, any changes in market-making practices precipitated by the requirements could have a significant impact on the pricing and liquidity of OTC derivatives markets. This could have particularly important effects in regional or local markets where fewer liquidity providers are present. Reductions in market liquidity and fragmentation of exposures would attenuate some of the benefits of the reforms.

5.5. Margining and market volatility

More comprehensive posting of collateral will strengthen the link between market price volatility and margining requirements. When market volatility is low, margin requirements will also be low, making it less costly to take risk using derivatives. As volatility rises (or is expected to rise) collateral requirements will increase. This may reduce the ability of some market participants to trade or maintain existing positions. This may further increase market volatility. A similar dynamic could materialise, albeit with the opposite sign, in periods when volatility decreases.

5.6. Changes in hedging practices

The Group has not been able to quantify the macroeconomic costs arising from changes in behaviour once the reforms are in place. These include the ability of dealer banks to alter their business models and practices in response to the new regulatory environment by reducing involvement in OTC derivatives market-making, lowering their use of OTC derivatives for hedging, choosing alternative hedging instruments (such as exchange-traded derivatives) and changing their asset-liability composition, or increasing their reliance on other fee-based income.

In some cases, end users rely on OTC derivatives to hedge market risks inherent in funding that they obtain from banks and elsewhere. For example, they might use FX derivatives to change the effective currency of their funding, or an interest rate derivative to switch their interest rate obligations from variable to fixed payments. In these cases, with loans and OTC derivatives packaged together, allocating reform costs to loans (one part of the package) instead of OTC derivatives (the other part) does not affect the estimates.

But in other cases, non-bank institutions use OTC derivatives to hedge business risks other than those associated with funding. In these cases, it is difficult to measure macroeconomic costs arising from the likely reduction in hedging activity. On the one hand, assuming no reduction in hedging and assigning the costs to banks' loan books may lead the Group to underestimate costs if reduced hedging activity by end users is more costly than what is reflected by increased loan spreads. On the other hand, it may lead to costs being overestimated if (i) derivatives users find less costly methods of controlling risk as the cost of OTC derivatives use rises or (ii) costs imposed on end users have smaller effects than those imposed on banks.

An important aspect which may balance out the macroeconomic costs of reduced hedging is that, in the pre-reform era, the costs of trading were unlikely to have fully reflected the risks imposed by these instruments on the financial system as a whole. In particular, neither the role of OTC derivatives markets as a channel of contagion for shocks (which is modelled in this exercise) nor the effects of opacity in this market (which is not modelled, but is discussed in Section 5.8) were reflected in market prices.

5.7. Cross-border regulatory uncertainties

As the regulatory regimes are gradually put in place there are indications of potential differences in the scope and application of OTC derivatives regulation across jurisdictions. There is a risk that overlaps, gaps or conflicts in the frameworks, if not properly addressed, could create the potential for regulatory arbitrage (migration of trading to certain jurisdictions), increase systemic risk and also lead to market fragmentation. At the time of writing, it is impossible to know what the consequences of these difficulties will be.

Among the cross-border issues in this category is the regulatory treatment of CCPs. For example, the European Market Infrastructure Regulation (EMIR) and the Commodity Exchange Act (CEA) as modified by the Dodd-Frank Act contain prescriptive rules that may prevent European/US banks from participating in third-country CCPs that are not currently recognised by the European Securities and Markets Authority (ESMA) or that are not currently registered as a Derivatives Clearing Organization (DCO) as per CFTC regulations.

The potential non-recognition of third-country CCPs could negatively affect Asian OTC derivatives markets as it could affect market liquidity, restrict participation and undermine price discovery. The extraterritorial application of regulatory frameworks could affect European and US banks' participation as these banks are already clearing members in Asian clearing houses and may be potentially shut out of certain business lines. Non-recognition could imply that some CCPs would be treated as non-qualifying, thereby attracting a much higher regulatory capital requirement for trade exposures and default fund contributions, which could act as a disincentive for OTC derivatives trading. Hence there is a risk that significant contributors to market liquidity may be forced to withdraw thereby making those markets shallower. The resulting impact on the price discovery process could also influence hedging decisions, which would adversely affect banks and corporates' ability to manage interest rate and other risks, thereby potentially increasing systemic risk.

5.8. Transparency

Opacity of a market gives rise to negative externalities. Existing OTC derivatives market opacity may, in some cases, have created incentives to execute too many transactions (see Acharya and Bisin (2013)). It may also have increased the risk of market illiquidity when counterparty risk uncertainty became more acute. In the past, this made it difficult to efficiently resolve defaulting derivatives dealers in the event of failure. As such, an additional benefit of the regulatory reforms not captured by the quantitative analysis is that, by helping reduce the concentration of counterparty risk, they may help lessen the too-big-to-fail problem related to systemically important banks. On the other hand, it is difficult to assess the risks for financial stability of new interconnections that arise from the need for indirect clearing and collateral transformation services.

One likely benefit of the reforms is that greater standardisation of products and lower counterparty risk will facilitate the comparison of pre-trade prices, which should improve competition and lead to more accurate price differentiation. The increased posting of collateral and use of central clearing also means that detailed information about individual counterparties becomes less important. In contrast, as more trades are moved onto CCPs it will become increasingly important to ensure that market participants have ongoing access to reliable information about the positions, risk management practices and financial health of the CCP.

5.9. Risk-taking and risk management practices

The regulatory reforms will not only reduce the risk of systemic financial crises quantified here, they are also likely to reduce the risk of less severe episodes of financial turbulence and of the failure of single financial institutions. They do this in two ways. First, minimum margin requirements are likely to make it less likely that risks build up within a financial institution without all main departments (treasury, risk management, back office, top management) realising it. The reforms may also indirectly lower the risk of financial instability due to poor internal controls at financial institutions.

And second, by reducing counterparty risk embedded in OTC derivatives, the reforms can help reduce price model risk. At present pricing models for derivatives take counterparty risk into account, but these risks are difficult to measure or calibrate and often call for subjective judgment. Therefore, reducing counterparty risk lowers this modelling risk, making it less risky to price and value derivatives.

6. Conclusion

This report presents the MAGD's findings on the macroeconomic impact of OTC derivatives regulatory reforms in the long run, ie when the reforms have been fully implemented and their full economic effects realised. As the expected benefits of having a more robust financial system are long-run they are compared with long-run costs. Across national estimates, the results suggest that the regulatory reforms are likely to have a small positive net macroeconomic impact.

As with any impact assessment, there are a number of uncertainties that could not be resolved in the modelling exercise. These fall into three main categories: (1) those related to the fact that the regulatory frameworks have not been finalised; (2) a lack of availability and access to actual bilateral exposure data related to OTC derivatives; and (3) a paucity of quantitative modelling techniques that allow for a joint analysis of the costs and benefits.

The analysis has been designed to capture the uncertainties surrounding the final design of the regulation by adopting a scenario approach. The use of regulatory scenarios has been combined with a diverse set of macroeconomic as well as network models.

The lack of availability and access to data has been particularly acute for the assessment of the reform benefits. It has not been possible for the Group, despite reaching out to both the official and the private sector, to obtain a complete set of data on the actual structure of the bilateral exposures (including net of collateral) related to OTC derivatives. To the extent possible, the network used has been calibrated to match existing available data.

Due to the tight timeline for the analysis it has not been possible to design, let alone implement, new quantitative models and techniques that consider the numerous benefits and costs of OTC derivatives regulatory reforms in a common analytical framework.

Despite the need to make various modelling assumptions and employ only the limited data available, the Group concludes that the economic benefits of reforms are likely to exceed their costs, especially in the low-costs and central scenarios. As central clearing is important to realising these benefits, regulators and market participants must work to make as many OTC derivatives as possible safely centrally clearable, with either a modest number of central counterparties or central counterparties that interoperate. This should include efforts to harmonise the rules governing cross-border transactions, so that market participants have equal access to CCPs.

Part II – Technical background chapters

7. Benefits

This report quantitatively assesses the economic benefit of the planned reforms in terms of a lower probability of financial crises arising from contagious losses in the OTC derivatives market. In particular, the analysis focuses on mark-to-market losses on bilateral exposures. Such losses played an important role in the 2008 global financial crisis and led to the introduction of the Credit Valuation Adjustment (CVA) capital charge (see BCBS (2011)).[16] Other benefits are discussed qualitatively in Section 5.

The model architecture is shown in the blue part of Graph 1. First, a shock is applied to the default probabilities of the G-16 dealers at the core of the OTC derivatives market. This triggers a cascade of mark-to-market losses that flows around the network of OTC derivatives counterparties. More specifically, counterparties with OTC derivatives exposures to the G-16 dealers increase the credit valuation adjustments (CVAs) that they apply to these exposures to reflect higher probabilities of default. This generates mark-to-market losses, which erode their equity and raise their leverage. Observing this, counterparties exposed to these institutions make their own CVA adjustments. Eventually, the cascade of losses comes to an end, but it leaves leverage in the financial system higher than before. If too many banks end up with too high leverage, this triggers a financial crisis, which has major economic costs.

The planned reforms reduce the likelihood of a financial crisis by lowering OTC derivatives exposures. This occurs both through collateralisation and through multilateral netting brought about by central clearing. Smaller exposures weaken the cascade of mark-to-market losses, which softens the increases in leverage that result from any given initial rise in G-16 dealer default probabilities, reducing the probability of a financial crisis. The benefit of reforms is calculated as the change in this probability, multiplied by an estimate of the GDP cost of financial crisis.

To implement the model, the main requirements are to: (1) construct a network of OTC derivatives exposures; (2) quantify a relationship between counterparty credit risk, mark-to-market losses and leverage ratios; (3) model the impact of changes in leverage ratios on default risk; and (4) calibrate the likelihood of the shock that brings the system to its “tipping point”. The methodologies used in each case are detailed in Sections 7.1 to 7.4, with Sections 7.5 and 7.6 providing results and sensitivity analyses.

Before turning to the analysis it is worth setting out the key variables that characterise the initial state of the network. These are summarised in Table 2. All data refer to the end of 2012, except for those firms with mid-year reporting dates.

[16] BCBS (2009) further notes (on page 28) that during the crisis “mark-to-market losses due to credit value adjustments (CVA) were not directly capitalised. Roughly two-thirds of counterparty credit risk losses were due to CVA losses and only one-third were due to actual defaults.”

Key variables used in analysing the benefits of reforms — Table 2

Variable	Description
Leverage ratio	Leverage is calculated as Tier 1 Capital / Total Assets. Total Assets includes derivatives exposures. For firms reporting on a US GAAP basis, these have been adjusted to include derivative assets gross of netting. Risk-weighted assets are not used due to difficulties encountered in compiling a comparable database.
Probability of default	Probability of default is inferred from CDS prices. CDS premia are a function of both probability of default and loss given default (LGD). Standard assumptions apply with LGD = 60%. But prices are also adjusted to take into account country-specific factors.[1]
Derivatives exposures	Derivatives exposures are reported as mark-to-market values (assets and liabilities) and notional amounts (total only), broken down into the following product types: interest rate, credit, equity, commodity, currency and other.

[1] Adjustments to CDS premia for country-specific factors are described in Appendix 7.c.

Source: MAGD.

7.1. Constructing the network of OTC derivatives

Data on the set of bilateral exposures between all (or indeed any) players in the OTC derivatives market are not publicly available. It is therefore necessary to estimate a set of bilateral exposure matrices using some of the aggregate data highlighted in Table 2. Decisions have to be taken as to which actors to include in the network, and what methodology to use in populating the matrix of bilateral exposures.

Choice of network nodes

Prior research reports that the OTC derivatives market is concentrated, with a "core" set of participants dominating a so-called "periphery".[17] This suggests that, on an intra-financial basis, we do not need to extend the net too wide. In total, 41 banks and one central clearing counterparty (CCP) per asset class are included in the pre-reform network. The CCPs are not stressed for resilience (ie their default probabilities are assumed constant) and therefore are unnamed, playing a proxy role for the industry as a whole. The list of banks has been compiled to include: the G-16 dealers, other dealers identified as having significant interaction with CCPs, and a number of other banks to represent individual jurisdictions (Table 3). Note that no non-financial counterparties are included in the network. The focus of the benefits exercise is to examine contagion in the OTC derivatives market and, since non-financial firms lie in its periphery, they are of secondary concern in this regard.

[17] See Craig and von Peter (2010), Markose (2012), Langfield, Liu and Ota (forthcoming).

Institutions in the network of OTC derivatives exposures Table 3

G-16 dealers	Other dealers/banks
Bank of America Merrill Lynch	ANZ Banking Group
Barclays	Banca IMI SpA
BNP Paribas	Banco Santander
Citigroup	Bank of China
Crédit Agricole	Bank of New York Mellon
Credit Suisse	BBVA
Deutsche Bank	Commerzbank
Goldman Sachs	Commonwealth Bank
HSBC	Danske Bank
JP Morgan Chase	Dexia
Morgan Stanley	DZ Bank
Nomura Group	Group BPC
Royal Bank of Scotland	Intesa
Société Générale	LBBW
UBS	Lloyds Banking Group
Wells Fargo	Mitsubishi UFJ
	Mizuho
	National Australia Bank
	Nordea Bank
	Rabobank
	Standard Chartered
	State Street
	Unicredit Group
	WestLB
	Westpac

Source: MAGD.

Estimating bilateral connections

The standard approach in the literature for populating bilateral exposure matrices is to use maximum entropy methods. These methods aim to ensure that identified aggregate exposures are distributed as evenly as possible across the network. Intuitively, and particularly for networks where concentrations in exposure exist, this approach is likely to underestimate contagion.[18] Various alternative techniques have been developed to improve upon maximum entropy,[19] but the primary innovation is to impose priors on the network, with the aim of moving it towards the "true" state of the world. For the purpose of this exercise, these priors are expressed in the form of the following "connectivity" assumptions:

- The G-16 dealers have exposures to one another with probability 100%.
- The G-16 dealers have exposures to other dealers with probability 50%, and vice versa.
- Other dealers have exposures to one another with probability 25%.

These priors apply to all scenarios and aim to capture the spirit of the "core-periphery" structure mentioned previously. But they are necessarily arbitrary and it is therefore necessary to assess the sensitivity of the results to these priors; the

[18] See Guerrero-Gómez and Lopez-Gallo (2004) and Mistrulli (2011).

[19] See Halaj and Kok Sorensen (2013).

results of this analysis are presented in Section 7.6. The networks have been designed taking into account input from market participants and supervisors.

Alongside the "connectivity" priors, two further sets of decisions are required to estimate the network. The first relates to the proportion of derivatives exposures assumed to be centrally cleared. This will vary according to the scenarios and data set out in Annex 2. Table 4 summarises the resulting assumptions. The scenarios further differ according to the number of players affected: pre-reform, the clearing assumptions are assumed to apply only to current clearing members; post-reform, they are applied to all participants in the network.

Proportions of OTC derivatives assumed centrally cleared

In per cent | Table 4

Product	Pre-reform[1]	Post-reform[2]		
		Central	Low costs	High costs
Interest rate	50	70	75	70
Credit	20	55	60	55
Equity	0	55	70	55
Commodity	10	50	80	50
Currency	0	15	20	15

[1] Pre-reform, clearing proportions apply only to current clearing members. [2] Post-reform, clearing proportions apply to all participants in the network.

Source: MAGD.

Given these assumptions, five separate networks are estimated, one for each of five product types (interest rate, credit, equity, commodity and currency) with the "other" category excluded. In each case, the network is estimated under "relative entropy", in which case exposures are spread evenly subject to the "connectivity" priors described above. Importantly, the estimation ensures that the sum of each firm's bilateral assets and liability exposures for each product type matches its aggregate position.

The second decision then relates to the netting benefits available to market participants. In the pre-reform scenario, it is assumed that all bilateral exposures belong to the same netting set. This implies a very high level of netting, so that the resulting net exposures can be regarded as a lower bound. Net exposures are calculated for each product and bilateral relationship as the maximum of assets minus liabilities and zero; this produces numbers in line with the assumptions set out in Section 3. These are then augmented by an add-on as specified by BCBS guidelines, which limits the degree of netting to no more than 60%.[20] Netting assumptions for the post-reform scenarios are consistent with the guidelines set out in Annex 2.

[20] See www.bis.org/publ/bcbs128d.pdf.

7.2. Quantifying mark-to-market losses and changes in leverage

Contagion hinges upon the relationship between counterparty credit risk and leverage ratios. Central to this relationship is the CVA, which aims to reflect the impact of each firm's counterparties' credit risk upon the true valuation of its (derivative) assets.[21] In general, the CVA attributed to a portfolio of bilateral exposures, $x_{ij}(p)$, of firm *i* to firm *j* for product, *p*, with average maturity of *T* days and daily marking to market is assumed to take the following form:

$$CVA\left(x_{ij}(p), PD_j\right) = LGD \times PD_j \sum_{t=1}^{T} DF_t EE_{ijt}(p) \quad (1)$$

Where $EE_{ijt}(p)$ is *i*'s expected exposure to firm *j* with respect to product *p* at time *t*, DF_t is the risk-free discount factor, PD_j is the probability that counterparty *j* defaults at time *t* conditional on it not having previously done so and LGD is the percentage loss-given-default. Note that, for the sake of simplicity, the conditional probability is assumed to be invariant to time. The LGD is further assumed to be constant, at a level of 75%.[22]

Maturity and volatility assumptions for expected exposures

Table 5

Product	Maturity[1] (in years)	Volatility[2] (annualised, in per cent)
Interest rate	3.7	1.1
Credit	3.0	1.9
Equity	2.3	10.1
Commodity	1.8	1.1
Currency	1.8	6.1

[1] Average maturity for each product is inferred from the BIS semiannual survey of derivatives. [2] Volatility for each product is implied by information provided by the BCBS-IOSCO QIS (confidential).

Sources: BIS and MAGD calculations.

The main difficulty lies in calibrating the expected exposures, *EE*. The technical details are relegated to Appendix 7.a. Importantly, these are calibrated for each <u>type</u> of exposure and rely on estimates of the maturity, *T*, and volatility of exposures, σ.[23] Details of these estimates can be found in Appendix 7.b. The results are set out in Table 5. An additional assumption relates to the proportion of exposures against which variation margin is posted under the pre-reform scenario. A figure of 60% is assumed based on the 2012 ISDA Margin Survey, which found that 71.4% of trades are covered by collateral agreements, of which 83.9% are two-way. For this proportion it is assumed variation margin is posted daily.

From equation (1) it follows that shocks to PD lead to changes in the CVA. Any such changes are immediately equated with mark-to-market losses. So let $L_i(\Delta PD_j)$ denote the losses incurred by firm *i* in response to a change in firm *j*'s PD. Then:

[21] Thus the CVA is defined as the difference between the default-free portfolio value of assets and its true market value.

[22] Given that OTC derivatives rank *pari passu* with senior unsecured debt, this LGD might appear relatively high. Yet, in the case of Lehman Brothers, the settled recovery rate was only around 9% (see Gregory (2012), page 211).

[23] Note that the volatilities are calibrated per unit nominal exposure.

$$L_i(\Delta PD_j) = \sum_p CVA(x_{ij}(p), \Delta PD_j) \quad (2)$$

Total losses in each round for firm *i* are calculated by aggregating equation (2) across all counterparties, *j*. These losses in turn impact firm *i*'s leverage ratio as they are subtracted both from its pre-existing capital (*K*) and its assets (*A*), that is:

$$K_i \longrightarrow K_i - \sum_j L_i(\Delta PD_j) \quad and \quad A_i \rightarrow A_i - \sum_j L_i(\Delta PD_j) \quad (3)$$

7.3. Modelling the impact of leverage on default risk

The change in leverage ratio for each firm *i* conditional on a vector of shocks to the PDs of its counterparties is given by equation (3). Note that in this chapter the leverage ratio (LR) is defined as K/A. The next task is to assess what this change in leverage ratio implies for the firm's own default probability. There are two obvious approaches for doing so. The first is to specify a fully-fledged credit risk model for each firm. The second is to estimate a relatively simple empirical relationship between PDs and leverage ratios based on cross-sectional data, specifically using CDS premia.

The first of these options is preferable, but modelling credit risk is notoriously challenging. There is a large class of so-called structural models based on Merton (1974). But in their most tractable forms, Merton-type models are likely to prove deficient not least because they are not generally designed to accommodate the balance sheet structure of banks. And to modify such models for the specific characteristics of all 41 banks in the network would be beyond the scope of the exercise. A further problem lies in the fact that there is no reason to believe that Merton-based PDs will match the CDS premia that are necessarily used to calibrate the likelihood of shocks to PDs (see Section 7.5).

The second option is not without its drawbacks either. By construction, the sensitivity of the probability of default to the leverage ratio will be equal across institutions, while there may be good reasons for this to vary. Equally, CDS prices may reflect a number of firm-specific characteristics that are impossible to adjust for accurately in the absence of a detailed credit risk analysis; without doing so, any cross-sectional regression results may be biased. On the positive side, this option is pragmatic, simple and transparent.

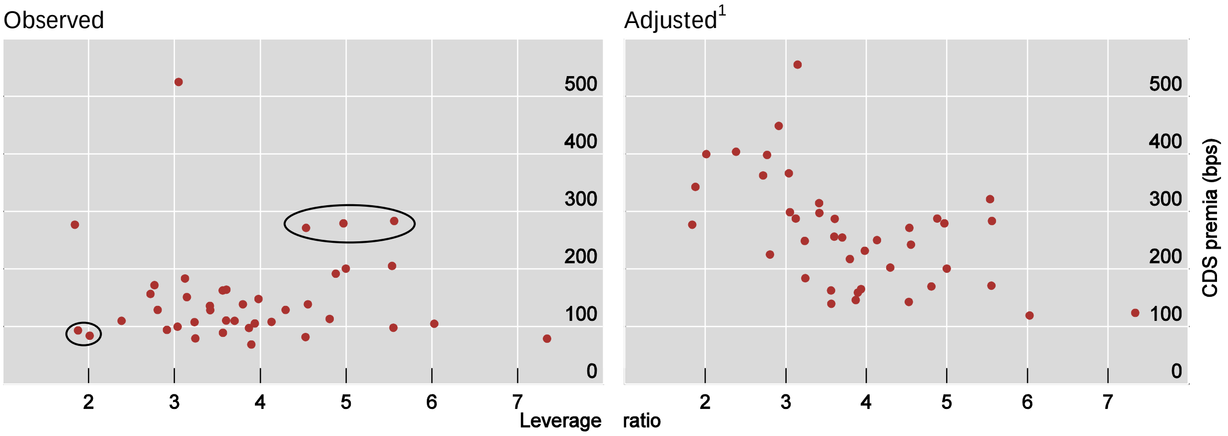
The approach taken in this exercise is to combine elements of both options. Specifically, a cross-sectional approach is used, but with two modifications: the first to reflect that CDS premia are likely to incorporate country-specific factors, and the second to allow for idiosyncratic influences upon the relationship between PDs and leverage ratios, as implicit in the Merton model.

The necessity of the first of these adjustments is easily illustrated by an examination of the raw data. The left-hand panel of Graph 3 plots observed CDS premia for the network of firms against their leverage ratios. Intuitively, higher leverage ratios (more capital) should be accompanied by lower CDS premia. Viewed on this cross-sectional basis there is a positive, albeit diffuse, relationship between the two.

One possible explanation for this pattern is that expected losses implicit in these prices are lower for some countries than for others. Consistent with this, the two observations highlighted towards the bottom left-hand corner of the plot, where CDS premia appear low relative to respective leverage ratios, relate to banks domiciled in Germany and Switzerland. These countries are perceived as having particularly low credit risk. In contrast, the three observations highlighted towards the top right-hand corner, where CDS premia appear high relative to leverage ratios, belong to banks located in Italy and Spain. These countries are perceived as having higher credit risk.

Bank CDS premia and leverage

Graph 3



[1] Adjusted data are derived using the methodology set out in Appendix 7.c.

Source: MAGD calculations.

In order to use the cross-section of CDS premia to derive a relationship between firms' PDs and their leverage ratios, it is essential to correct for this bias. The right-hand panel of Graph 3 shows the result of one such approach, in which all CDS prices are multiplied by a scalar that aims to reflect country-specific influences over market PDs and/or LGDs. This is necessarily a somewhat judgmental exercise, and the size of the multipliers will impact the resulting sensitivity of PDs to leverage ratios. Consequently, results are presented in Section 7.6 for a range of multipliers. The methodology used to extract these multipliers from the data is described in Appendix 7.c.

The plot of the adjusted CDS premia in Graph 3 offers a much more intuitive pattern than the observed data – with CDS premia clearly falling as leverage ratios increase. Even then, however, there is significant variation amongst banks. To take account of this, a regression is estimated to include the equity volatility, σ_E, of each firm, specifically in the form:

$$CDS = 3.7562 - 0.4001.LR + 0.0108.\sigma_E \qquad (4)$$

Further details as to the properties of this regression alongside the results of alternative specifications are provided in Appendix 7.d. Note that, given CDS prices are approximately equal to PD x LGD, where these terms should now be comparable across banks, the coefficient level of –0.40 has to be divided by the standard LGD assumption of 60%. This produces a sensitivity of PD to leverage in the region of –0.67. This implies that every fall in the leverage ratio of 1 percentage point raises adjusted CDS prices by 40 basis points and default probabilities by 67 basis points.

7.4. Calibrating the incidence of shocks that "tip" the system

The outstanding task is to characterise what it means for the system to "tip" into an unstable state and to calibrate the probability of shocks arising to bring it to that condition. Two candidate metrics arise from the literature:

- To class the system as unstable if the system losses experienced as a result of the shock exceed a certain proportion of the available capital to absorb them.
- To class the system as unstable if the number of firms experiencing distress, as defined by a particularly low leverage ratio, reaches a certain threshold.

In both cases, it is necessary to define a threshold number that demarcates a crisis period from normal times, which is inevitably judgmental. To mitigate this, the approach taken in this paper is to rely also on the trajectory of the relevant metric. In practice, this implies a particular focus on the second metric as defining the "tipping point". So let the size of shock required to push the system into instability be denoted by Z^*. In order to qualitatively demonstrate the benefit of the OTC derivatives reform, it is necessary only to show that – post-reform – the aggregate shock at which the system becomes unstable – denoted by Z^{**} – is much larger than the initial level, Z^*. But to quantify this benefit, specifically in terms of the impact on GDP, it is necessary to transform Z^{**} and Z^* into probabilities of crises.

To do this, the first decision is to identify the time period over which the shock is envisaged as hitting the system. Since the shock is supposed to precipitate the onset of a crisis, rather than reflect its impact, the time horizon is chosen as relatively short, namely three months. The next task is to translate Z into a variable that can be readily observed – specifically, to translate PDs into CDS prices. To do this, the PD shock is first multiplied by 60% to give a standardised equivalent shock to CDS premia and then discounted by the country multipliers to give firm-specific trigger points, Z_i^*. Letting n denote the number of firms to which the "aggregate" shock applies, all that remains to do is to calibrate:

$$\mathbb{P}\{Crisis\} = \mathbb{P}\{\Delta CDS_1 > Z_1^*,\ \Delta CDS_2 > Z_2^*, \dots, \Delta CDS_n > Z_n^*\} \tag{5}$$

Computing (5) requires further assumptions about the tendency of firms' CDS prices to move together. The methodology used is to join together an empirically inferred set of (normalised) univariate probability distributions of daily changes in CDS prices for each of the n banks using a "t-copula". This embodies a set of parametric assumptions about the dependence structure between the n distributions; specifically, the copula is characterised entirely in terms of two parameters: (i) an n x n correlation matrix and (ii) a number of degrees of freedom, represented as a scalar.

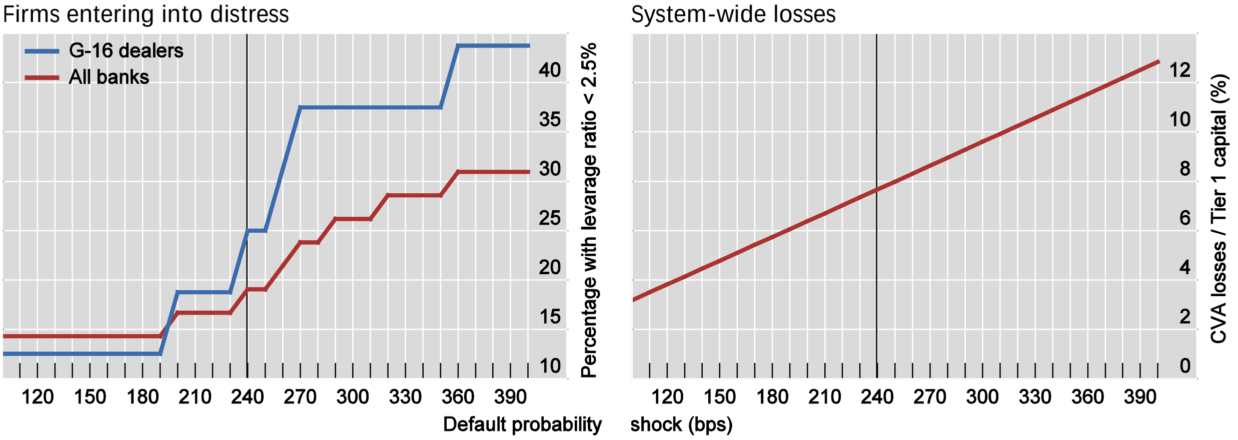
The copula is used to simulate a large number of synthetic data points based on the best-fit correlation matrix and degrees of freedom parameter. These data points are then used to construct distributions around changes in CDS premia at a three-month horizon by successively drawing and summing randomly reordered groups of coincident observations of daily changes. $\mathbb{P}\{Crisis\}$ is then calculated as being equal to the number of instances where, over one year, the changes in CDS premia simultaneously exceed the trigger points, divided by the number of simulations.

7.5. Main results

The results for the pre-reform scenario are shown in Graph 4. The left-hand panel shows the percentage of G-16 dealers and all banks with leverage ratios below 2.5% across a range of PD shocks for the baseline network specification.[24] The tipping point is identified at 240 basis points, when the number of G-16 dealers with leverage ratios below 2.5% reaches four, or 25%, and at which point any subsequent shocks lead to a significant rise. At this point, the percentage of all banks in the network with leverage ratios below 2.5% has reached 19%, while system-wide losses as a percentage of Tier 1 capital are in the region of 7.7% (see right-hand panel). This tipping point corresponds to an annual crisis probability of 0.26%. Assuming crises cost 60% of pre-crisis GDP, this translates into a GDP impact of 0.16%.

Pre-reform scenario impact of a default probability shock

Graph 4



Source: MAGD calculations.

The results for the post-reform scenarios are shown in Graph 5. The left-hand panel of Graph 5 shows the system-wide losses for each of the post-reform scenarios. In all three instances, losses are reduced to immaterial levels. This is a result of the significant reduction in expected exposures, which allows little scope for losses associated with CVA charges. The probability of crisis related to OTC derivatives exposures is therefore found to be negligible. Moreover, for none of the shock probabilities considered does the number of G-16 dealers with leverage ratios below 2.5% rise above three (compared to the pre-reform tipping point of four at 240 basis points).

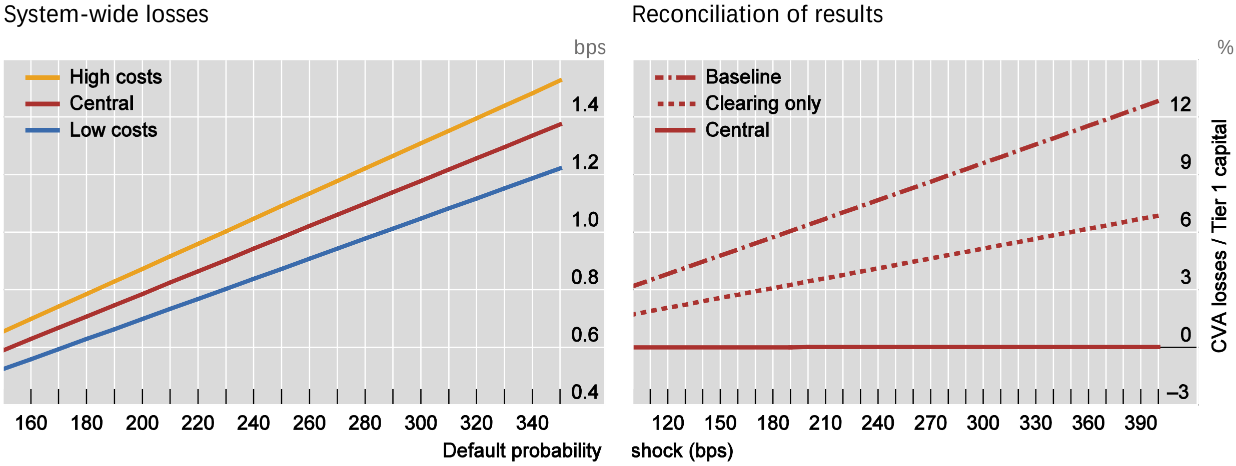
The right-hand panel of Graph 5 shows the importance of central clearing and increased collateralisation as drivers of the difference between the pre-reform results and the results for the central post-reform scenario. The increase in central clearing reduces contagion losses by around 50%. Collateralisation does the rest.[25]

[24] As we are using probabilistic networks, we show the average results based on 100 draws of the network.

[25] There are no modeled benefits from increased capital because the analysis focuses on intra-financial exposures. These exposures must be collateralised post-reform and hence have very low capital charges. Where threshold exemptions would apply to initial margin, the benefit of capital charges is proxied by assuming exposures are fully collateralised. Higher capital levels would help

Post-reform impact of a default probability shock

Graph 5



Source: MAGD calculations.

7.6. Sensitivity analysis

Considered below are the sensitivity of the results to the choice of the bilateral exposure network, the sensitivity of CDS premia to leverage and the choice of crisis tipping point.

Network

As mentioned in Section 7.1, one major source of uncertainty relates to the choice of the network connectivity priors. The left-hand panel of Graph 6 shows the range of tipping points across simulated networks for three sets of priors: (i) the baseline, in which the G-16 dealers are connected with each other with probability 100%, with other dealers with probability 50%, leaving other dealers to be connected to one another with probability 25%; (ii) a more "sparse" degree of connectedness, with respective probabilities (100%, 25%, 10%); and (iii) a more "dense" degree of connectedness with probabilities (100%, 75%, 50%). Since these are probabilistic networks, we show both averages and ranges of results based on 100 draws for each type of network (see left-hand panel in Graph 6).

For the baseline networks we find an average tipping point of 240 basis points. For the sparse networks we find an average tipping point of 220 basis points. These are less resilient due to exposures being less diversified. The dense networks have an average tipping point of 250 basis points. This type of network is more resilient due to the greater diversification of counterparty exposures. These three average

to mitigate credit risk with non-financial counterparties, but this is not included in the quantitative benefits analysis.

tipping points give a range for the probability of crisis from 0.37 to 0.22%. The corresponding range for the impact of a crisis is 0.13–0.22% of GDP.

CDS premium sensitivity to leverage

Another source of uncertainty relates to the relationship between CDS prices and bank leverage. The right-hand panel of Graph 6 summarises the sensitivity of the baseline results to the country-specific CDS multipliers. A range of multipliers are considered where these impact the sensitivity of PDs to changes in the leverage ratio (see Appendix 7.c).

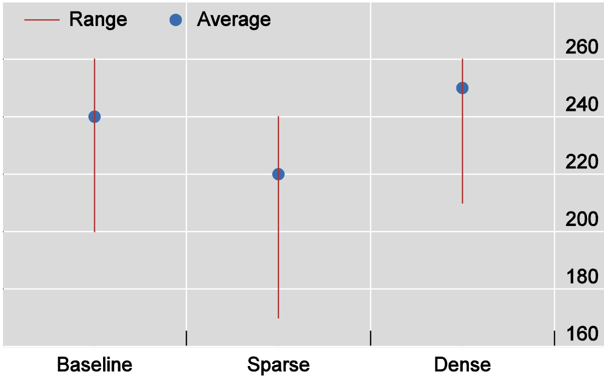
Choosing 10% lower multipliers reduces this sensitivity and dampens contagion. The tipping point, however, is unchanged. With lower multipliers a given tipping point requires larger moves in observed CDS premia as the market expected losses are implicitly lower. In this case, the crisis probability is found to be 0.19%. Conversely, choosing 10% higher multipliers raises the sensitivity of default probabilities to the leverage ratio. This lowers the tipping point to 230 basis points; the resulting crisis probability is significantly higher than the baseline case, at 0.55%, accentuating the increased potential for contagion the greater weight market participants attach to leverage ratios when assessing default risk. This analysis puts the GDP impact in the range of 0.11–0.33%. The central case remains at 0.16% of GDP.

Key sensitivities

In basis points[1]

Graph 6

Network sensitivities[2]



Regression sensitivities

	Baseline	Low sensitivity	High sensitivity
Impact on adjusted CDS of 1 percentage point fall in LR	+40	+36	+44
Tipping point	240	240	230
Crisis probability (%)	0.26	0.19	0.55

[1] Unless otherwise indicated. [2] Vertical lines show ranges of results from multiple simulations; markers show the averages.

Source: MAGD calculations.

Crisis tipping point

The assumed baseline tipping point for a crisis to occur corresponds to four out of the 16 main dealers having critically low leverage ratios. If the tipping point is increased to six out of the 16 main dealers, the corresponding CDS threshold increases from 240 to 270 basis points. The crisis probability declines from 0.26% to 0.15% and the GDP impact declines from 0.16% to 0.09%.

Appendix 7.a – Calculation of expected exposures

Expected exposures are calculated in a similar way for each product type, differing only in the maturity and volatility assumptions set out in Table 5. So for any product type, let X_t denote the scale-free counterparty-risk-free mark-to-market value of a derivatives exposure. It is assumed that X_t follows a random walk with zero drift and normally distributed innovations:

$$X_t = X_{t-1} + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma^2), \quad \epsilon_t \text{ are iid}$$

The current value of the exposure, X_0, is found for each product *per unit notional* by dividing each firm's aggregate product exposures, *x*(*p*), by the estimated notional exposure to that product.[26] This is denoted by the scaling factor, α. Thus in the following, *EE*'s refer to *per unit notional* expected exposures. To derive *EE* numbers for use in equation (1), these are simply multiplied by the firm's actual exposure to its counterparty, x_{ij},, divided by the scaling factor, α.

Solution for EE with no margins

In the absence of margins, the expected exposure at any future point in time, *t*, is given simply by the expected maximum positive value of X_t , ie:

$$EE_t = \mathbb{E}[\max\{X_t, 0\}]$$

The argument in the expectation is a censored normal, where the normal has mean α and variance $\sigma^2 t$. It follows that:[27]

$$EE_t = \alpha\Phi\left(\frac{\alpha}{\sigma\sqrt{t}}\right) + \sigma\sqrt{t}\phi\left(\frac{\alpha}{\sigma\sqrt{t}}\right)$$

Here $\Phi(.)$ and $\phi(.)$ are the cumulative density and probability density functions of the standardised normal distribution respectively.

Solution for EE with margins

With daily variation and initial margins, the proposition looks rather different. The variation margin represents the mark-to-market value in the previous period $t - 1$, ie $VM_t = \max\{X_{t-1}, 0\}$, and is itself time-varying. The initial margin, meanwhile, is calculated as a one-off charge, based on an *n*-day margin period of risk, such that: $\mathbb{P}\{X_n - X_0 > IM_n\} = 0.01$. Following BCBS standards, *n* is assumed equal to 10 days.

In this case, the current value of the exposure no longer enters the equation; as a result the expected exposures are homogenous of degree one, ie $EE(\sigma) = \sigma EE(1)$. The following is therefore predicated on the assumption that $\sigma = 1$. *EE* is given by:

$$EE_t = \mathbb{E}[\max\{\mathrm{X_{t+n}} - \mathrm{VM_t} - \mathrm{IM_n}, 0\}]$$

The solution to this is significantly more complex than the case for no margins, but can be expressed in the following form:

26 Note that while the aggregate product exposures are given by the data, the notional values have to be estimated given that the only data available are on the total value of notional derivatives (ie the sum of assets and liabilities) per product. The notional values are estimated assuming that the split between derivatives with positive and negative values is the same as that for the mark-to-market exposures.

27 This can be derived as the expectation of a censored normal, by noting the maximum is the expected value of a variable Y that takes a value y for y > a and a otherwise. Then E[Y] = P(y > a).E(y|y>a) + P(y≤a).a where E[y|y>a] is the truncated expectation and is given by: E[y|y>a] = $\mu + \sigma\phi(s)/P(y > a)$ with $s = (a - \mu)/\sigma$. In this case, a = 0, $\mu=\alpha$ and $\sigma=\sigma\sqrt{t}$.

$$EE_t = -\left[\frac{IM_n}{2} + \frac{\sqrt{t-1}}{\sqrt{2\pi}}\right]\left[1 - \Phi\left(\frac{IM_n}{\sqrt{n}}\right)\right] + \frac{1}{2}\phi\left(\frac{IM_n}{\sqrt{n}}\right) + \left[\frac{t-1}{\sqrt{2\pi(n+t-1)}} exp\left\{-\frac{IM_n}{2(n+t-1)}\right\}\right]\left[1 - \Phi\left(IM_n\sqrt{\frac{t-1}{n(n+t-1)}}\right)\right] + \int_0^{\infty} c\phi_\eta(c)\left(\Phi_X(c) - \frac{1}{2}\right)dc$$

Here, $\Phi_X(c)$ is the cumulative distribution function of X_{t-1}, ie normal with zero mean and variance (t-1), and $\phi_\eta(c)$ is the probability density function of a variable with mean $-IM_n$ and variance n. Note that it is not possible to derive a closed-form solution for the integral term, but this can be accurately evaluated using quadrature.

Appendix 7.b – OTC derivatives maturity and volatility estimates

Average maturities for four of the different derivative product types (interest rate, credit, equity and currency) are inferred from the end-December 2012 BIS semiannual derivatives survey. The calculations are replicated in Table 6 below. With no data available for commodity derivatives, these are simply assumed to have the same average maturity as currency derivatives.

Average maturities of OTC derivatives

Table 6

	Notional amounts outstanding (in millions of US dollars)			Weighted average maturity (in years)
	1 year or less	Over 1 year and up to 5 years	Over 5 years	
Interest rate	190,672,326	180,259,652	118,770,637	3.7
Credit	5,077,783	18,055,712	1,935,228	3.0
Equity	3,349,798	2,329,471	572,043	2.3
Currency	48,135,376	13,727,800	5,495,276	1.8
Memo: Mean maturity (in years)	*0.5*	*3*	*10*	

Source: BIS semiannual OTC derivatives statistics, at end-December 2012: www.bis.org/statistics/derdetailed.htm.

Average volatilities are inferred from the results of the BCBS-IOSCO QIS study available to regulators. This reports initial margin estimates for bilaterally netted portfolios across the following product types: interest rates and currency, credit, equity, commodity and other. Volatilities consistent with the dollar amount of these portfolios can be inferred from the internal model standard, which assumes a confidence level of 99% and a margin period of risk of 10 days. All that remains to do is transform this dollar-amount volatility into the desired scale-free level (σ), by dividing through by the gross notional amount of the relevant portfolios.

Estimated volatilities of OTC derivatives exposures

In per cent, per unit of notional amount

Table 7

	Daily	Annualised
Interest rate and currency	0.068	1.08
Credit	0.119	1.90
Equity	0.635	10.08
Commodity	0.387	6.14

Source: BCBS-IOSCO (2013) QIS Study (confidential).

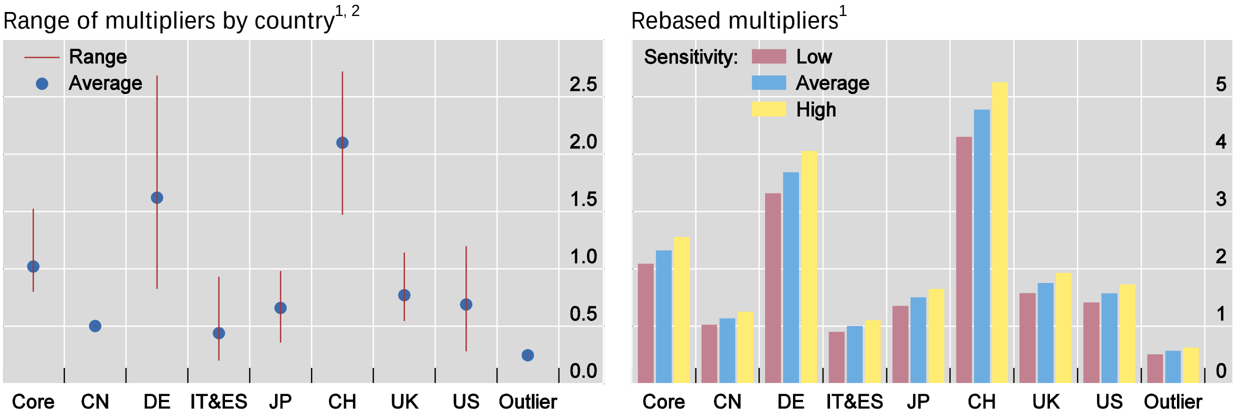
The results of this calculation are replicated in Table 7. Note that since interest rates and currency estimates are combined in the BCBS-IOSCO QIS study, the volatilities of these two product classes are assumed equal.

Appendix 7.c – Methodology for adjusting bank CDS premia

The purpose of adjusting the raw CDS prices for country-specific effects is to produce a consistent set of data from which it is possible to uncover a useful relationship between CDS premia and leverage ratios. The hypothesis upon which the following adjustment is based is that individual banks attract different LGD assumptions in the CDS market, and that a significant factor in determining these assumptions is the country in which they are incorporated. Variations in LGD would then reflect various factors ranging from the strength of the markets in which banks primarily operate and the willingness and ability of the sovereign to stand behind them in the event of default.

To make the necessary adjustments, two key assumptions are made. First, that banks incorporated in four countries attract broadly similar LGDs – Australia, Denmark, France and the Netherlands; this is based on a cursory analysis of the data, which suggests that the cross-section of banks in these four countries produce a broadly consistent relationship between CDS premia and leverage ratios. Second, that two countries – Italy and Spain – attract LGDs consistent with the market standard assumption of 60%; this is based on the observation that the rating agencies tend to assess banks in these countries as enjoying the prospect of little or no government support.

Multipliers applied to bank CDS prices Graph 7



CH = Switzerland; CN = China; DE = Germany; ES = Spain; IT = Italy; JP = Japan; UK = United Kingdom; US = United States.

[1] "Core" here refers to Australia, Denmark, France and the Netherlands. The "Outlier" is *Dexia*. Italy and Spain are used as the numeraire upon which country-specific multipliers are anchored. [2] Vertical lines show ranges of results for multiple banks; markers show the averages.
Source: MAGD calculations.

Armed with these two assumptions, one approach would be to estimate a regression equation relating CDS prices and leverage ratios, with dummy variables included to capture country-specific factors. But this approach suffers from the small sample of banks relative to the number of parameters. Instead, the adjustments are calculated as follows. First, a regression is estimated between CDS premia and leverage ratios for those banks that are incorporated in the four countries mentioned above. Second, the regression is used to calculate fitted values for all other banks in the sample; taking the ratio of these fitted values and actual CDS prices then produces a set of firm-specific multipliers. The left-hand panel of Graph 7 shows that the range within countries is not particularly large, providing some support for the idea that country factors influence the relationship between CDS premia and leverage ratios.

The baseline results are therefore based on the average values derived for each country, rebased against Italy and Spain. Given how important the levels are in determining the sensitivity of PDs to changes in leverage ratios, however, results are also produced for a range in which the country multipliers are assumed to be ±10% of their average values, leading to lower and higher sensitivities respectively. The resulting set of country multipliers are shown in the right-hand panel of Graph 7.

Appendix 7.d – Relationship between bank CDS premia and leverage

Using the counterfactual CDS prices, adjusted following the method described in Appendix 7.c, an econometric specification is required to link CDS premia with leverage ratios. The specifications considered follow the spirit of Merton models, which link theoretically the composition of a firm's balance sheet to the pricing of credit-sensitive instruments it has issued – and, by implication, to CDS contracts linked to the performance of those instruments. Balance sheet leverage is a key input to Merton models, alongside other variables that typically include a measure of the volatility of the firm's assets. This, in turn, is often obtained as a transformation of equity volatility because it is more easily observed. An advantage of Merton models is that they provide an economic description of a firm's default process and so they are useful for building narrative. But they often perform less well empirically than statistically based econometric models.

Selected alternative regression specifications — Table 8

Variable	Model 1		Model 2		Model 3		Model 4	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	4.3299	1.4 x 10–11	3.7562	2.2 x 10–7	1.8819	0.4154	2.6237	9.6 x 10–10
K/A	–0.4430	3.7 x 10–4	–0.4001	0.0013	–0.3620	0.6464		
σ_E			0.0108	0.1472	0.0877	0.0569		
$(K/A)^2$					0.0325	0.6563		
${\sigma_E}^2$	–				–4.5 x 10–4	0.0672		
$(K/A) * \sigma_E$					–0.0065	0.3882	–8.8 x 10–6	0.9966
R^2	0.2871		0.3270		0.4113		4.9 x 10–7	
AIC	100.4		100.2		101.2		114.0	

A = assets; AIC = Akaike information criterion; K = capital; R^2 = goodness of fit coefficient; σ_E = equity volatility.

Source: MAGD calculations.

For tractability and fit to the data, the approach adopted for this exercise is to restrict the potential explanatory variables for CDS premia to leverage and equity volatility, and investigate the performance of various econometric specifications spanning the different combinations of linear, quadratic and interaction terms. Table 8 sets out a regression specification for a selection of the investigated models. Model 2, involving linear terms in leverage and equity volatility alone, appears best overall because, simultaneously: the signs on the two terms are intuitive (negative and positive respectively); they have reasonable statistical significance (p-values); and alternative specifications do not yield as satisfactory R^2 values and information criterion at the same time. Moreover, Model 2 performs best overall (using the same criteria as described above) under the two sensitivity experiments described in Appendix 7.c, the final results of which are summarised in Table 9.

Regression results for alternative sensitivities

Table 9

Variable	Lower sensitivity		Higher sensitivity	
	Coefficient	p-value	Coefficient	p-value
Constant	3.3807	2.21 x 10–7	4.1323	2.20 x 10–7
K/A	–0.3600	0.0013	–0.4401	0.0013
σ_E	0.0097	0.1473	0.0119	0.1473
R^2	0.3270		0.3270	
AIC	91.791		107.383	

A = assets; AIC = Akaike information criterion; K = capital; R^2 = goodness of fit coefficient; σ_E = equity volatility.

Source: MAGD calculations.

8. Costs

Increased capital charges from Basel III, mandatory minimum margin requirements and mandatory clearing of standardised OTC derivatives will increase the cost of trading OTC derivatives. These reforms will have direct and indirect effects on both dealers and end users. In this chapter, we focus on estimating the increase in the direct costs related to the full implementation of the reforms, leaving the indirect effects – which can both increase and decrease costs – as a subject for qualitative discussion (see Section 5). We do not attempt to estimate transition costs or one-time costs of implementing reforms.

Estimating the direct cost of full implementation necessitates making some assumptions both about how regulators will choose to implement the reforms and about how market participants will react. In almost all cases where there is uncertainty, we choose assumptions that result in higher estimated costs. In particular, we assume that the size of the derivatives market will remain unchanged post-reform and that funding costs will not adjust to changes in the capital structure of derivatives users. The estimates should therefore be considered an upper bound on the true direct cost of reforms. We also estimate three scenarios to incorporate our uncertainty about factors in the evolution of the market.

We measure three categories of costs arising from reforms: (i) the cost of increased collateral required by CCPs and by bilateral margining rules; (ii) the cost of increased regulatory capital required by Basel III; and (iii) other direct costs of reform. The sum of these costs, when compared to the pre-reform costs of trading OTC derivatives, gives an estimate of the extra costs of using OTC derivatives once reforms have been fully implemented. We estimate the change in annual global costs as between €15 billion and €32 billion, with a central estimate of €20 billion (Table 10).[28]

For input into macroeconomic models, we need to estimate how the change in derivatives costs will change banks' lending spreads (the difference between lending and deposit rates). We assume that all direct costs of reform (including those affecting end users) will be absorbed by banks and that the banks will recover the costs by widening the lending spread across their loan books. This is likely to overestimate the effects on the lending spreads since banks can absorb some of the costs for competitive reasons and eliminate some high-cost derivatives activity. This technique also misrepresents – but does not ignore – the effects of derivatives reform outside the loan book for the reasons discussed in Section 5. We estimate the total size of the global banking loan book at €24 trillion using a sample of 114 medium-sized and large banks from seven jurisdictions. By excluding small banks we somewhat overestimate the effect on the lending spread. Small banks are less likely to make extensive use of OTC derivatives and are therefore excluded from our analysis. Yet the macroeconomic models used in the study augment the spread for all banks, thereby exaggerating the effects of derivatives reform on the economy. We estimate that lending spreads will increase by between 6 and 13 basis points, with a central estimate of 8 basis points.

[28] The total cost estimates are not intended to be comprehensive. We exclude costs that will not change from the pre-reform to the post-reform period since our goal is to measure the change in costs. For example, capital figures exclude the counterparty credit risk capital charge, which will remain relatively unchanged.

The following sections take each of the three cost categories in turn and explain how we estimate costs.

Cost scenarios[1]

In billions of euros[2] Table 10

	Pre-reform	Post-reform scenarios		
	2012	Low cost	Central	High cost
Collateral costs				
Initial margin – non-centrally cleared	134	437	614	614
Initial margin – centrally cleared	32	305	272	587
Variation margin pre-funding	212	274	316	457
CCP default fund	6	61	54	117
Total collateral (4% haircut adjusted)	400	1,120	1,307	1,847
Cost of additional collateral (%)	0.70	0.55	0.70	0.94
Cost of additional collateral	3	6	9	17
Capital costs				
Non-centrally cleared	167	335	352	352
Centrally cleared	0	12	11	23
Total capital	167	347	362	375
Cost of capital (%)	6.7	6.3	6.7	7.3
Cost of capital	11	22	24	27
Other costs				
Clearing fees	0.4	0.9	0.9	0.9
Total costs	14	29	35	46
Change in costs		15	20	32
Size of global loan book	212	24,338	24,338	24,338
Change in lending spread (%)		0.06	0.08	0.13

[1] Cost figures are annual. Totals may not sum due to rounding. [2] Unless otherwise indicated.

8.1. Cost of increased collateralisation

Increased collateralisation of trades

Increasing the amount of collateral used to back trades is an important part of the reform of OTC derivatives markets. All trades that move to central clearing will be backed by initial and variation margins in addition to default funds according to CCP rules governed by CPSS-IOSCO principles (CPSS-IOSCO (2012)). Non-centrally cleared trades between financial institutions will be subject to universal variation margin requirements and broad initial margin requirements according to principles laid out by BCBS-IOSCO (2013). Together, these requirements will result in the total amount of collateral used to back trades rising to between €1.1 trillion and €1.8 trillion, with a central estimate of €1.3 trillion.

In 2012, the WGMR conducted a quantitative impact study (QIS) that assessed margin requirements related to proposed margining rules for non-centrally cleared OTC derivatives.[29] The QIS concluded that initial margin requirements would result in the posting of €0.7 trillion of collateral on a global basis.[30] Since the QIS was conducted, certain changes were made to the proposed rules and these changes will affect the total collateral required. The two most significant changes are (i) the exemption from initial margin requirements of physically settled FX swaps and forwards, which will decrease collateral requirements; and (ii) the consolidation of exposures when applying the minimum exposure threshold, which will increase collateral requirements. The QIS data do not allow a precise estimate of the effect of these changes. We estimate that the changes will result in a net decrease in collateral requirements in excess of €0.1 trillion, giving a final collateral requirement from mandatory initial margins on non-centrally cleared trades of €0.6 trillion.

The second component of increased margin requirements comes from trades that move to central clearing. The BCBS-IOSCO QIS asked survey respondents to estimate the amount of derivative trades that would move to central clearing based on a list of derivatives that are likely to be clearable. The resulting increase in the proportion of central clearing is very similar to that assumed in the central scenario of this report. The BCBS-IOSCO QIS estimates the collateral requirements on these trades under the BCBS-IOSCO minimum margin requirements at €0.8 trillion.

Under central clearing, two factors will reduce margin requirements. First, because CCPs are able to more effectively replace defaulted portfolios, they calculate margins using a shorter replacement period (generally five days for CCPs versus 10 days used by the BCBS-IOSCO rules). Second, CCPs allow multilateral netting but may cause portfolios to be fragmented. These two netting effects go in opposite directions and their total effect will depend on the portfolio of each participant and the degree of fragmentation of portfolios among CCPs (Duffie and Zhu (2011) and Cont and Kokholm (2012)). We assume that the two netting effects exactly offset for non-bank financial institutions, which account for 33% of OTC derivatives exposures among all financial institutions. The only initial margin benefit of moving to CCPs for these participants is from the reduced replacement period, resulting in CCP margins being 71% of the BCBS-IOSCO proposed margins. In contrast, dealers will generally gain a large benefit from multilateral netting due to their many offsetting trades. We use estimates of multilateral netting benefits provided in the BCBS-IOSCO QIS to estimate the CCP margin as 19% of the BCBS-IOSCO proposed margins. The total margins from centrally cleared trades are therefore estimated as €272 billion in the central case.

In addition to initial margins, CCP participants will need to contribute to the CCP default fund that is used to mutualise losses that exceed margin amounts. To estimate the future size of default funds, we assume that the ratio of default funds to initial margins will remain constant and estimate this ratio at 0.2, using data from two major OTC derivatives CCPs. This gives an estimated default fund in the central scenario of €54 billion.

[29] See Appendix C of BCBS-IOSCO (2013). At the time of writing, the BCBS was doing QIS work on specific aspects of derivatives-related regulatory reforms, but results were not available.

[30] This QIS surveyed large banks, which calculated expected margin requirements using their internal models.

The BCBS-IOSCO margining rules and the move to CCPs will also increase the use of regular mark-to-market variation margin payments. Since these payments are either paid out to market participants (in the case of CCPs) or rehypothecable (in the case of non-centrally cleared trades), their total value does not have macroeconomic effects. The need to be prepared to make margin payments at short notice will, however, require market participants to hold precautionary collateral available for posting. We assume that market participants hold excess collateral in an amount that covers one day of variation margin payments under the same assumptions used to calculate initial margins (covering a 99th percentile change in daily mark-to-market value). This gives a prefunding requirement of €316 billion in the central case. This represents an increase from the pre-reform case of only €104 billion because a large proportion of trades (estimated at 60%) already have variation margin exchanged.

Finally, we assume that collateral is subject to a haircut of 4% (as the BCBS-IOSCO requires for high-quality collateral with a maturity greater than five years) and gross up the collateral demand to account for this.

Total amounts of collateral needed post-reform depend on how effectively the market can implement central clearing. This will affect, among other things, the proportion of OTC derivatives that can be centrally cleared and the effectiveness of multilateral netting. We assume that the percentage of OTC derivatives that will be centrally cleared increases significantly after reforms in the central scenario, and somewhat more in the low-costs scenario, broadly as set out in Annex 2. This increases collateral demands from central clearing, which is more than offset by decreases in collateral for non-centrally cleared trades due to the superior netting at CCPs.[31] In the high-costs case, we assume that multilateral netting is ineffective, either because it is offset by the loss of cross-asset-class netting or because of clearing fragmentation. The only advantage of moving to central clearing therefore comes from the shorter replacement period.

Cost of collateral

We estimate the cost of collateral as the spread between the funding cost for collateral and the return earned on posted collateral. We assume that collateral is composed of high-quality government debt securities with an average maturity in the range of one to three years. This collateral maturity roughly corresponds to the average maturity of OTC derivatives given in Table 5 and with industry practice. We further assume that the collateral is funded by external debt with a maturity similar to that of the collateral. We then use the Bank of America Merrill Lynch financial indices to find option-adjusted spreads (OAS) between investment-grade debt instruments of corporate financial sector issuers and government debt.[32] Consistent with CGFS (2013), we assume in the central scenario that collateral demands are manageable with the current and future supply of safe assets. Therefore, historical costs estimates are justified.

[31] To estimate the resulting initial margin demands, we extrapolate from the ratio of initial margin to gross notional in the pre-reform and central cases. This allows us to calculate a new ratio of initial margin to gross notional that accounts for the likelihood that derivatives users will choose to clear first those trades with the greatest multilateral netting potential.

[32] We include the following Bank of America Merrill Lynch indices to reflect the major derivatives markets: EB01 (1-3 year Euro financial index), JF01 (1-3 year Japan financial index), UF0V (1-5 year Sterling financial index) and CF01 (1-3 year US financial index).

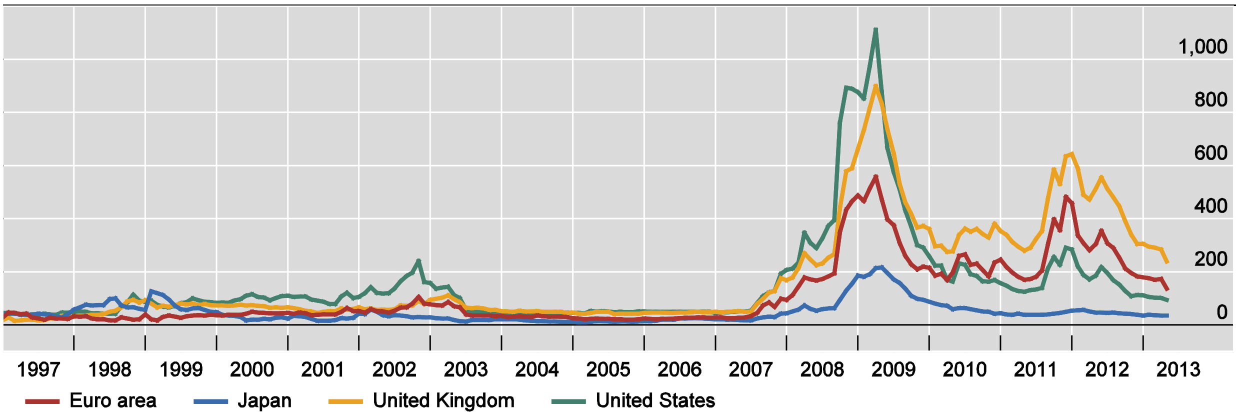
We use the same indices for both dealer and non-dealer collateral costs. This implies that the non-bank costs will equal the bank costs. Many buy-side derivatives users (eg pension funds) will have excess safe assets on hand that they can use as collateral at little or no cost, while some buy-side derivatives users will face higher funding costs due to poor access to credit (eg non-bank retail lenders).

We focus on the OAS time series for the euro area, Japan, United Kingdom and United States for 1996 to 2013 (Graph 8 and Table 11). Pre-crisis (December 1996 to December 2007) spreads differ markedly from crisis (January 2008 to December 2009) spreads. The goal is to estimate a long-term average collateral cost, which should be considerably less than the recent crisis-influenced costs. Relative to the probability of a financial crisis, the crisis period constitutes a disproportionately large component of the sample period. Data limitations prevent us from collecting a more representative time series, so we instead compute a weighted average of pre-crisis and crisis spreads. We do not use the post-crisis data (after December 2009) since the presence of the European sovereign debt crisis and quantitative easing make this period atypical and not easily classifiable as either a crisis or non-crisis period. We use a crisis probability of 4.5%, which is based on a conservative (pre-Basel III) estimate of crisis frequency (BCBS (2010)) and results in average spreads ranging from 37 basis points (Japan) to 99 basis points (United States).[33]

Yield spreads on bonds issued by financial institutions[1]

In basis points

Graph 8



[1] Indices of option-adjusted spreads over yields on government bonds with maturities of one to three years (for the United Kingdom, one to five years).

Source: Bank of America Merrill Lynch.

To determine the overall mean funding cost, we aggregate the spreads for the four indices in proportion to the total OTC derivatives notional amount outstanding in the respective currencies according to BIS data (Table 12).[34] On this basis, the estimated global mean funding cost is 70 basis points.

[33] The 4.5% estimate reflects the frequency of banking crises in BCBS member countries. This contrasts with the 0.26% probability of a crisis related to OTC derivatives computed in Section 7.5 of this report.

[34] The fact that derivatives users may issue debt in one currency, buy collateral in a second currency and trade derivatives in a third currency complicates the choice of an optimal weighting scheme. The chosen weights correspond to approximate market shares and are a good compromise.

Yield spreads on bonds issued by financial institutions[1]

In basis points

Table 11

	Euro area	Japan	United Kingdom	United States
Non-crisis period (95.5% weight)[2]	38	33	59	78
Crisis period (4.5% weight)[3]	303	121	472	547
Weighted average	50	37	78	99

[1] Indices of option-adjusted spreads over yields on government bonds with maturities of one to three years (for the United Kingdom, one to five years). [2] December 1996 to December 2007. [3] January 2008 to December 2009.

Sources: Bank of America Merrill Lynch; MAGD calculations.

Cost of funding collateral

Table 12

	Euro	Japanese yen	Sterling	US dollar
OTC FX derivatives notional amount (US$ bn)	23,797	14,111	7,825	57,354
OTC interest rate derivatives notional amount (US$ bn)	187,363	54,812	42,444	148,676
Weight (%)	39	13	9	38
Average option-adjusted spread (basis points)	50	37	78	99
Mean funding cost (basis points)		70		

Sources: Bank for International Settlements; Bank of America Merrill Lynch; MAGD calculations.

In the low-costs scenario we assume that derivatives reform and other financial sector reforms will reduce the probability of a crisis and we therefore use only the pre-crisis spreads to calculate a collateral cost of 55 basis points. In the high-costs scenario, we assume that increasing collateral demands will make it difficult or costly to locate high-quality collateral. To approximate the impact of this, we assume that low-yielding short-term collateral is financed with longer-maturity debt, which empirically carries higher yields. Specifically, we compute the spread between up to one-year government bonds and one- to three-year financial issuer debt. This yields a collateral cost of 94 basis points.

The collateral cost we calculate using this technique is likely to overestimate true funding costs. It does not include important risk offsets. For example, buying safe assets for collateral will decrease the average riskiness of the derivatives user's assets. This will cause the overall funding cost for the derivatives user to decline and thereby offset the cost of collateral. Similarly, collateralised OTC derivatives transactions will appear more attractive to counterparties due to their lower counterparty risk. This should result in improved pricing through a lower credit valuation adjustment, which could be reflected in a lower cost of trading OTC derivatives (Mello and Parsons (2012)). The true long-run cost of collateral comes only from financial frictions such as asymmetric information in the debt issuance market and should therefore be lower than the cost calculated here. For this reason, our collateral cost estimates should be considered an upper bound that overestimates the true cost of collateral.

8.2. Cost of increased regulatory capital

Increased capital requirements

Basel III rules increase the amount of regulatory capital required to protect against the counterparty risk inherent in OTC derivatives. The increase comes principally from a new capital charge designed to protect against variations in the credit valuation adjustment (CVA) that measures asset valuation changes related to counterparty credit risk.[35] Increased capital charges for centrally-cleared transactions – related to trade exposures and to exposures to the CCP default fund – will also increase costs post-reform.[36] In contrast to the collateral calculations, where a QIS is available, the data to calculate future capital charges are limited and we must therefore rely on more approximate calculations. Using the available information, we estimate additional capital requirements compared to the pre-reform period will be between €179 billion and €207 billion.

The CVA capital charge is based on current and potential future exposures from OTC derivatives. Essentially all transactions among financial institutions will have mandatory variation margin payments under BCBS-IOSCO and CCP rules, meaning that there will be little current exposure for these trades. Potential future exposure will also be mostly eliminated in cases where initial margin is exchanged. We therefore estimate CVA capital charges for (i) the potential future exposures related to transactions among financial institutions that do not attract initial margin, and (ii) the current and potential future exposures for transactions involving non-financial end users who are not subject to margining or clearing requirements.[37]

Our estimate of the CVA capital charge is based on the current exposure method (CEM). Under this method, banks calculate the required capital using a formula based on their exposures, the credit rating of their counterparties, and any CDS hedges that reduce risk. Compared to the internal model method used by the largest dealers, the CEM is less risk-sensitive, failing to fully recognise diversification and some risk mitigants. In most cases, the CEM will therefore result in higher capital charges.[38] We use data from the BIS semiannual OTC derivative statistics (BIS (2013)) to estimate the notional outstanding size of different buckets of derivatives organised by product and maturity as in Table 6. Because of a lack of available data, we must make assumptions for other parameters to estimate the

[35] The counterparty credit risk charge implemented in Basel I and II may decrease by a small amount due to the increased collateralisation of trades. MAGD does not attempt to estimate this change.

[36] Basel III also sets a new maximum leverage ratio intended as a backstop to provide an extra layer of protection against model risk and measurement error in risk-based capital measures. MAGD assumes that the risk-based capital charges bind (so banks have no excess capital) but that the backstop leverage ratio does not bind and therefore does not impose direct costs.

[37] The EU is expected to exempt non-financial end users from CVA capital charges. We do not consider this exemption in our estimate, which therefore represents an upper bound on the possible charges.

[38] The BCBS is in the process of creating a new non-internal model based approach to calculating capital charges on derivatives exposures (BCBS (2013)). This method will in most cases result in lower capital charges than the CEM.

capital charge for each bucket. We then sum across the buckets to get total capital charges.[39]

To estimate the capital charges related to exposures to CCPs, we use Method 2 of the interim rules of the BCBS (BCBS (2012)). This method applies a flat risk weight of 1250% to all default fund exposures, subject to an overall cap on all CCP exposures equal to 20% of the trade exposures to the CCP. To estimate trade exposures, we assume that replacement cost is zero, and potential future exposure is 1.41 times larger than initial margin. This in turn implies that trade exposures are 1.41 times larger than initial margin. Finally, we assume that collateral is not bankruptcy-remote from the CCP but that segregation and portability are provided and therefore collateral is subject to capital charges with a 2% risk weight. This gives total capital charges of €11 billion in the central scenario.

We also assume that the risk-weighted capital requirements are more stringent than the revised leverage ratio (BCBS 2013 (2)), which prohibits the netting of derivatives exposures against collateral received. The leverage constraint is assumed to not bind under normal circumstances; data limitations prevent us from assessing the conditions under which the constraint could bind for some derivatives-intensive banks.

Cost of capital

In order to increase the amount of regulatory capital, banks will need to finance more of their assets through equity rather than debt. This reflects a situation where a bank's capital structure is changed by raising equity to retire debt.[40] Therefore, the incremental cost of regulatory capital is approximated by the difference between the cost of equity and the cost of debt. These respective costs are estimated for the banking sector at a global level.

Our technique for calculating the cost of regulatory capital overestimates the true cost because it ignores the risk-shifting effects of a change in capital structure. A shift in funding sources from debt to equity (ie a decrease in leverage) will decrease the expected volatility of the cash flows for both debt and equity investors. This decrease in risk will reduce the required return to both debt and equity, offsetting the increased cost of shifting from debt to equity funding. In the absence of financial frictions, this offset would be perfect and there would be no cost to increasing capital (Modigliani and Miller (1958)). The most important frictions that typically justify a high cost of increasing equity capital – the tax advantage of debt, agency costs and information asymmetries – are less relevant for banks in a macroeconomic context (Admati and Hellwig (2013)). But since some frictions exist, the cost of increased regulatory capital is not likely to be zero.[41] As there is no

[39] We assume a BBB counterparty credit rating for non-financial institutions and A for financial institutions, 100% net-to-gross ratio, a 100% risk weight and no CVA hedges that reduce capital charges. The last three assumptions in particular result in overestimation of the true amount of regulatory capital required.

[40] We do not estimate transition costs, which may be important if a large regulatory capital increase is necessary over a short period. With a sufficient transition period, increased equity relative to debt can come from retaining earnings.

[41] For example, banks may have a special role in creating liquidity through bank deposits, which may increase the relative value of debt financing (Van den Heuvel (2008), DeAngelo and Stulz (2013)).

consensus on how to estimate the appropriate offset, we choose a conservative approach and overestimate costs by ignoring the risk offset that is likely to remove a large part of the estimated cost. [42]

The costs of equity and debt vary across the business cycle and particularly during a financial crisis. For our macroeconomic study of the long-run effects of reform we use historical data to estimate long-run averages of these costs. We determine that the global average cost of equity faced by the banking sector is expected to be in the range of 10.8 to 11.5%, and the global average cost of debt is in the range of 3.9 to 4.8%. While these results are based on specific techniques and assumptions, as discussed below, they are broadly in line with estimates obtained using other common techniques and estimates recently published by other groups (eg OECD (2013) and PWC (2012)).

We estimate the cost of equity using the Capital Asset Pricing Model (CAPM) and the cost of debt using the yields on banking and financial sector bond indices. To approximate the cost of equity, our analysis uses data on 34 banks in the euro area, the United Kingdom and the United States included in the BCBS-IOSCO QIS dataset and Japanese banks identified by the Bank of Japan. We also include Australian and Swiss banks in our analysis, although these account for less than 5% of the weighted average cost. The results from different regions are weighted according to each currency's relative weight in the December 2012 BIS OTC derivatives statistics, as discussed in the cost of collateral section above.

The CAPM cost of equity estimation requires three parameters, namely the risk-free rate, the equity risk premium and the beta coefficient. The CAPM is a well-established model of asset pricing, which estimates the required post-tax equity return on a firm (R_e) as a linear function:

$$R_e = R_f + \beta_e [E(R_m)] - R_f]$$

where R_f is the risk-free rate of return, β_e is the beta coefficient (systematic risk) and $[E(R_m) - R_f]$ is a measure of the market risk premium. The risk-free rate is typically approximated with yields on benchmark government bonds. We assume that the regulatory reforms will be implemented over the next five to 10 years, and therefore select yields on government debt of corresponding maturities.

We estimate the equity risk premium as the long-run average of returns on broad equity market indices over government bond yields. Dimson, Marsh and Staunton (2011) estimate the equity risk premium for Japan as 9.1%, the United Kingdom as 5.2% and the United States as 6.4%. For beta coefficients we use a one-year rolling window of daily returns, and regress the returns for each individual bank on the returns of the appropriate market portfolio.

The market indices chosen are the FTSE All-Share index for UK banks, the Stoxx Europe 600 (excluding UK) index for European banks, the S&P 500 Composite index for US banks and the Nikkei 225 index for Japanese banks. Table 13 breaks down the average CAPM-based cost of equity by currency area and time period. Using outstanding amounts of OTC derivatives per currency as weights, the average global

Importantly, this type of argument does not imply that the risk offset does not exist, only that the risk offset does not completely eliminate the cost of increased equity financing.

[42] Miles, Yang and Marcheggiano (2012) present several different techniques for empirically estimating the change in cost of capital as the capital structure of banks changes.

long-run cost of equity is 11.5%. The left-hand panel in Graph 9 shows the evolution of the cost of equity over the past 10 years, with elevated levels during the financial crisis period.

Estimated cost of bank equity based on the Capital Asset Pricing Model

In per cent

Table 13

	Long-run mean[1]	Pre-crisis mean[2]	Post-crisis mean[3]
Country averages:			
Euro area	10.3	9.5	10.9
Japan	11.4	11.7	9.5
United Kingdom	11.3	10.4	11.8
United States	12.8	11.8	12.6
Global estimate:			
Weighted average	11.5	10.8	11.5

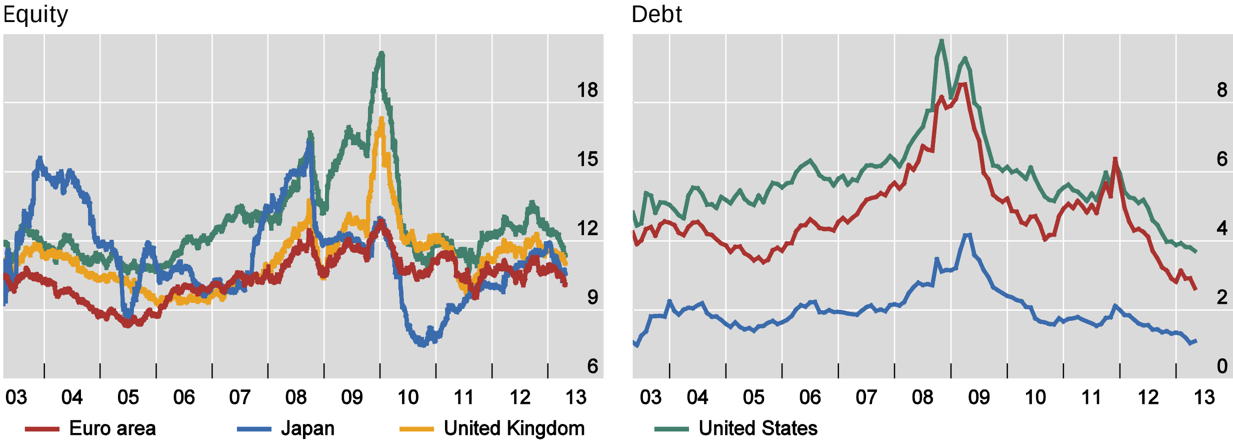
[1] April 2003 to April 2013. [2] April 2003 to December 2007. [3] January 2010 to April 2013.

Sources: Bank of America Merrill Lynch; Bloomberg; Dimson, Marsh and Staunton (2011); MAGD calculations.

Estimated cost of bank capital

In per cent

Graph 9



Sources: Bank of America Merrill Lynch; Bloomberg; Dimson, Marsh and Staunton (2011); MAGD calculations.

To estimate the cost of debt for the banking sector at a global level, we find bank debt with maturities that match those of the bonds used previously to estimate risk-free rates. We then compute the global cost by averaging the yields on European, Japanese and US banking (or financial) sector bond indices produced by Bank of America Merrill Lynch. Average yields in each currency between 2003 and 2013 are reported in Table 14 and illustrated in Graph 9 (right-hand panel), which shows the yields spiking during the crisis period. Using a similar weighting scheme as for the cost of equity, we arrive at a global long-run cost of debt of 4.8% for the banking sector.

Estimated cost of bank debt

In per cent Table 14

	Long run mean[1]	Pre-crisis mean[2]	Post-crisis mean[3]
Country average:			
Euro area	4.8	4.4	4.1
Japan	2.0	1.8	1.7
United States	5.8	5.5	5.2
Global estimate:			
Weighted average	4.8	4.5	4.2

[1] April 2003 to April 2013. [2] April 2003 to December 2007. [3] January 2010 to April 2013.

Sources: Bank of America Merrill Lynch; Bloomberg; Dimson, Marsh and Staunton (2011); MAGD calculations.

Other direct costs

OTC derivatives reforms will result in many other direct costs to market participants such as legal and information technology expenses. These costs would be very difficult to estimate and are, at least in part, one-time costs that will not be important in the long run. In addition, these costs are, at least in part, attributable to investments that also create important benefits such as improved process standardisation and straight through processing that will reduce operational risks in the market. In this exercise we exclude both the costs and benefits of these effects.

We do estimate one other direct cost: the clearing fees that fund the costs of operating central counterparties. We collected data on the clearing fees paid to two major OTC derivative central counterparties and scaled this up in the post-reform scenarios to account for five major CCPs. In addition, we assumed that CCPs charge a 10 basis point fee on posted collateral as part of their funding. These costs totalled a little under €1 billion.

9. Macroeconomic modelling

This chapter summarises the approaches used to model the long-run macroeconomic impact of a change in lending spreads, which represents the primary cost of changes to OTC derivatives regulation considered in the MAGD analysis.

The macroeconomic models used across participating jurisdictions vary in two main dimensions. First, some jurisdictions used structural Dynamic Stochastic General Equilibrium (DSGE) models to assess the impact of the reforms, while others used macroeconometric models. The latter category primarily consists of reduced-form systems of theoretically grounded behavioural equations, but also includes some VAR and error-correction models.[43]

Second, the models differ in the way in which the financial system is specified. For a majority of models, the financial sector is represented through exogenously determined spreads between lending rates, deposit rates and policy rates. Another group of jurisdictions used models featuring more sophisticated financial sectors, which typically incorporate a financial block with an explicit role for banks as intermediaries between households and firms in capital markets. This enables the inclusion of multiple financial assets with different time horizons and risk characteristics. A third class of models incorporate financial frictions that capture feedback mechanisms through which the financial system can potentially affect the real economy. In most cases, these frictions are modelled in the spirit of the Bernanke, Gertler and Gilchrist (1999) financial accelerator framework in which firms must pay an external finance premium when borrowing from financial institutions. Appendix 9.a describes some of the models used in the analysis.

The reported results suggest that the way the financial system is modelled has more of an impact on the magnitude of the estimated effects of OTC derivatives reform than whether a structural or reduced-form model was used. In what follows, we describe the way in which the financial sector is modelled for each group of models in more detail, summarise the results for each group, and discuss some issues that may affect the interpretation of these results.

Models with exogenous spread variables

The most common way of modelling the cost of OTC derivatives reform across jurisdictions was to assume the existence of an exogenous spread between borrowing rates and deposit or policy rates, as in Gaspar and Kashyap (2006). This type of ad hoc financial system is used in both DSGE and macroeconometric models. In these models, the interest rate faced by firms and households when they borrow funds is specified as:

$$BR_t = R_t + Spread_t \qquad (1)$$

where BR_t is the interest rate paid by firms and households when they borrow funds, R_t is the deposit or policy rate and the credit spread, $Spread_t$, is the

[43] For a description of the type of reduced-form macroeconometric models used in the MAGD exercise, see Hamburg and Tödter (2005), Minella and Souza-Sobrinho (2009), Hurtado et al (2011) and Sámano (2012).

difference between these two interest rates. The costs of OTC derivatives reform were modelled as a permanent increase in the spread term.

The mechanism through which increased spreads affect the broader economy differs across models. In most of the structural models, the increase in spreads raises the effective rate at which firms discount future profits. This reduces the net present value of future profits, which decreases investment demand, lowers the size of the economy's capital stock and causes a permanent contraction in output. Household income also falls, resulting in a decrease in consumption. In models featuring an open-economy dimension, the decrease in consumption and investment demand may be partially offset by a reduction in the demand for imports.

The mechanisms linking changes in spreads to GDP vary across the less structural macroeconometric models. In models featuring a system of behavioural equations, spreads typically appear as an explanatory variable in equations for specific components of GDP. For example, in several models, higher spreads raise the user cost of capital, which is an explanatory variable in the equation for business investment. In some models spreads also affect variables such as loan delinquency rates, which may allow these models to capture some of the broader impacts of tighter financial conditions beyond the direct price effects. In the reduced-form VAR and ECM models, the costs of the reform reflect historical statistical relationships between GDP and loan spreads.

Models featuring exogenous loan spreads report the estimated costs of the reform to be in a range between 0.02 and 0.22% of GDP, with most results in the range of 0.02 to 0.08% of GDP. This is typically lower than the costs reported in the models discussed below. One explanation for the lower estimates is that in these models the impact of changes in spreads occurs largely through changes in the price of credit, abstracting from changes in the quantity of credit, for example due to the effects of higher borrowing costs on firm net worth and financial sector leverage. Quantity channels are likely to amplify the impact of financial shocks in more sophisticated models. Moreover, in several models monetary policy was able to offset much of the impact of increased spreads on lending rates by permanently lowering the policy rate. In the case of structural models, this may partly be the result of assuming the existence of a representative agent, which means that the adverse effects of lower policy rates on deposit holders may not be captured. In models that do take account of such effects, monetary policy may have less scope to offset the impact of increased lending spreads. However, it is worth noting that even in models in which monetary policy was assumed not to respond to changes in spreads, the estimated costs of the OTC derivatives reforms was still generally below those reported by models with explicit financial sectors.

Models with agency frictions affecting banks

A second group of jurisdictions modelled the banking sector explicitly. While the specific form of the financial sector differed across models, a common approach requires firms to raise loans from banks to fund their labour costs and capital acquisition before they are able to produce output. Banks make these loans using funds raised from depositors.

As in Gertler and Karadi (2011), frictions in these models arise because banks are able to divert a proportion of deposits away from productive loans for their own benefit. This creates an agency problem and forces banks to pledge some of their own equity into their loans in order to attract deposits. Because of this, banks face a balance sheet constraint and cannot lend out more than a given multiple of bank equity:

$$L_t \leq \gamma E_t \tag{2}$$

where L_t is the amount of bank lending, γ is a function of the model's parameters that governs the maximum extent of bank leverage, and E_t is total bank equity. In these models, an increase in credit spreads is typically modelled as a change in parameter values that tightens the balance sheet constraints of banks.

Several of the models with agency frictions also feature a richer modelling of other economic characteristics. Examples include the incorporation of multiple interest rate maturities, multiple types of households, including savers and borrowers, as well as a housing sector. The inclusion of multiple household types reduces the scope for monetary policy to offset the impact of OTC derivatives reform as lower policy rates reduce the income of savers and, hence, their consumption.

Models with agency frictions typically report larger costs of OTC derivatives reform than models that do not feature an explicit financial sector. The range of costs for this group of models was 0.05 to 0.60% of GDP, although most results were towards the lower end of that range.

In contrast to models that do not feature an explicit financial sector, models incorporating agency costs are able to capture a broader set of linkages between changes in credit spreads and economic activity. In particular, a tightening of balance sheet constraints requires banks to reduce the supply of credit even abstracting from its impact on spreads. However, one concern that may arise with this approach is that the estimate of the cost of higher credit spreads may be sensitive to which parameter is used to achieve the desired change in credit spread. For example, a given change in spreads from an exogenous change in capital requirements may have a different impact to one resulting from an increase in bank monitoring costs.

Models with financial accelerator frictions

A further set of jurisdictions use DSGE models that incorporate a financial accelerator mechanism. In these models, banks find it costly to verify the riskiness of individual entrepreneurs and firms. Consequently, when lending, banks demand a risk premium that is negatively related to a borrower's net worth. In the case of a firm borrowing funds to purchase capital, this may take a form such as:

$$Spread_t = \psi\left(\frac{K_{t+1}}{N_{t+1}}\right) \tag{3}$$

where ψ, which depends upon underlying parameters including the size of the verification costs, governs the size of the external finance premium; K_{t+1} is the capital stock of the firm; and N_{t+1} is the net worth of the firm. Several jurisdictions use models that extend the basic financial accelerator framework, for example by assuming that banks also face agency frictions or that banks find it costly to verify the riskiness of loans to households.[44]

In the financial accelerator models, the increase in credit spreads was modelled as either an increase in verification costs in the spirit of Bernanke, Gertler and Gilchrist (1999) or as an increase in the dispersion of the riskiness of borrowers as in Christiano, Motto and Rostagno (2010). Both cases lead banks to demand a higher risk premium when they lend to firms and households. The higher risk premium reduces the net worth of firms, which creates an additional channel through which the effect of the change of spreads on real activity can be amplified beyond the direct price effects. As with the agency cost models, a concern may be that the estimate of the impact of the reform may not be invariant to the parameter changes used to achieve the desired change in credit spreads. This applies in particular to parameters that capture the information friction between borrowers and lenders.

On average, models featuring a financial accelerator tend to report larger costs than models featuring less sophisticated financial sectors, with estimates ranging from 0.03 to 0.93% of GDP. These larger estimates are likely, in part, to reflect the larger amplification of financial shocks in financial accelerator models compared to models with less sophisticated financial sectors.

Limitations of the modelling exercise

As with any macroeconomic modelling exercise, a number of caveats and limitations should be acknowledged:

The tight timeline for the analysis means that it has not been possible in many instances for jurisdictions to develop models specifically designed to measure the costs of permanent changes in credit spreads. In addition to the relatively unsophisticated modelling of the financial sector in many models highlighted above, another concern is that many of the models used in this exercise were developed to analyse transitory economic fluctuations at a business cycle frequency rather than the long-run implications of permanent policy changes.

A further limitation of the analysis is that the differences in the modelling approach adopted by the different jurisdictions limits the extent to which one can compare results across models. For example, it is unclear to what extent variation in the estimated costs across jurisdictions reflects differences in sensitivity to changes in credit spreads as opposed to differences in modelling approaches.

Finally, the modelling exercise was conducted on an individual country basis and so abstracts from spillover effects across economies. Taking account of these spillovers may have led to larger estimates of the cost of the reforms.

[44] For examples of this type of models, see Benes and Kumhof (2013) and Muto, Sudo and Yoneyama (2013).

Appendix 9.a – Descriptions of selected macroeconomic models

This appendix contains descriptions of some of the macroeconomic models used by MAGD members to evaluate the impact of increases in lending spreads.

Reserve Bank of Australia

The RBA policy model (Jääskela and Nimark (2011)) is a small open economy extension of Christiano, Eichenbaum and Evans (2005) with Calvo-style rigidities, a working capital channel, and investment and capital utilisation costs. We estimate the parameters of the model using Bayesian methods.

For the purposes of the MAGD exercise, we have amended the model by incorporating credit spreads. In the extended version of the model aggregate demand, for instance, responds to the lending rate, which is defined as the policy rate plus an exogenous credit spread. For the purposes of estimation, the spread is measured as the difference between average lending rates and average funding costs. In the model an increase in the spread lowers demand and capital accumulation, leading to a decrease in GDP. Monetary policy follows a Taylor rule that does not respond to the spread directly but via its 'second round' effects on inflation and output.

Background papers

Christiano, L, M Eichenbaum and C Evans (2005): "Nominal rigidities and the dynamic effects of a shock to monetary policy", *Journal of Political Economy*, vol 113, pp 1–45.

Jäskela, J and K Nimark (2011): "A medium-scale New Keynesian open economy model of Australia", *Economic Record,* vol 87, pp 11–36.

Central Bank of Brazil

The model used to estimate the costs for the Brazilian economy is a small-size, semi-structural model comprising 13 behaviorial equations, including foreign variables, and real and financial variables describing the domestic economy. Among these, the model includes the quantity of credit (measured by the real growth rate of freely allocated credit to the private sector), lending interest rates and bank capital, thus capturing the transmission to the real economy of changes in bank regulation through shifts in quantities rather than prices. It is not the official forecasting model used by the Central Bank of Brazil, but it has been utilized as a complementary tool to address specific questions.

Bank of Canada

The ToTEM II (current version of the Terms of Trade Economic Model) is a multi-sector, open-economy dynamic stochastic general-equilibrium (DSGE) model. It contains sectors producing four distinct finished products: consumption goods, investment goods, government goods, and export goods, as well as one commodity-producing sector. In ToTEM II dynamic equilibrium equations for all variables reflect utility- and profit-maximizing decisions by rational agents, allowing the model to tell coherent and internally consistent stories about the current and expected evolution of the Canadian economy. ToTEM II includes 90-day and 5-year riskless as well as 90-day and 5-year risky assets for both households and firms. In order to allow long-term interest rates to have an independent effect on aggregate demand, ToTEM II abandons the traditional assumption of perfect asset substitutability, and further introduces a subset of households who participate only in the long-term asset market. ToTEM II also assumes risk spreads faced by households and firms are exogenous. This allows the model to capture variations in the effective interest rates faced by households and firms as a result of the regulatory changes that affect the risk spreads.

In the model, the change in the short- and long-term spreads faced by households affects consumption demand. The increase in the spreads causes an increase in the effective interest rate faced by households. This gives households an incentive to postpone consumption, reducing the demand for consumption goods. The reduction in consumption in turn reduces the demand for capital by firms that produce consumption goods and, therefore, investment demand declines.

Investment demand is also affected by the change in the short- and long-term spreads firms face. The increase in the spreads causes the effective rate at which firms discount future real profits to increase. As a result, the net present value of future profits is reduced, leading to a decrease in investment demand. The decline of consumption and investment generates downward pressures on output and prices. Monetary policy reacts by cutting the policy rate in order to stabilize inflation and output gap. On the trade side, the reduction in the policy rate generates a real exchange rate depreciation that makes Canadian manufactured and commodity exports cheaper for the rest of the world. This leads to an increase in exports. In turn, the real depreciation of the Canadian dollar, combined with the decrease in the demand for consumption and investment goods, leads to a decrease in imports. Finally, the decline in consumption and investment, although partially offset by the increase in net export, leads to a decrease in GDP.

Background paper

Dorich, J, R Mendes, Y Zhang (2011): "Introducing multiple interest rates in ToTEM", *Bank of Canada Review*.

Bank of France

The model used for the Bank of France's contribution is also used for the Eurosystem's quarterly macroeconomic forecasting exercise. It fully describes national accounts and is made up of roughly 60 econometric equations, the long-term relationships being mainly consistent with neo-classical theory while short-term dynamics being more in the neo-Keynesian tradition, with the possibility to simulate a variety of shocks.

Deutsche Bundesbank

To estimate the macroeconomic effects of changes to the OTC derivative landscape, in the framework of the MAGD Macro subgroup, the traditional macroeconometric model (MEMMOD) of the Bundesbank for the German economy was used. It is designed as a central tool for German macroeconomic projections in the context of the Broad Macroeconomic Projection exercises of the Eurosystem and is used for simulation and economic policy scenario analyses at the Bundesbank. While the structure of the model strongly resembles the former German block of the multi-country model, described in Hamburg and Tödter (2005), it has undergone a number of substantial changes in order to adjust it to the requirements of the ESCB projection process. To name a few, significant modifications had to be applied to the trade equations when decoupling the block from the multi-country framework;

energy and non-energy imports have been modelled separately; and the database has been replaced with seasonal- and working-day adjusted National Accounts data. Interest rates, exchange rates, foreign demand and foreign competitors' and commodity prices are exogenous and follow the common assumptions in the ESCB projection exercises.

The MEMMOD model consists of roughly 180 behavioural equations and definitions. A majority of the behavioural equations are modelled as a two-stage error-correction process. The model is well described by neo-classical relations in the long-run, while it maintains Keynesian features in the short-run. The production technology is modelled as a Cobb-Douglas function with capital and labour as production factors. There are price and wage rigidities as well as adaptive expectations. The model distinguishes the main domestic demand components (private and public consumption, machinery and equipment, non-housing construction and residential investment), comprises the labour market, and a fiscal block with the main public expenditure and income components.

The current version of the model incorporates no explicit financial sector. In contrary to a standard DSGE model, the Bundesbank macroeconometric model features no detailed micro-foundation. Moreover, the estimation does not rely on the early available and often very useful survey indicators. Recently there has been initiated a long-term broadly-based revision process, which aims to take on board some of these points.

Background papers

Hamburg, B and K Tödter (2005): "The macroeconometric multi-country model of the Deutsche Bundesbank", in Fagan, G and J Morgan, J. (eds): Econometric Models of the Euro-area Central Banks.

Deutsche Bundesbank (2000): "Macro-Econometric Multi-Country Model: MEMMOD", documentation available on the Deutsche Bundesbank website: http://www.bundesbank.de/Redaktion/EN/Downloads/Core_business_areas/Monetary_policy/economics_macro_econometric_multi_country_model.pdf?__blob=publicationFile.

Hong Kong Monetary Authority

The quantitative model used by the HKMA is a reduced-form macro-econometric model. Following Gambacorta (2011) and Wong et. al (2011), an error correction model is developed by linking GDP with interbank interest rate (proxy by HIBOR) and lending spreads (proxy by banks' net interest margins) in Hong Kong. The estimation is based on quarterly data during 1998 Q1 – 2012 Q4.

Background papers

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Wong, E, T Fong, K Li and H Choi (2010): "An assessment of the long-term economic impact of the new regulatory reform on Hong Kong", *Research Notes*, no 5, Hong Kong Monetary Authority.

Reserve Bank of India

The macroeconomic model used to assess the impact of an increase in bank lending rates GDP in India is estimated by a structural VAR (SVAR) model, wherein real GDP growth and lending rate (weighted average lending rate) have been taken as endogenous variables. Thus these variables witness dynamic interaction among themselves and inflation and exchange rate variables have been taken as exogenous variables. In absence of quarterly data on lending rate, annual data has been used and the time period considered is from 1990-91 to 2011-12. In the analysis, it is assumed that the lending rate has a contemporaneous impact on GDP.

Bank of Italy

The model used is a reduced-scale version of the Bank of Italy Quarterly Model (BIQM) was used. The BIQM is a semi-structural large-scale econometric model which has Keynesian features in the short run and neo-classical properties in the long run. An increase in lending spreads has an effect on the steady state of the model, because it affects capital accumulation. In particular, the rise in lending spreads induces a downward adjustment in firms' demand for capital, which causes a fall in the stock of productive capital and hence in output supply.

Background paper

Locarno, A (2011):"The macroeconomic impact of Basel III on the Italian economy", Questioni di Economia e Finanza (Occasional Papers), vol 88, Bank of Italy, Economic Research and International Relations Area.

Bank of Korea

The Bank of Korea Dynamic Projection Model (BOKDPM) is a hybrid type DSGE model which modified the GPM (Global Projection Model, IMF). It is a New Keynesian small open economy model with two countries (Korea and US). The model has real and financial linkages between the Korean and US economy and incorporates trend and cyclical component, ie it does not need to restore trends with other models or processes. Parameters are estimated using Bayesian methods.

The BOKDPM has two parts, a core and satellite model. The core model consists of Korean, US economy and international commodity (oil) markets. The satellite model consists of GDP components (consumption, investment, etc.). After the core model forecasts are finalized, the satellite model uses the core model output to forecast GDP components. The model includes a financial block to reflect the increasing importance of linkages between real and financial sector after the recent global financial crisis. Bank lending tightness links real and financial blocks and influences interest rate levels, such as CD and CP rates. These processes measure the effect of credit crunch on domestic real and financial economy.

Bank of Mexico

A macroeconometric financial block is appended to an otherwise standard semi-structural small open economy neo-Keynesian model for policy analysis. The macroeconometric financial block is essentially a set of "reduced form" equations that facilitates the analysis of the effects of lending spreads, delinquency indexes and credit to the real economy. It is assumed that the channel through which the financial block impacts economic activity and, in turn, inflation is through the effect of lending spreads on economic activity.

Background paper

Samano, D. (2011), "In the Quest of Macroprudential Policy Tools", Banco de México Working Paper Series, 2011-17.

Financial Conduct Authority (United Kingdom)

As was the case in the MAG (2010) study, the National Institute Global Econometric Model (NiGEM) was used to conduct the macroeconomic simulations.[45] NiGEM is an estimated macroeconomic model, which uses a 'New-Keynesian' framework. It is structured around the national income identity, can accommodate forward-looking consumer behaviour and has many of the characteristics of a DSGE model. Unlike a pure DSGE model, NiGEM is based on estimation using historical data. It thus strikes a balance between theory and data and can be used for both policy analysis and forecasting.

Background papers

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Barrell, R, S Kirby and R Whitworth (2011): "Real house prices in the UK", *National Institute Economic Review*, no 216 pp F62–8.

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Federal Reserve Bank of New York

The FRBNY DSGE model is a medium-scale dynamic stochastic general equilibrium model. It builds on the neoclassical growth model by adding nominal wage and price rigidities, variable capital utilization, costs of adjusting investment, habit formation in consumption (as in Christiano, Eichenbaum and Evans (2005), Smets and Wouters (2007)), and financial frictions, as in Bernanke, Gertler and Gilchrist (1999) and Christiano, Motto and Rostagno (2010). The economic units in the model are households, firms, banks, entrepreneurs, and the government. Households choose how much to consume, to save in the form of the form of bank deposits and government bills, and to supply labour services to firms. Monopolistically competitive firms produce goods used for both consumption and investment. Financial intermediation involves both banks and entrepreneurs. These actors should not be interpreted in a literal sense, but rather as a device for modelling credit frictions. Banks take deposits from households and lend them to entrepreneurs. Entrepreneurs use their own wealth and the loans from banks to acquire capital, which they rent to goods producers. Entrepreneurs' revenue may not be enough to repay their loans, in which case they default. Banks protect against default risk by pooling loans to all entrepreneurs and charging a spread over the deposit rate. Such spreads vary endogenously as a function of the entrepreneurs' leverage, but also exogenously as a result of "spread shocks" which

[45] A general description and background information on the NiGEM macroeconomic model is available at http://nimodel.niesr.ac.uk/logon/economics/NiGEM%20Overview.pdf

capture changes in entrepreneurs' riskiness or other financial intermediation disturbances that affect entrepreneurs' borrowing costs. Finally, the government sector comprises a monetary authority that sets short-term interest rates according to an interest-rate rule and a fiscal authority that sets public spending and collects lump-sum taxes. The model's parameters and shocks are estimated via Bayesian methods using the following quarterly data series from 1984Q1 to the present: real GDP growth, core PCE inflation, the labor share, aggregate hours worked, the effective federal funds rate, the spread between Baa corporate bonds and 10-year Treasury yields, as well as market expectations about future policy rates based on OIS rates when possible. Details on the structure of the model, data sources, and results of the estimation procedure can be found in Del Negro, Giannoni and Patterson (2012).

Background papers

Bernanke, B, M Gertler and S Gilchrist (1999): "The financial accelerator in a quantitative business cycle framework," in J Taylor and M Woodford, eds., *Handbook of Macroeconomics*, vol 1C, Amsterdam: North-Holland.

Christiano, L, M Eichenbaum and C Evans (2005): "Nominal rigidities and the dynamic effects of a shock to monetary policy", *Journal of Political Economy*, vol 113, pp 1–45.

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Smets, F and R Wouters (2007): "Shocks and frictions in US business cycles: a bayesian DSGE approach," *American Economic Review*, vol 97 (3), pp 586–606.

Federal Reserve Board

The FRB/US model is a relatively large-scale system of equations intended to mimic the aggregate behaviour of the U.S. economy. In the parlance of the BIS, FRB/US would be called a "semi-structural" model. However one characterizes it, the model is in the broad class of New Keynesian models in that it is based on optimizing, forward-looking agents making decisions subject to sticky prices. Most of the behavioural equations are derived from economic theory and are estimated using quarterly data taken from the National Income and Product Accounts and other sources. Although expectations are explicit, the empirical fits of the structural descriptions of macroeconomic behaviour are comparable to those of reduced-form time series models. Private agents make expenditure decisions on the basis, in part, of the current and expected future evolution of user costs for the sector in question, a portion of which is a risky rate of interest. Generally speaking, monetary and fiscal policies are both endogenous in the model. In the case of the simulations carried out here, a simple Taylor rule is used, although any other reasonable policy rule would deliver similar results for the question at hand. There are a range of choices of fiscal objectives from which a user can select; in most instances, fiscal policy adjusts slowly to stabilize the deficit-to-GDP ratio. The model can be used for several different purposes, including: forecasting; evaluation of the likely consequences of aggregate disturbances for the domestic economy; and analysis of the macroeconomic effects of alternative fiscal and monetary policies. Simulations of the model can be conducted under the assumption of rational expectations, or

VAR-based expectations. For long-run simulations such as the ones carried out here, it makes no difference which form of expectations is assumed and so for computational convenience we use VAR-based expectations.

European Central Bank

The first model used was the DSGE model of Darracq Pariès, Kok and Rodriguez Palenzuela (2011). This is estimated on euro area data and has the following set of financial frictions: bank capital channel with capital accumulated out of retained earnings and adjustment costs on bank capital structure which depends on the regulatory regime; imperfect interest rate pass-through on lending rates for households and NFCs, financial accelerator mechanism for households loans for house purchase (housing wealth as collateral) as well as for NFC loans (capital stock as collateral) which allows for endogenous default rates. The model can be used in particular to assess the effects of a bank capital shock and changes in the target capital ratio, also taking into account the risk sensitivity of capital requirements. A second version of the model could be used with binding collateral constraints à la Iacoviello (2005). The model is estimated on euro area data using Bayesian likelihood methods using quarterly time series from 1986q1 to 2008q2.

The results from the first model were compared with those of the Angeloni and Faia (2013) model which incorporates banking theory in a general equilibrium macro framework and captures key elements of the financial fragility experienced during the recent crisis. In the model, the banking sector is adapted from Diamond and Rajan (2000, 2001), and banks have special skills in redeploying projects in case of early liquidation. Uncertainty in project outcomes injects risk in banks' balance sheets. Banks are financed with deposits and capital; bank managers optimise the bank capital structure by maximising the combined return of depositors and capitalists. Banks are exposed to runs, with a probability that increases with their degree of leverage. The desired capital structure is determined by trading-off balance sheet risk with the ability to obtain higher returns for outside investors in ''good states'' (no run), which increases with the share of deposits on the bank's liability side.

The results were also benchmarked against three other DSGE models, namely Gertler and Karadi (2011), Christiano et al (2010) and Kolasa and Lombardo (2013).

Background papers

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Annex 1

Terms of reference

Dear Stephen,

We are writing to follow-up on your presentation to the FSB plenary meeting on 28 January on a possible macroeconomic impact assessment of OTC derivatives regulatory reforms. As you know, the FSB endorsed the undertaking of such an assessment before the St Petersburg Summit in early September.

With this in mind, the OTC Derivatives Coordination Group (consisting of the FSB, BCBS, IOSCO, CPSS, and CGFS Chairs) requests that you coordinate an international cooperative effort to undertake a quantitative macroeconomic impact assessment of the various regulatory reforms focused on OTC derivatives markets. Specifically we would like you to chair and coordinate the effort, with BIS secretariat support, but also drawing on the expertise and resources offered by other FSB members, including the IMF as well as relevant working groups of the standard setting bodies.

From our perspective, the primary reforms of interest are those that will affect margining, clearing, collateral and capital adequacy practices related to OTC derivatives; however, to the extent possible, the effect of reforms to improve transparency and pricing efficiency in OTC derivatives markets should also be considered.

As was the case for previous groups of this type, the macroeconomic impact assessment should assess the transitory and longer-term macroeconomic benefits and costs of the proposed regulatory reforms to these markets. The macroeconomic benefits of the reforms are expected to come in the form of a reduction in forgone output from a lower frequency and severity of financial crises, as well as from more efficient allocation of capital and resources as externalities are internalised. By contrast, costs may arise from a fall in the availability or increase in the costs of the intermediation and risk transfer services supporting economic activity.

The results of the macroeconomic impact study will form an important part of public communication alongside the finalisation of the relevant international policies. In light of this, the findings of the impact study – on a preliminary basis if necessary – need to be available in advance of the September 2013 Summit meeting of the G20.

Scope

The analysis should focus on the macroeconomic impact of regulatory changes that directly affect markets for OTC derivatives with respect to areas such as margining, clearing, collateral and capital adequacy. Specifically the group should seek to examine the impact of (i) Basel III capital charges for derivatives exposures; (ii) minimum margin requirements for OTC derivatives; (iii) mandatory shift to central clearing.

Information and modelling needs

It is understood that the quality of the assessment will depend on the availability of reliable data and sound quantitative analytical methods. Authorities may need to gather firm-level OTC derivatives related exposures, including net of collateral, for major market participants, especially dealers, to assess the impact of reforms on the interconnectedness of firms. Data for end-users may be required to estimate the risks transferred across sectors. A set of quantitative assessment framework models that capture the direct impacts of derivatives market reforms on banks and other intermediaries and on the stability of the financial system, will also be required. In particular, a net benefit assessment will require models that link contagion risk in OTC derivatives markets to broader financial market functioning and the likelihood of crisis or changes in output.

Process

As you suggested, the work could be organised in two stages. The first stage would explore the availability of quantitative analytical frameworks and models as well as the availability of the data needed for these analytical methods that can be used for the impact assessment. This would include sharing of quantitative analytical work that has already been completed or is underway which considers the quantitative impact of OTC derivatives regulatory reform on the economy. Given the multitude of working groups involved in assessing the impact of the regulatory reforms, structured cooperation and coordination with these groups would be valuable. The standard setting bodies stand ready to discuss with you how far QIS data gathered by them may be able to assist this effort and if joint efforts could be considered. You should also consult other FSB member authorities who could provide input in the coming weeks. The output of this first stage would be a detailed feasibility assessment.

Conditional on the outcome of the feasibility assessment, the second stage would be the actual impact assessment. It is our expectation that (as in earlier efforts) national authorities running national models in the main derivatives centers would perform the majority of the analysis of costs and the potential benefits in terms of reduced contagion risk and the mapping of this to the impact on macroeconomic output. In order to facilitate the analysis at the global level, which would be coordinated by the BIS, the national authorities should to the extent possible work according to a common protocol to ensure some consistency in national assessments. The quantitative information gathered should as far as possible be shared with relevant standard setting bodies to assist them with their objectives.

We would be pleased to have the results of the feasibility study by late March, and look forward to receiving a draft report for the FSB meeting on 25-26 June 2013.

Sincerely yours,

Mark Carney	Stefan Ingves	Masamichi Kono	Paul Tucker
FSB	BCBS	IOSCO	CPSS

Annex 2

Key features of regulatory reform scenarios

Scenario	Pre-reform scenario	Central scenario	Low-costs scenario	High-costs scenario
Mandatory central clearing				
Coverage	40% of outstanding notional amount of OTC derivatives cleared centrally.[1] By market segment: CM = 10%; CR = 10%; EQ = 0%; FX = 0%; IR = 50%. Assumed that only dealers clear centrally and that there is one CCP in each market segment.[2]	60% of outstanding notional amount of OTC derivatives cleared centrally.[1] By market segment: CM = 50%; CR = 55%; EQ = 55%; FX = 15%; IR = 70%. Reflects central clearing of all clearable products in BCBS-IOSCO (2013) QIS. These include major-currency basis swaps, FRAs, IRS and OIS; major index CDS and many single-name CDS; bilateral equivalents of XTD commodity swaps and FX options; and single-name equity swaps and options. FX forwards and swaps and NFIs assumed exempt. CCPs as in pre-reform scenario.	As for central scenario, plus central clearing of inflation swaps, swaptions, additional CM, EQ and FX options and more single-name CDS. Hence, 70% of outstanding notional amount of OTC derivatives cleared centrally.[1] By market segment: CM = 80%; CR = 60%; EQ = 70%; FX = 20%; IR = 75%.	As for central scenario.
Implications for netting	For derivatives dealers and other banks, the ratio of net to gross exposures for centrally cleared trades is one quarter of the ratio for bilateral trades. For other derivatives users, the centrally cleared and bilateral ratios are the same.	For derivatives dealers and other banks, gross exposures moved on to CCPs net down to one quarter of previous bilateral amounts. (Hence, with more central clearing, total net exposures fall). For other derivatives users, net exposures remain constant.	As for central scenario.	For all market participants, moving gross exposures on to CCPs does not affect net exposures.
Margin requirements				
Centrally cleared	As for central scenario.	Initial margins on centrally cleared positions assumed to cover PFEs, which are calculated as 99.5th-percentile five-day losses where necessary. Variation margins cover CEs.	As for central scenario.	As for central scenario.
Non-centrally cleared	Variation margins exchanged in 70% of cases; 80% of which are two-way exchanges and 20% are one-way. Initial margins rarely exchanged.	Initial margins on non-centrally cleared positions (excl FX forwards and swaps, which are exempt) cover PFEs, which are calculated as 99th-percentile 10-day losses where necessary, less a €50 million counterparty "threshold". Variation margins cover CEs. NFIs assumed exempt from these margin requirements.	As for central scenario.	As for central scenario.
Bank capital requirements				
DR charge	Computed using the CEM formula (with NGRs that vary with counterparty). Applied to all positions.	Computed using the CEM formula (with NGR of 1). Applied fully to positions with NFIs (assumed BBB-rated), while PFEs for financial institutions (assumed A-rated) are limited to no more than the €50 million initial margin threshold.	As for central scenario (although with more central clearing in this scenario, the base of the CCR charge – uncollateralised bilateral exposures – falls).	As for central scenario.
CVA charge	Not applicable.	Computed using the standardised CVA formula (with no CDS hedges). Applied fully to positions with NFIs (assumed BBB-rated), while PFEs for financial institutions (assumed A-rated) are limited to no more than the €50 million initial margin threshold.	As for central scenario (although with more central clearing in this scenario, the base of the CVA charge – uncollateralised bilateral exposures – falls).	As for central scenario.
CCP trade exposure and default fund charges	Not applicable.	Assumed that trade and default fund exposures to CCPs satisfy BCBS (2012) conditions for 2% and 1250% risk weights, respectively. Size of potential trade exposures and default fund contributions based on historical relationships with initial margins. Total risk-weighted exposures to CCPs capped at 20% of trade exposures.	As for central scenario.	As for central scenario.

CM = commodities; CR = credit; EQ = equities; FX = foreign exchange; IR = interest rate; CCP = central counterparty; QIS = quantitative impact study; IRS = fixed-to-floating interest rate swaps; FRA = forward rate agreements; OIS = overnight index swaps; CDS = credit default swap; XTD = exchange-traded; NFI = non-financial institution; PFE = potential future exposure; CE = current exposure; CCR = counterparty credit risk; CEM = current exposure method (which maps CEs to PFEs, based on notional amounts and the NGR); NGR = net-to-gross ratio (of market value of OTC derivatives positions after and before netting); CVA = credit valuation adjustment.

[1] Figures adjusted for the doubling of contracts that occurs with central clearing. This replaces a contract between counterparties A and B with, first, a contract between A and a CCP and, second, a contract between the same CCP and B. On this adjusted basis, the outstanding notional amount of all OTC derivatives was $480 trillion in the pre-reform scenario. It is assumed to remain at this level in the post-reform scenarios. [2] Although the trade volumes cleared by EQ, FX and CM CCPs are small in the pre-reform scenario.

Annex 3

Summary of discussions with market participants

In addition to several ad hoc discussions, MAGD organised a meeting with OTC derivatives market participants at the Bank of England on 15 May 2013. Twenty eight private sector institutions were represented at this meeting, including derivatives dealers, clearing houses and other market infrastructure providers, hedge funds, pension funds, investment managers and non-financial companies. The discussions focused on the potential effects of reforms to OTC derivatives regulations related to central clearing, margining and bank capital requirements.

Central clearing

There was widespread support for more central clearing. However, this was subject to an important caveat: that the safety of positions with central counterparties (CCPs) had to be unquestionable. Hence, CCPs should not clear illiquid derivatives, which could undermine their robustness.

Some discussants suggested measures that could raise even further the perceived safety of positions with CCPs. In turn, this might encourage more central clearing. One suggestion was for more transparency about the risks and risk-absorption capacity held by CCPs. Another was for more clarity about CCP access to central bank liquidity lines and frameworks for their resolution. A third idea was to enhance the protection of collateral under central clearing (where cash and securities are often held in omnibus accounts at the CCP or one of its Direct Clearing Members (DCMs)) to include that often found in bilateral agreements (where tri-party accounts guarantee the return of particular securities). Fourth, portability arrangements, which allow for the transfer of positions from a defaulting DCM to another DCM, needed to be robust, including in times of stress. One derivatives user saw value in portability across clearing systems.

Reflecting the liquidity of different types of derivatives, discussants agreed that prospects for central clearing varied enormously by market segment. For example, essentially all interest rate swaps on major currencies could be cleared centrally, while no equity derivatives referencing smaller emerging market indices were clearable. Also because of their illiquidity, bespoke derivatives were not seen as clearable. Shorter-dated contracts were more likely to be cleared centrally than longer-dated ones. Across the whole of the OTC derivatives market, the expectation was that 70% of outstanding notional amounts could be cleared centrally.[46]

Discussants were much more uncertain of the effects of more central clearing on netting. In part, this depended on the number of CCPs in each segment of the market (some concentration relative to the present state was widely expected) and whether these CCPs would interoperate (formidable legal challenges made this unlikely in the next several years). It also depended greatly on the portfolios of

[46] This figure, which is equivalent to a little under 60% if the doubling of centrally cleared contracts is reversed, is close to the central-clearing proportion in MAGD's central scenario.

market participants. Some hedge funds had already significantly reduced their net counterparty exposures by moving derivatives to CCPs. Dealer banks had also gained more from netting particular types of derivatives with CCPs than they had given up from netting across derivative types on a bilateral basis. In contrast, scope for non-financial companies to enhance netting was much more limited, as their "one-directional" positions generated many fewer offsetting positively valued and negatively valued contracts. Moreover, institutional investors and some non-financial companies were concerned that their net exposures could increase under a central clearing mandate. For example, pension funds holding interest rate swaps and inflation swaps with common counterparties would have to break apart these netting sets under the current clearing structure, since there are CCPs for interest rate swaps but not for inflation swaps.

Derivatives users noted that netting gains would be enhanced if CCPs could clear more types of derivatives. They listed inflation swaps, basis swaps, swaptions and other options as products they would like to clear centrally. On the one hand, CCPs were keen to accommodate these customer requirements, but on the other hand, they had to adequately model and test new products before offering to clear them. Another possible solution for market participants who might experience reduced netting efficiencies was to use a multilateral compression service. One infrastructure provider aimed to bring together institutions whose netting sets would be broken apart in opposite ways and to compress these on a multilateral basis.

Several non-dealers highlighted the operational costs of central clearing, which could be a heavy burden for many smaller users of derivatives. These included the one-off legal costs of appointing DCMs as well as ongoing costs of managing collateral and administering margin payments. One large non-financial company estimated that it might need to double the size of its treasury department from around a dozen staff to manage these tasks. Others said that they preferred to manage their OTC derivatives counterparty risk (through diversification and other means) than face these new challenges. They also suggested that the marginal benefit of incorporating these non-systemic firms in the network of centrally cleared exposures would be smaller than the extra costs that they would incur.

End users also noted difficulties related to the strict collateral requirements of central clearing. CCPs only accept cash for variation margin and high-quality liquid securities like government bonds for initial margin. End users typically do not hold substantial quantities of these assets. An advantage of bilateral clearing for them was being able to negotiate posting of collateral assets that they do hold.

Margining

The major dealers were content to post and receive variation margin against current bilateral derivatives exposures as described in the joint February 2013 proposal of the Basel Committee on Banking Supervision (BCBS) and the International Organization of Securities Commissions (IOSCO). This was conditional on non-segregation of variation margins from different customers, which could then flow from one to another via the dealers. Indeed, with roughly balanced derivatives books, margin inflows and outflows would be quite even as long as institutions on one side of any market segment were not exempted from posting. If they were, the dealers would need to maintain higher liquidity buffers. They would also need more liquidity in case margin inflows and outflows were not synchronised. This could often arise within the trading day, as dealers may need to post margin to CCPs on behalf of clients before receiving margin from those clients. However, the dealers associated substantial benefits with variation margins, not least from the limitation of losses to a modest proportion of exposures when Lehman Brothers failed.

In contrast, the major dealers had a number of objections to posting initial margin against potential future bilateral derivatives exposures:

First, this would require a lot of additional collateral, which they would have to fund. One major dealer estimated that initial margins might total €0.7–1.7 trillion across the market. An equal value of (post-haircut) collateral would then be required, since initial margin collateral cannot be re-hypothecated under the BCBS-IOSCO standards. Although dealer banks already held unencumbered assets worth much more than this amount, only a small subset of these assets were reportedly eligible for initial margin. This distinction was said to account for one of the results in the Quantitative Impact Study of the BCBS-IOSCO proposals, which suggested that dealer banks already had more than enough assets available to cover initial margin requirements. Rather, one of them said that it would need to double its typical annual long-term unsecured debt issuance to fund these margin requirements.

Second, some dealers thought the extra demand for initial margin collateral would be significant relative to its supply, leading to higher collateral prices. Some of them expected that this would start to affect prices from mid-2014, as the largest derivatives dealers prepared for the BCBS-IOSCO standards to take effect from the start of 2015. They thought this would be compounded by additional demand for collateral assets related to Basel III's Liquidity Coverage Ratio. Other dealers thought there was sufficient collateral in the financial system to avoid noticeable price effects, but that it was not always in the right institutions. New collateral transformation services could solve this problem. However, this business did not appeal to some of the dealer banks because it quickly grows balance sheets. It was therefore suggested that only a few would offer the service, which could be expensive given the limited competition.

Third, the dealers expressed concern about procyclicality of initial margins. Although the way initial margins are calibrated in the BCBS-IOSCO proposals limits this effect, they could still rise somewhat when financial markets became more volatile. Dealers would then simultaneously need to post more collateral, for which they would need more funding. One dealer bank estimated that it would need to raise tens of billions of dollars in times of severe market stress. This was seen as a major challenge, since it could not raise even a few billion dollars during the market stress of late 2008.

Fourth, the dealers argued that trade-off between the benefits and costs of initial margins deteriorated as the size of the margin requirements increased. The cost of funding each extra dollar of initial margin was constant or increasing as institutions took on more debt. In contrast, the benefit of posting marginal units of collateral diminished, since it became increasingly less likely that losses in the event of default would be large enough to cause this collateral to change hands.

Many non-dealers also had significant concerns about the BCBS-IOSCO bilateral margin standards. While these would eliminate counterparty credit risks, they would create new costs and risks associated with liquidity management, and the non-dealers were less comfortable with these new challenges. These included modelling the value of derivatives portfolios, sourcing collateral and making high-frequency margin payments.

Non-financial companies highlighted the difficulties of posting cash for variation margins. These could be large, given the one-directional positions often held by the companies. For example, one firm that used foreign exchange swaps to stabilise the local currency value of its overseas earnings estimated that a 10% change in the USD/GBP exchange rate could require it to post cash worth 5–10% of its total assets as variation margin. Another company highlighted the cost and difficulty of transferring funds for variation margin payments to its affiliates around the world sufficiently quickly. It also noted that it would have to borrow some of the needed cash, generating a credit exposure for the lender instead of the original derivatives counterparty. Finally, another firm raised the question of what it would do if it was in-the-money and received variation margin. It was not a bank and, hence, not in the business of scouring money markets for the best short-term returns on excess liquidity.

Institutional asset managers highlighted some of the difficulties for them of posting initial margins. They also had one-directional positions, so initial margins would be large. They had many assets on their balance sheets, but often not enough high-quality liquid securities, which would be needed for initial margins. Some managers suggested they would adjust their portfolios to include more high-quality liquid securities. This would reduce expected returns for their investors. Other managers thought they might use collateral transformation services. One manager reported an offer from a bank to swap equities for a total return swap on the same equities plus some collateral that was eligible for initial margins. However, this introduced counterparty credit risk on the total return swap.

The two-way positions of hedge funds would help to limit their variation and initial margin requirements, but some were concerned that these might still be high. In particular, they were concerned that only the major dealer banks would be allowed to use internal models to determine bilateral margin requirements. The alternative standardised approach tended to produce much higher margin requirements.

Relatedly, discussants suggested that margin requirements for non-centrally cleared trades might have a greater effect on financial businesses in the Asia-Pacific region than in Europe or North America. This reflected more widespread use of the standardised approach in that region.

Bank capital requirements

Dealer banks expected to boost their capital ratios in response to the regulatory reforms. The new capital requirements that would make the most difference were the credit valuation adjustment (CVA) charge, the capital charge on exposures to CCP default funds and possibly also charges on trade exposures to any CCPs not recognised by local regulators.

The CVA component of the counterparty credit risk (CCR) charge could significantly increase CCR capital requirements. One bank anticipated a threefold increase, with multiples of five to 10 for long-dated exposures and much smaller multiples for short-dated exposures. Another bank expected increases across the banking sector of 50–300%, again with much larger proportionate increases for long-dated exposures, especially where those exposures related to one-directional positions that would reduce the credit quality of the counterparty when they fell in value. Reflecting this, exposures to non-financial companies were expected to attract much higher capital charges, as these firms have been exempted from posting collateral and their positions are often long-term and one-directional. Similarly, it was suggested that FX and cross-currency derivatives, in the absence of central clearing solutions, could become much more expensive due to capital charges under Basel III.

Although the new capital charge for CCP default fund exposures was also expected to be significant, this forecast was quite uncertain. This was partly because a review of this capital charge was in progress. It also reflected uncertainty about the size of default funds that CCPs would maintain in a world of more comprehensive central clearing.

In addition, there was a possibility of high new capital charges on certain CCP trade exposures. Banks were most concerned about exposures to Asian CCPs, which may not be recognised as "qualifying CCPs" by US and European regulators. If that were the case, the risk weight applied to these exposures would be 50% instead of 2%. It would then be commensurately more costly for US and European banks to supply derivatives cleared on Asian CCPs.

Non-dealers expected dealer banks to pass on to them most of the costs of holding more capital. The dealer banks acknowledged that this would probably happen. Some of it would occur directly, through less favourable pricing of OTC derivatives. In particular, FX forwards and swaps could be affected if these products were exempted from margin requirements. And, given the prevalence of different currencies around the world, this could affect businesses trading in Asia much more than those concentrating on North American or European markets. In addition, some passing-on of costs could happen indirectly, by raising the price of loans to clients who were also derivatives counterparties. Non-dealer banks might also raise the cost of loans if it became more expensive for them to hedge these credit exposures with credit default swaps (CDS).

End users were clearly aware of a link between bank capital needs and OTC derivatives prices. Several end users had already noticed a deterioration in pricing in recent years as bank capital requirements had increased. Some had also noticed improvements in pricing when exposures with them were exempted from the prospective CVA capital charge. Despite this clear link to derivatives pricing, end users said they were content to pay a bit more if this was associated with a safer banking system. Some of them also preferred this to collateralising their derivatives exposures, as the latter would force them to undertake more active and costly liquidity management. Some end users indicated a preference for managing credit risk by diversifying across bilateral counterparties.

Market participant reactions to the new regulation

Some discussants suggested that higher costs of non-centrally cleared OTC derivatives would cause market participants to rely increasingly on standardised instruments. For example, they could use exchange-traded futures and options or cleared OTC derivatives. This was despite these instruments offering imperfect hedges. That said, residual risks could then be hedged with relatively small quantities of bespoke derivatives.

Not using derivatives at all because of higher costs seemed a step too far, certainly for large institutions. It was, however, seen as more likely that smaller firms could find it difficult to justify the infrastructure costs of complying with the new regulations. As a result, it was suggested that some smaller pension funds and non-financial companies might choose to hedge much less or not at all.

If the number and diversity of derivatives users did contract in some segments of the OTC derivatives market, then the liquidity of these products was expected to decline. Furthermore, it was suggested that the liquidity of some clearable products could fall enough to prevent them being cleared centrally. The cost of derivatives use would then probably rise further, not least because of breaking netting sets with CCPs.

Annex 4

Participating institutions and authorities

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Reserve Bank of Australia

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Skander van den Heuvel
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