FEATURE ARTICLE

A first analysis of derivatives data in the Hong Kong Trade Repository

by Monetary Management Department

As part of global regulatory reforms, the HKMA started in 2013 to collect derivatives data through the Hong Kong Trade Repository. This article describes the data collected in the month of November 2014 and the patterns observed. Given the limited coverage of the current reporting requirements, the analysis is not meant to be a description of the Hong Kong derivatives market as a whole. The aim is to contribute to the discussion by central banks and researchers on how to bring more transparency to derivatives markets using the data collected by trade repositories.

Introduction

As part of the international regulatory reforms that followed the global financial crisis, Hong Kong is in the process of implementing a reporting framework with the objective to improve transparency in the market for over-the-counter (OTC) derivatives.

The data collected by trade repositories on OTC derivatives differ in many ways from standard regulatory data. They shift the focus away from the balance sheet of each financial entity in isolation and put the spotlight on how financial activities and products link institutions into multiple networks of counterparty relationships. At times of market stress, these networks can serve as conduits of contagion and amplifiers of stress, hence the interest from regulators to understand their structure.

The challenge for regulators is to devise ways to aggregate the data — typically thousands of trades between institutions, with different product types, maturities and currencies — in ways that help understand how the OTC derivatives market works, which institutions are critical to its functioning and whether the market structure changes.

In Hong Kong, an interim phase of reporting requirements (ahead of full statutory ones) took effect in August 2013 requiring licensed banks to report their transactions in two derivatives products, interest rate swaps and non-deliverable forwards, to the Hong Kong Trade Repository (HKTR). The HKTR was set up by the HKMA as a result of the decision to centralise the information in one single data repository with direct access by the regulators.

Using data collected during the month of November 2014, this article presents an initial framework for analysing this new data source to assess the financial stability of the market and potential risks. It presents stylised facts on the part of the market covered by reporting requirements and identifies the core institutions key to its functioning. Due to the partial nature of the data, it cannot be taken as an exhaustive description of the OTC derivatives market in Hong Kong. A more comprehensive picture will be available when the reporting requirements are implemented in full and data sharing starts to take place with other jurisdictions.

Why reporting of OTC derivatives to trade repositories

In 2008 Lehman Brothers and AIG were large, global financial institutions with footprints in several products and countries. OTC derivatives played an important role in the demise of both institutions in the space of a few days. At Lehman Brothers, the vast number of derivatives contracts on its balance sheet linked the investment bank to thousands of counterparties and indirectly to their counterparties. Through interconnectedness, stress on Lehman Brothers' balance sheet spread to large swathes of the financial sector just like diseases spread through contagion. At AIG, derivatives played an even larger role. Losses and collateral calls associated with derivatives brought the institution to its effective default; the threat from interconnectedness led to its bailout. When market participants and regulators realised that no comprehensive map of the connections in the financial system was available and that such a large firm as AIG could collapse from a set of misjudged derivatives contracts, their confidence in the efficiency of the self-regulated world of OTC derivatives evaporated.

Financial contagion between institutions and across markets is now regularly identified as one of the key vulnerabilities in the financial system.[1] Several policy responses have emerged in the fields of supervision, macroprudential policy and resolution. With OTC derivatives a potential conduit for contagion, global regulators set themselves the two objectives of improving transparency in the derivatives market and to reduce the counterparty risk that any single financial institution can pose.[2] To serve these objectives, the G20 countries are in the course of adopting two key requirements: that all OTC derivatives transactions are reported to trade repositories and that all standardised OTC derivatives transactions are cleared at central counterparties. Hong Kong is implementing the new requirements in phases.[3] The Financial Stability Board monitors progress in implementing these reforms. While the overall package of reforms might increase banks' operational costs, the expectation of the regulatory community is that the increased costs will be outweighed by the economic benefits of reducing the likelihood of future disruptions to the financial system.[4]

Studying financial networks to understand interconnectedness and contagion

In the financial system, market participants interact daily through multiple financial activities and product exchanges. OTC derivatives, like securitisation and interbank lending, give rise to networks of institutions engaged in, and interlinked via, that specific financial activity. Since different products attract different market participants, each product generates a distinct network. Institutions key for the functioning of one network may be irrelevant in another.

1 Financial Stability Board (2015), "FSB plenary meets in Frankfurt", press release, 27 March; European Systemic Risk Board (2015), "ESRB General Board meeting in Frankfurt", press release, 26 March.

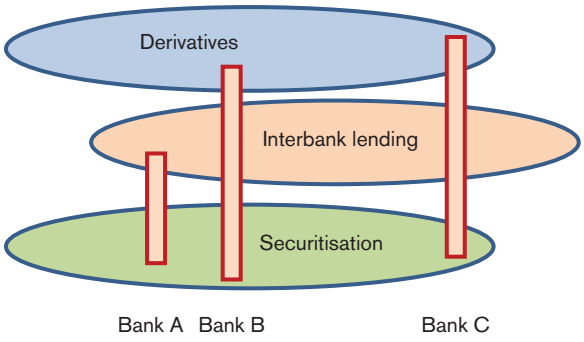
2 G20 Leaders (2009), "The Pittsburgh Summit", statement, 24-25 September.

3 For more detail the following references are available on the HKMA website: "Developing a Trade Repository for OTC Derivatives Trades in Hong Kong", press release, December 2010; "Interim reporting requirements for OTC derivatives transactions", circular (June 2013); Conclusions on consultations on the Securities and Futures (OTC Derivative Transactions — Reporting and Record Keeping Obligations) Rules (November 2014, May 2015).

4 Bank for International Settlements (2013), *Macroeconomic impact assessment of OTC derivatives regulatory reforms*.

The networks of institutions created by trading different financial products combine in the financial system as "an interlocking set of individually complex webs", stacked one on top of the other like layers (Figure 1).[5] Interlinkages between institutions and between products allow financial stress to migrate from one institution to another and from one layer to another.

FIGURE 1
The financial system as a set of interlocking layers of products and financial activities



The risks intrinsic to this kind of connectivity became apparent in 2008 when "the mortgage originated by a bank was repackaged by a SIV, that financed it through ABCP, that was bought by a MMF, into which a retail investor placed their savings".[6]

Interlinkages can arise via direct counterparty exposures, via indirect exposures (i.e. by being the counterparty of a counterparty), or via immaterial effects linked to confidence, perceptions and similarities. The latter can be just as powerful as the former two in creating cascading effects between institutions.

To understand contagion in financial networks, economists and regulators have taken an interest in network theory, originally developed in physics to visualise how forces bind together structures such as atoms. Medicine used it to study the propagation of diseases through contagion. The rise of social networks and internet data more recently generated practical applications for social sciences aiming to identify how complex webs of people or information are linked.

To date the main insight for the study of financial stability is that networks generated by financial products tend to have a core-periphery structure. Table 1 describes the pattern of flows between financial entities under this network model. The core is characterised by a small set of institutions intermediating the majority of exchanges in the market, mostly with each other. In contrast, institutions at the periphery of the network are less active in the market and tend to trade with institutions in the core but not with each other. Several papers have found this pattern in the credit default swap (CDS) market (in the EU and in the US) and in the interbank market in various countries (the UK, Germany, Italy and India).[7]

TABLE 1
Typical pattern of flows in core-periphery networks

	Core	Periphery
Core	High	
Periphery	Medium	Low

[5] Quote from Haldane, AG (2015), "On microscopes and telescopes", speech at Lorentz centre, Leiden, 27 March. See also: Haldane, AG (2009), "Rethinking the Financial Network", speech at the Financial Student Association, Amsterdam, 28 April; Zhou Xiaochuan (2013), "The multi-layered feature of capital market", The People's Bank of China, speech.

[6] Carney, M (2014), "The future of financial reform", speech at the Monetary Authority of Singapore, 17 November.
SIV is special investment vehicle, ABCP is asset-backed commercial paper, MMF is money market fund.

[7] The key paper to generate the insight of the core-periphery structure is by Craig, B and G von Peter (2010), "Interbank tiering and money center banks", BIS Working Paper 322 (later published in *Journal of Financial Intermediation*, 2014). Applications are found in: ESRB (2013), "Assessing contagion risks from the CDS market", Occasional Paper 4; Langfield, S, Liu, Z and T Ota (2014), "Mapping the UK interbank system", Bank of England working paper 516; Markose, S and S Giansante (2011), *Financial Stability Report*, Reserve Bank of India, pp. 61–63, June.

Gai and Kapadia (2010) noted a "robust-yet-fragile" tendency in financial systems: while the probability of contagion may be low, the effects can be extremely widespread when problems occur.[8] The core-periphery structure reinforces this tendency by giving a powerful role to the core institutions. Core institutions are able to influence the rest of the network through their large share of the intermediation activity (concentration) and numerous counterparty links (interconnectedness). Core institutions' own financial health is typically the key to whether they act as a stabilising or destabilising force. If a shock hits the network, they can either stabilise it by absorbing the shock and keeping it localised, or they can propagate the shock to the rest of the network and potentially amplify it. Furthermore, the complexity of a network and lack of information about how individual institutions are involved can generate herd effects that further amplify the impact of a shock. With the benefit of hindsight, AIG and Lehman Brothers in 2008 were core institutions in several of the financial networks they were involved in.

New data sources: horizontal data on financial activities

Possible paths of financial contagion are hard to map using supervisory data alone. Supervisory data tend to have a vertical perspective, focused on individual financial institutions. They allow a detailed analysis of an institution's balance sheet, its business model and product mix, but other than the largest exposures, it is typically not possible to build an exhaustive picture of its counterparties and the counterparties of counterparties.

The nature of the data collected by trade repositories is different. They have a horizontal perspective showing how a financial activity binds institutions into a network — the distribution of a product among its holders, whether its holdings are concentrated or widespread, who the largest players are in the market and how they interact with one another. In short, they allow mapping concentration and interconnectedness.

Each perspective gives a partial and complementary picture of financial institutions and their role in the financial system. The horizontal perspective allows mapping the chain of exposures between institutions and the potential cascading effects from one another; but lacks the depth of knowledge about each institution's unique mix of products and customers which ultimately determines whether market participants have confidence in the institution. The vertical perspective allows a good grasp of the fundamentals of an institution, but tends to miss the interactions with the rest of the financial system that can propagate contagion and amplify stress. The journey towards understanding how to fully exploit the synergies between the two types of data is only at the beginning.

Visualising horizontal data to describe the shape of networks can improve the understanding of interlinkages and uncover patterns in the distribution of interconnections not seen in summary statistics or other types of quantitative or distributional analysis.[9] Later sections of this article use visualisation techniques to describe the network structure of the OTC derivatives data collected by the HKTR and to identify core-periphery patterns.

[8] Gai P and S Kapadia (2010), "Contagion in Financial Networks", *Proceedings of the Royal Society*, vol. 466, no. 2120, pp. 2401-2423.

[9] Paddrik ME, Haynes R, Todd A, Scherer W and P Beling (2014), "Visualizations for Financial Market Regulation", Office of Financial Research (OFR) Staff Discussion Paper.

A framework for analysing financial stability risks from OTC derivatives

In setting out to assess the risks to financial stability from OTC derivatives, the horizontal and the vertical perspective complement each other (Table 2).

The vertical perspective analyses the derivatives portfolios as one component of the broader balance sheet of an institution; it assesses the overall risk exposure and the robustness of the risk management framework.

The horizontal perspective exploits the distribution of OTC derivatives among institutions to understand two additional dimensions. First, horizontal data can help map out who holds what on the derivatives market, which institutions would be most affected by a shock in a specific product and the interlinkages that might propagate contagion. Second, horizontal data can help imagine how the reactions to a shock by market participants might combine into potentially destabilising effects for the financial system and how liquidity in derivatives might evolve in response to shocks.

On the first horizontal dimension, the complementarity with vertical data is clear. The mapping of linkages and interconnections between two financial institutions should be viewed in the context of the total exposure between two institutions. Trade repository data map the distribution of derivatives, but financial institutions have also other financial products on their balance sheet. Exposures in OTC derivatives and in other products may respond to market movements with additive as well as offsetting effects to each other. One near-term challenge for regulators is how best to integrate the two different views of derivatives to maximise the information available.

The second dimension in which horizontal data can help is to build consistent scenarios of how the rest of the market would react if an institution became impaired and how liquidity would change. During the global financial crisis, damaging feedback loops were observed — losses at some institutions created a series of defensive responses by other market participants which materially exacerbated the impact of the financial crisis.[10] In the case of OTC derivatives or other complex assets whose value is difficult to ascertain quickly, the potential for such systemic effects can be larger because they can suffer larger mark-downs than a thorough analysis of fundamentals would suggest.

Ultimately the horizontal and the vertical view bring different information to the table and should be integrated into a unified risk assessment.

TABLE 2
Analysing financial stability risks from OTC derivatives

↓	→
Focus on entities	**Focus on derivatives binding institutions into a network**
Risks from institutions using derivatives with inadequate risk management	Risks from the network structure and potential for contagion
	Risks from defensive responses of market participants and changes in market liquidity

[10] Institutions facing losses on their assets and writing off capital accordingly were downgraded by rating agencies. In reaction, their counterparties raised collateral calls, which led the stressed institutions to liquidate assets via fire sales at reduced prices. By depressing the price of the assets in the market, the impact of the initial stress spread to other institutions that had to mark down the value of their assets accordingly and led to further downgrades.

Stylised facts on the OTC derivatives data in the Hong Kong Trade Repository

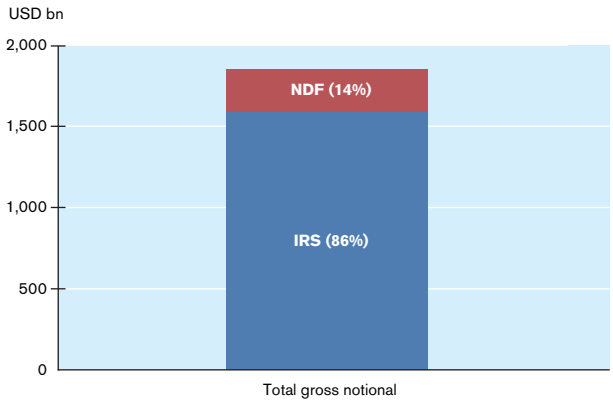
Under the interim reporting requirements in force in Hong Kong, at the end of November 2014 the HKTR had detailed information on over 73,000 OTC derivatives positions with a total notional amount of US$1,854 billion. A survey run half-yearly by the HKMA suggests that, at the end of June 2014, the total derivatives notional amount on the balance sheet of authorized institutions in Hong Kong was HK$71,140 billion (around US$9,180 billion).[11] Assuming the size of the market remained broadly constant in the intervening time, the interim reporting requirements, which cover a subset of products and institutions, captured approximately a fifth of the total notional amount. The coverage is going to increase as the reporting requirements are extended to all asset classes.

Interest rate swaps (IRS) and non-deliverable forwards (NDF) were chosen under the interim reporting requirements because of their large market share in Hong Kong and their perceived systemic importance to the local market. IRS, typically the largest asset class in every jurisdiction, serve the need or desire by financial institutions or businesses to insure their balance sheet against interest rate movements. NDF are used to exchange flows referencing commodities or currencies that are not freely exchangeable, a feature of a number of emerging markets' currencies.

The notional amount of OTC derivatives reported to the HKTR comprised US$1,592 billion in IRS and US$262 billion in NDF — a split of 86% and 14% (Chart 1). Just over a third of the gross notional value of the HKTR positions was cleared with central counterparties, predominantly by institutions with large international operations.

Around 80 licensed banks reported their derivatives positions against other licensed banks, as required by the rules in force, and also in some cases against a broader set of counterparties, likely in anticipation of the full scope of reporting requirements. Grouping institutions at the parent level, the data included 71 financial groups as reporting entities and 109 as counterparties (Chart 2).[12] Of these, the vast majority has some cross-border operations. Around 13% of gross notional positions were between entities within the same financial group, more often in NDF than in IRS (25% vs 12% of gross notional respectively).

CHART 1
Gross notional positions in the HKTR

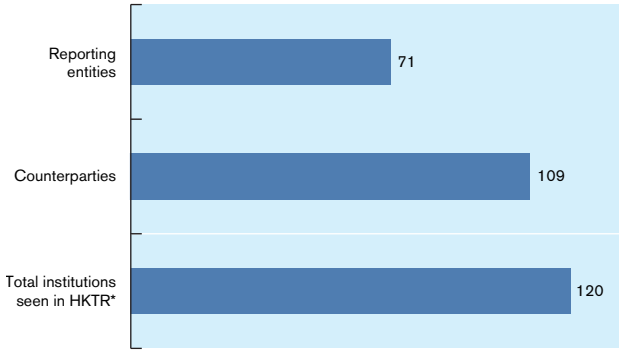


Sources: HKTR data and HKMA staff calculations.

[11] Hong Kong Monetary Authority (2014), "Results of surveys on selected debt securities and off-balance sheet exposures to derivatives and securitisations", *Quarterly Bulletin*, December.

[12] The choice of grouping reporting entities and counterparties under their parent institution is aimed at identifying the key economic nodes in the derivatives network. Other types of analysis might prefer other approaches — an analysis of exposures in case of default would prefer to maintain the legal distinction between entities fully guaranteed by their parent and those that are not.

CHART 2
Institutions included in the HKTR



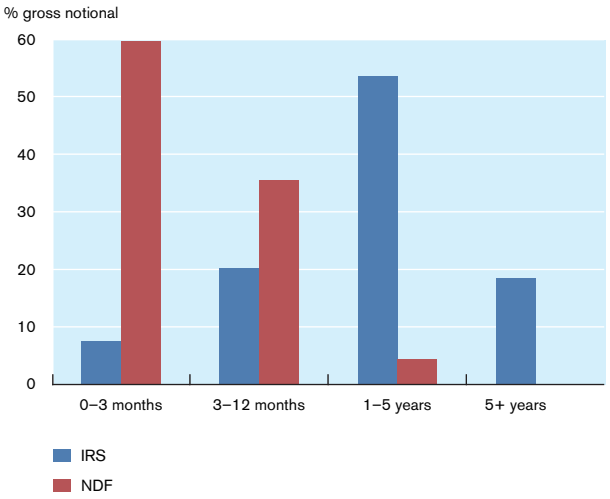
* Some institutions are both reporting entities and counterparties.

Sources: HKTR data and HKMA staff calculations.

A total of 41 licensed banks booked new trades over the month. The average weekly turnover of OTC derivatives in November 2014 was US$46 billion as measured by new trades, split into US$18 billion of IRS and US$28 billion of NDF.

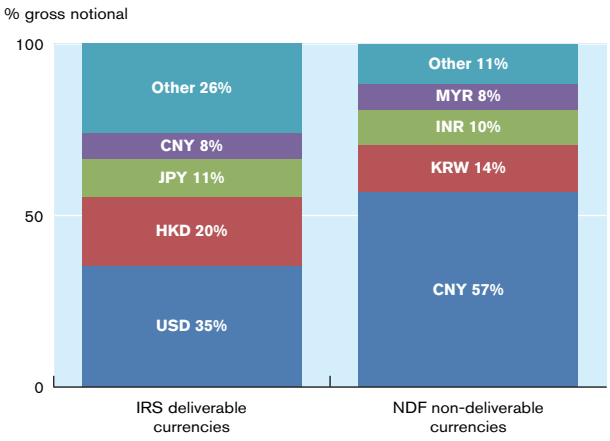
The larger share of NDF in turnover than in positions is due to their shorter average maturity. Nearly 60% of NDF in the HKTR had a residual maturity of up to three months, in contrast with a residual maturity of over one year for nearly 70% of IRS (Chart 3). Another difference between the two products is that IRS positions tend to have larger notional amounts. The average gross notional of an IRS contract (US$31 million) is nearly three times as large as the average gross notional of a NDF contract (US$12 million).

CHART 3
Maturity of IRS and NDF positions



Sources: HKTR data and HKMA staff calculations.

CHART 4
Currency breakdown of IRS and NDF positions



Sources: HKTR data and HKMA staff calculations.

The most widely used currency for IRS is the US dollar (35% of gross notional), followed by the Hong Kong dollar (20%), the Japanese yen (11%) and the renminbi (8%) (Chart 4). The remainder comprises a broad array of other Asian, European and emerging market currencies. In NDF, the most common non-deliverable currency is the renminbi (57% of gross notional), followed by the Korean won (14%), the Indian rupee (10%) and the Malaysian ringgit (8%), against the US dollar as deliverable currency.

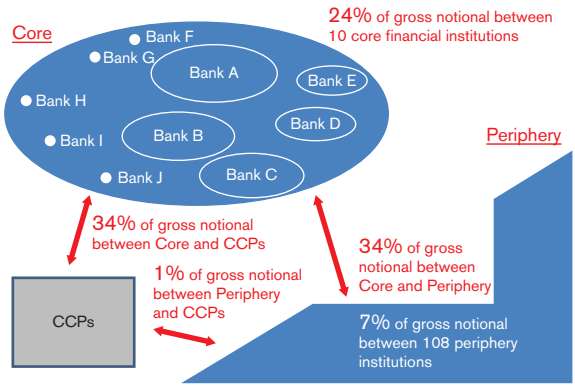
The network structure in the HKTR derivatives data

Consistent with findings from other financial markets and countries, the data on OTC derivatives collected by the HKTR have a core-periphery structure. Chart 5 maps the network structure of the HKTR data — institutions are the nodes of the network and the derivatives trades they report between each other (measured by gross notional) are the links between the nodes.

The core is identified as the institutions that rank highly on each of three measures of concentration, interconnectedness and complexity. The ranking is within the same data set — it is unclear whether a high value would also be high in global data because of the absence of international benchmarks for these measures. For each institution, concentration is measured by the gross notional of derivatives positions; interconnectedness by the number of counterparties; and complexity by the number of derivatives positions on balance sheet (or trade count). The intuition is that institutions that intermediate a large share of the market have the potential to stabilise or destabilise the system; that the number of connections to other counterparties can be important conduits for propagating contagion; and that a large number of derivatives positions open can introduce complexity and opacity on balance sheets.

CHART 5

Core-periphery structure of the derivatives network



Sources: HKTR data and HKMA staff calculations.

Ten institutions rank consistently at the top in all three criteria and form the core of the network. Together they are counterparty to 92% of the total gross notional of derivatives reported in the month of November 2014. The pattern of outstanding positions in Chart 5 is similar to that described in Table 1 for the core-periphery structure. The core has bilateral trades with other core institutions (24% of total gross notional), with central counterparties (34% of total gross notional) and with periphery institutions (34% of total gross notional). In contrast, periphery institutions trade little with other periphery institutions (7% of total gross notional) and clear with central counterparties only 1% of the total gross notional value. Most of the trades between the core and central counterparties are likely to be cleared trades between two core institutions.

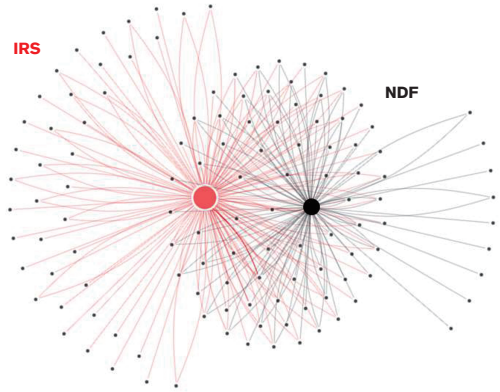
Core and periphery institutions have a very different involvement in the derivatives market. Core institutions have on average 67 counterparties and periphery institutions have four. Each core institution has on average 1,200 derivatives trades on its balance sheet and periphery institutions have around half of those.

The involvement of institutions in networks of different products is a conduit for potential contagion spreading from one product to another. For example, if an institution involved in both markets were to suffer large losses in one class of derivatives, it might try to reduce its exposure in other classes of derivatives in an effort to avoid further losses. Such reaction may cause significant price movements if the institution is a major player in that market.

There is some overlap in the institutions involved in the two derivatives products included in the HKTR but it is not complete. Chart 6 maps the network of institutions involved in each product, with IRS positions in red and NDF positions in grey.[13] Just over half of the institutions have positions in both products; the others have positions only in one of the two.

CHART 6

Map of the network of IRS and NDF derivatives



Sources: HKTR data and HKMA staff calculations.

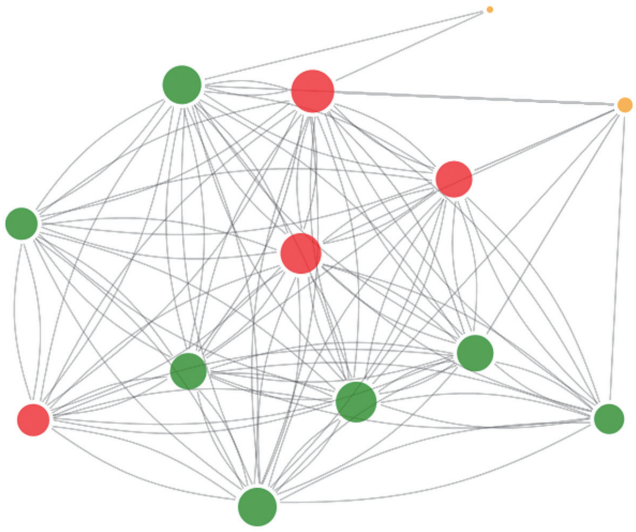
Identifying institutions systemically important to market functioning

Recognising the core institutions in each financial network helps regulators target resources for market surveillance and gives additional information to identify systemically important financial institutions. Charts 7 and 8 depict separately the core of the network of institutions involved in IRS and NDF.

The red nodes identify institutions that are core in both networks; the green nodes are institutions that are core in one product and not the other. Yellow nodes are central counterparties. The node size is proportional to the number of counterparties. The links between any two nodes represent the derivatives positions reported to the HKTR by one against the other (say, by node *a* towards node *b* and by node *b* towards node *a*). A node with links to many other nodes is highly connected to the rest of the core.

CHART 7

Core of the IRS network



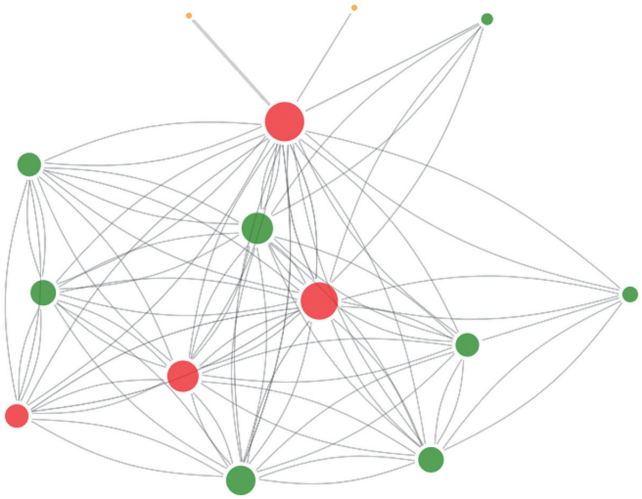
Sources: HKTR data and HKMA staff calculations.

Note: In charts 7 and 8, each node is a financial institution in the HKTR data. Red nodes identify institutions that are core in both the IRS and the NDF networks. Green nodes are institutions that are only part of the core in one product and not the other. Yellow nodes are central counterparties. Each node can have two links against any given counterparty — one for the derivatives it reports and one for the derivatives that its counterparty reports with it.

[13] See Markose, SM (2012), "Systemic risk from global financial derivatives: a network analysis of contagion and its mitigation with super-spreader tax", IMF Working Paper 282, for a chart on the overlap of selected global financial institutions in five derivatives markets using public data.

CHART 8

Core of the NDF network



Sources: HKTR data and HKMA staff calculations.

Using the same criteria to identify the core (concentration, interconnectedness and complexity), there are respectively 11 and 12 banks in the core of the IRS and NDF network. Only four institutions are core players in both products. In both networks, the core is counterparty to over 90% of both the trade count and the gross notional outstanding. Holdings of derivatives are more concentrated in the core of the IRS network, as measured by a higher Herfindahl index.[14]

Network theory has developed other more sophisticated algorithms to identify institutions central to a network. Intuitively, these measures take into account not only direct connections, but also indirect connections via counterparties of counterparties.[15] In parallel to building more comprehensive data on OTC derivatives, more research needs to be done to understand how these measures can be used in financial stability analysis.

Conclusion

OTC derivatives link institutions in daily exchanges and proved a conduit of contagion between financial institutions in the global financial crisis. Regulators have embarked on the challenge to bring greater transparency to it. Mapping the OTC derivatives markets is going to improve financial stability surveillance in several ways. In normal times, regulators are going to gain a better understanding of the market structure of OTC derivatives; the key players and the channels of potential contagion between institutions; who would be most affected by a market shock in a derivatives product; and early warning signals of potential structural changes or emerging stress. In case of disruption at a financial institution, the systemic analysis of the OTC derivatives network can complement supervisory analysis by identifying what is happening in the overall market — who holds similar derivatives, the state of liquidity, the reactions by other market players and the potential for contagion to other institutions.

This article points to the beginning of a strand of analysis, not to its conclusion. The road to bringing more transparency to the derivatives markets is still long. Most of the infrastructure has been built, but it needs yet more effort to improve data quality, to harmonise reporting standards across jurisdictions and to aggregate the data globally. Only then will the data collected by trade repositories be able to help regulators in their market surveillance and systemic risk assessment.

[14] The Herfindahl index measures concentration as the sum of squares of each institution's market share. A higher value on the index means higher concentration. The value of the index is 0.54 in the core of the IRS network and 0.35 in the core of the NDF network.

[15] For a review, see Langfield, S and K Soramaki (2014), "Interbank exposures networks", *Computational Economics*, June.