Monetary Authority of Singapore

Liquidity and Policy Analyses for Platform Trading of OTC Derivatives: A Perspective of Smaller Markets

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Liquidity and policy analyses for platform trading of OTC derivatives: A perspective of smaller markets*

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ABSTRACT

This paper analyses the criteria for assessing when it might be appropriate to mandate the trading of standardised over-the-counter derivatives ("OTCD") on trading platforms ("trading mandate"), in the context of smaller OTCD markets. Based on a review of academic literature, this paper examines the benefits and the challenges of a trading mandate and puts forward a two-stage assessment framework, comprising a trading infrastructure test and a product test. These tests seek to identify the appropriate conditions for implementation of a trading mandate, taking into account the associated risks of market fragmentation and regulatory arbitrage.

This paper also introduces a methodology to assess the liquidity of a product by employing a clustering technique. The clustering technique utilises a wide range of liquidity metrics observable from trade repository ("TR") data and assigns a liquidity rating to each product. Lastly, this paper analyses the costs and benefits of public dissemination of anonymised transaction-level post-trade data from the TR as an alternative to improve market transparency.

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1 INTRODUCTION

1.1 Arising from the global financial crisis of 2007/08 ("GFC"), the Group of Twenty ("G20") and the Financial Stability Board ("FSB") committed to OTCD regulatory reforms. One component of the reforms is to require standardised OTCD to be traded on exchanges or electronic trading platforms, where appropriate.

1.2 Global implementation of the trading mandate is at a nascent stage. Based on the *OTC Derivatives Market Reforms: Eleventh Progress Report on Implementation* by the FSB, only three jurisdictions – Japan, Mexico and the US – have commenced mandatory trading. The US[1] was the first jurisdiction to do so when the Commodity Futures Trading Commission ("CFTC") required a set of liquid, standardised interest rate swaps ("IRS") and credit default swaps ("CDS") to be traded on swap execution facilities ("SEFs") in Feb 2014.[2] Japan commenced its regime in Sep 2015, requiring certain Japanese Yen IRS to be traded on electronic trading platforms. Mexico commenced its trading mandate for certain Mexican Peso IRS in Apr 2016.

1.3 Other FSB member jurisdictions have taken steps to prepare for the implementation of a trading mandate in their respective jurisdictions by providing or proposing to provide for the legislative framework to empower the respective authorities to implement a trading mandate (FSB, 2016). In Singapore, MAS proposed changes to the Securities and Futures Act to provide legislative powers to implement a trading mandate, and also proposed a framework for the authorisation of market operators for OTCD trading.[3] Hong Kong and Australia have similarly provided for legislative powers for a trading mandate to be implemented in the Hong Kong Securities and Futures Ordinance and the Australia Corporations Act, respectively. In Europe, the Markets in Financial Instruments Directive II ("MiFID II") includes the framework for its trading mandate, slated to come into effect in Jan 2018.

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[1] The US Securities and Exchange Commission ("SEC") has proposed rules for security-based SEFs in 2011 (https://www.sec.gov/news/press/2011/2011-35.htm) but has yet to finalise them.

[2] List of swaps that are subject to the trading mandate by the CFTC can be found at: http://www.cftc.gov/idc/groups/public/@otherif/documents/file/swapsmadeavailablechart.pdf.

[3] Explanatory Brief on the Securities and Futures (Amendment) Bill, 7 Nov 2016: http://www.mas.gov.sg/News-and-Publications/Speeches-and-Monetary-Policy-Statements/Speeches/2016/Explanatory-Brief-Securities-and-Futures-Amendment-Bill-2016.aspx.

1.4 With the legislative framework in place, it remains for jurisdictions to assess the appropriateness of implementing the trading mandate based on conditions in their respective markets. Thus far, only the Australian regulators[4] and the European Securities and Markets Authority ("ESMA")[5] have set out their criteria for such assessment, which includes the appropriate liquidity metrics and threshold.

1.5 Academic research on the effects of implementing a trading mandate is thus far also limited to analysing larger and more developed OTCD markets. Benos et al. (2016) and Loon and Zhong (2016) studied the effects of a trading mandate in the US, focusing on different derivatives asset classes; Benos et al. studied the IRS market, while Loon and Zhong the CDS market. Both papers conclude that a trading mandate reduces transaction costs and improves liquidity. However, the findings are premised on the US market, which is one of the largest OTCD markets globally.

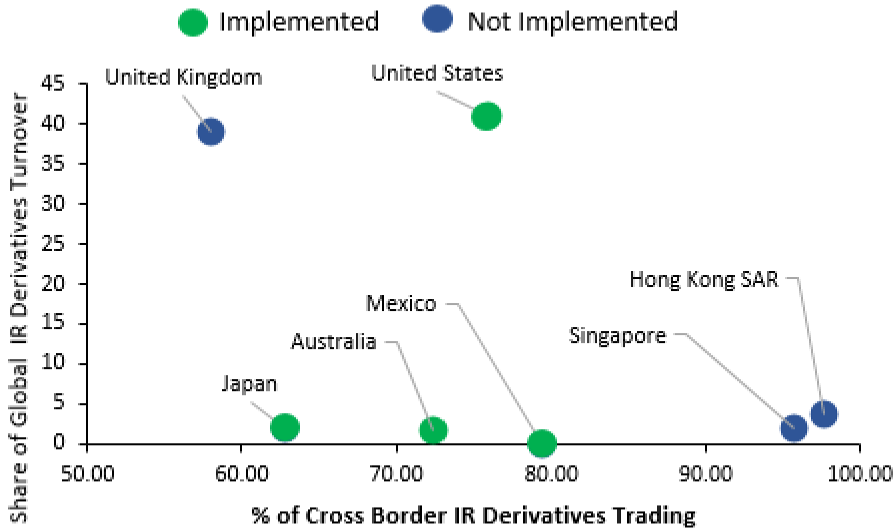
1.6 In this paper, we analyse the conditions conducive for policy makers to consider a trading mandate, in the context of smaller OTCD markets, which have mostly yet to implement a trading mandate (see Figure 1).[6] We review the benefits of a trading mandate and the potential impact on smaller markets, and propose a set of criteria for policy makers in assessing the implementation of a trading mandate in such markets. We also propose a liquidity assessment methodology to identify suitable products for trading on platforms. Lastly, this paper discusses the possibility of publishing post-trade data from trade repositories ("TR") as an alternative measure to improve market transparency, which could encourage voluntary trading on platforms.

[4] Report on Australian OTC Derivatives Market, Nov 2015, by Australian Prudential Regulation Authority, Australian Securities and Investments Commission and Reserve Bank of Australia.

[5] Discussion Paper on the trading obligation for derivatives under MiFIR, Sep 2016, by ESMA.

[6] In this paper, we consider a smaller OTCD market as one with significantly lower OTCD notional outstanding amount and/or turnover as compared to the US and UK (see Figure 1).

Figure 1
Size of OTC market vs cross border share of IR Derivatives trading



Source: BIS Triennial OTC Derivatives Statistics 2016, MAS Calculations
Note: The Cross Border Share of Trading represents the percentage share of trading volume done with at least one cross-border counterparty

2 POTENTIAL BENEFITS OF A TRADING MANDATE

2.1 We first approach our study by analysing the benefits of a trading mandate based on how it could play a part in achieving each of the three main objectives of the G20 reforms, namely (i) improving transparency; (ii) mitigating systemic risks; and (iii) protecting against market abuse.

2.2 We referenced academic and empirical research on market transparency and the observed effects of a trading mandate in the US. Currently, there is no clear consensus on the impact of implementing a trading mandate. Some research suggest an overall beneficial outcome with greater transparency and competition, while others show the negative impact of market fragmentation. We will elaborate on these findings below.

(i) Improving transparency

2.3 The GFC demonstrated that OTCD trading is relatively opaque with limited availability of pre- and post-trade transparency to market participants (Chen et al., 2011). Academic research into trading of other financial assets (e.g. shares) has shown that the transparency benefits offered through platform trading have had a positive effect on market quality (see for example, Madhavan (1996), Biais (1993), Pagano & Roell (1996), Baruch (2005), and Hendershott and Madhavan (2015)).

2.4 As such, it is envisioned by the G20 and FSB that a trading mandate would shift OTCD trading onto a centralised platform, where market participants could benefit from improved pre-trade information, reduced information asymmetry and lower costs through competitive increase in bids and offers. Empirical research by Benos et al. (2016) and Loon and Zhong (2016) support the case for pre-trade transparency through trading of OTCD on platforms. However, Avellaneda and Cont (2010) and IOSCO (2011) recognise that there could be costs to increased market transparency (e.g. "excessive" transparency may result in liquidity withdrawal of some participants, or the costs of market transparency may be borne by informed participants, i.e. large dealers and market makers), and these costs should be considered in light of the potential improvements in market quality.

(ii) Mitigating systemic risks

2.5 While a trading mandate can help mitigate systemic risks – through standardisation of contracts, bringing greater transparency to trades, and the resultant central clearing of trades executed on centralised platforms – in and of itself, a trading mandate is not seen to play a direct role in addressing systemic risks (FSB, 2010). Weistroffer (2009) argue that from a systemic risk perspective, there is no convincing case that a trading mandate would enhance market stability over and above the benefits achieved through mandatory central clearing. We note that the introduction of margining requirements for non-centrally cleared derivatives further act to mitigate systemic risks, by ensuring collateral is available to offset losses resulting from a counterparty default.

2.6 However, the GFC highlighted the possibility of a liquidity crunch for OTCD trading during market stresses, where market participants were unable to close out their positions to meet their liquidity needs (Financial Crisis Inquiry Commission, 2011). This is particularly acute in decentralised and opaque trading models, which is prevalent in OTCD markets. A trading mandate could thus be a factor to mitigate a liquidity crunch through pooling of liquidity onto platforms.

2.7 Liquidity pooling could also bring benefits to market participants in normal times, by reducing participants' search costs and promoting price discovery through increasing competition for bids and offers. Benos et al. (2016) conclude that the US CFTC's trading mandate has increased activity and liquidity, with the largest improvement in USD IRS contracts. This is observed through reduced execution costs, where the effect is economically significant for mandated USD contracts of as much as USD20 to 40 million daily to all market participants. The reduction in execution costs is attributed to shorter dealer intermediation chains and the elimination of associated dealer mark-ups. Loon and Zhong's (2016) research in the US CDS markets also find that trading on SEF has led to lower transaction costs and increased liquidity.

2.8 A key point, however, is that liquidity improvements tend to scale proportionately with the liquidity of the swaps – less liquid swaps achieved less improvement in execution costs than more liquid swaps.[7] This finding bears particular importance in smaller markets, where trading activity is much lower.

(iii) Protecting against market abuse

2.9 The GFC also uncovered the lack of monitoring and market surveillance over the OTCD market (FSB, 2010; Kiff et al., 2009; Stulz, 2009). As exchanges and some electronic trading platforms perform frontline surveillance of trading and members' compliance with its rules, a trading mandate can assist regulators in detecting and preventing market abuse. Furthermore, rules to govern trading on platforms may reduce unfair trading practices.

2.10 However, surveillance of OTCD markets is still at a nascent stage and challenges remain as to how surveillance should be performed on episodic OTCD markets, as compared to the traditional techniques applied for surveillance of cash equities or futures markets (IOSCO, 2013). For instance, the illiquid nature of OTCD trading may mean that traditional volume-based trend analysis used for surveillance of cash equities may not be as effective. Monitoring of OTCD data could nevertheless help inform cross-product or cross-asset surveillance and investigations into manipulation of underlying assets.

Identifying additional benefits of a trading mandate above the other G20 reform areas

2.11 As the reporting and clearing mandates are typically implemented ahead of a trading mandate, we take the benefits set out in the preceding paragraphs and drill down deeper to identify the benefits that a trading mandate can achieve on top of other components of the G20 reforms. We therefore map each component of the G20 reform to the intended objectives of improving transparency, mitigating systemic risks and protecting against market abuse in Figure 2 below.

[7] Benos et al. found that liquidity improvements are greatest for contracts where SEFs are more heavily used. For example, relative to mandated EUR IRS contracts, execution costs for mandated USD IRS contracts were lower by about USD10 to 13 million daily to all market participants.

Figure 2
Benefits of a trading mandate above other components of G20 reforms

G20 Reform Objectives

	Improve Transparency	*Mitigate Systemic Risks*	*Protect against Market Abuse*
Reporting Mandate	TR dissemination of post-trade transactions info	Systemic risk surveillance using TR data	Monitoring & investigation of *ex-post* TR data
Clearing & Margin Requirements	CCP's disclosure of risk and exposure info	Reduce counterparty credit risks	-
Trading Mandate	**Greater pre-trade transparency**	**Reduce liquidity risk via liquidity pooling**	**Fairer trading practices & market surveillance**

2.12 From Figure 2, we conclude that the reporting mandate largely achieves much of the improvements to market transparency. It provides authorities with information on the otherwise opaque OTCD market, allowing authorities to perform regulatory, supervisory and enforcement oversight over OTCD activities. In addition, Loon and Zhong (2014) also consider the clearing mandate to help improve transparency, through the central counterparty's ("CCP") public disclosure of market risk exposures and counterparty risk information, concluding that trading activities increased following the CCP's post-trade dissemination of daily trading volume, open interest and settlement prices.

2.13 The FSB recognised that TR data may also be informative to market participants and the public. Post-trade information has a number of important uses by market participants, such as enhancing the price discovery process, evaluation of execution quality/costs, inputs for marked-to-market valuations or to inform future trading decisions. To market participants, post-trade transparency could be achieved in two ways: either through the trading mandate via trading platforms or the reporting mandate via the public dissemination of TR data. The trading mandate could improve post-trade transparency as trading platforms could disclose post-trade information on trades which were transacted on its platforms to market participants. Post-trade transparency can also be achieved via publication of post-trade information from the TR to market participants (depending on the granularity and frequency of the published data).[8] We will further elaborate on a post-trade public dissemination regime in section 5.

2.14 However, pre-trade transparency remains an objective that cannot be achieved from the other components of the reforms. We therefore conclude that pre-trade transparency is the key distinguishing factor of a trading mandate.

2.15 The objective of mitigating systemic risks is addressed primarily by mandatory clearing and margin requirements for non-centrally cleared OTCD, as well as the reporting mandate which provides data for systemic risk surveillance. However, as discussed in paragraph 2.7, a trading mandate can play a role in mitigating liquidity risk through pooling liquidity onto trading platforms which serve as centralised venues for market participants to transact, without them having to bilaterally search for quotes and counterparties. This could be particularly important in times of market stress. However, liquidity pooling is not a panacea for liquidity risks; dealers and liquidity providers can still exhibit the same reluctance to make markets, even on platforms. In addition, for smaller markets, the effect of liquidity pooling may be less pronounced due to the concentration of liquidity providers for certain products (e.g. products that are mainly traded domestically); these liquidity providers are well-known to market participants and search costs could already be low.

2.16 To protect against market abuse, the reporting mandate provides authorities with information to conduct market surveillance and investigation. A trading mandate could supplement authorities' monitoring of ex-post TR data with pre-trade data from the order book, provided that effective market surveillance can be performed by the operators of trading platforms. In addition, theoretical research conducted by Kyle (1985), Carlin et al. (2007) and Vayanos and Wang (2012) have shown that market power and imperfect competition in opaque markets may lead to cooperative, predatory trading strategies or abuse of market power. A trading mandate could help address some of these market inefficiencies, as trading activities are subject to the trading platforms' rules and market surveillance.

[8] For example, in the US, post-trade transparency to market participants is achieved through dissemination of anonymised TR data.

Identifying the main beneficiaries of a trading mandate

2.17 As dealers may already have access to liquidity in the inter-dealer market, they generally benefit less from a trading mandate. Furthermore, dealers and/or market makers in OTCD markets may have sufficient market power and sophistication that prevents them from being at the end of unfair trading practices.

2.18 Instead, we consider the main beneficiaries of a trading mandate to likely be buy-side participants (e.g. fund managers and insurers), who are generally price-takers in OTCD markets. Increased pre-trade transparency for buy-side participants improves their price discovery process and reduces information asymmetry.

2.19 In summary, our analysis concludes that the trading mandate brings the following three benefits over and above other components of the OTCD reforms. These benefits mainly accrue to buy-side participants:

(i) **Greater pre-trade transparency** to market participants;
(ii) **Liquidity pooling onto centralised trading platforms**, which reduces participants' search costs, promotes price discovery and greater liquidity resilience, especially in times of market stress; and
(iii) **Fairer trading practices**, due to platform rules to regulate participants' trading behaviour and practices.

3 IMPLEMENTATION CONSIDERATIONS

3.1 Having identified the potential benefits from a trading mandate, we now turn to a number of implementation considerations that have to be addressed, especially for smaller markets: namely, the cross-border issues of market fragmentation and regulatory arbitrage, and the state of the market structure.

3.2 ISDA (2016) observed fragmentation of the EUR IRS market between US and non-US liquidity pools as a result of the US CFTC trading mandate, with an increase in transactions between EU counterparties from 70.7% in Sep 2013 (before the introduction of SEF rules) to 91.2% at the end of 2015. Benos et al. (2016) find similar results.

3.3 In addition, Giancarlo (2015) argue that fragmentation of market liquidity would increase market inefficiencies and price volatility due to smaller, disconnected liquidity pools. In addition, it could increase a firm's operational risks as additional processes are required to manage the different liquidity pools. Giancarlo also note that artificial market fragmentation can be avoided by taking into account the characteristics of trading in the OTCD markets, which are global in nature, with a wide array of liquidity and execution methods.

3.4 Research has also shown that regulatory arbitrage could be another implication of the trading mandate. Johnson (2014) and Griffith (2013) both acknowledge the possibility of certain market participants looking to take advantage of the regulatory gaps between jurisdictions, by restructuring their business models or trading activities to adhere to markets that are less regulated. Some ways market participants could reorganise trading activities include the de-guaranteeing of affiliates[9] or relocation of their trade execution activities to other financial centres without an equivalent trading mandate.

3.5 We are of the view that the implications of liquidity fragmentation and regulatory arbitrage could be particularly acute for smaller markets, especially for markets with large international participation.[10] Unlike larger markets such as the US, the fragmentation or relocation of liquidity could have an impact on the proper functioning of the domestic OTCD markets, and lead to a material decline in trading liquidity and depth.[11]

3.6 Apart from the implications cited by academic literature, another critical implementation consideration is the state of the market structure, such as the availability of trading infrastructure, liquidity and sophistication of market participants. In these areas, while regulators may play a role in developing the regulatory framework for trading platforms, much of the success of a trading mandate would depend on the market organically maturing and developing the necessary conditions to support such a mandate (e.g. emergence of regulated trading platforms, general increase in trading liquidity and sophistication of buy-side participants to trade directly on platforms). Larger markets, typically with a more diverse group of participants, provide a stronger business case for platform

[9] New York Times Editorial Board, July 2014, "Another Failure to Regulate Derivatives", http://www.nytimes.com/2014/07/03/opinion/another-failure-to-regulate-derivatives.html?_r=0.

[10] For example, as compared to UK and Japan, where the resident or local share of trading turnover comprise 32% and 65% of total FX Forward trading activity respectively, Singapore's resident share of trading turnover in FX Forwards only comprise about 5% of total FX Forward trading activity. Source: Singapore Foreign Exchange Market Committee "Survey of Singapore Foreign Exchange Volume in April 2016"; London Foreign Exchange Joint Standing Committee "Results of the Semi-Annual FX Turnover Surveys April 2016"; Tokyo Foreign Exchange Market Committee "Results of Turnover Survey of Tokyo Foreign Exchange Market July 2016".

[11] Degryse et al. (2014) find that the effects of market fragmentation may be asymmetrical, with fragmentation resulting in poorer market quality for the "local liquidity" (i.e. participants without access to the larger, "global" liquidity pool).

operators to invest and set up the relevant infrastructure in those jurisdictions given a higher demand for OTCD platform trading associated with a trading mandate. In smaller markets, by contrast, there could be a lower possibility of the emergence of domestic platforms, or foreign trading platforms willing to serve such markets.[12] More importantly, cross-border access to trading platforms is crucial in mitigating market fragmentation for markets that are dependent on non-domestic liquidity.

3.7 We also considered that the implementation of a trading mandate could be potentially disruptive to trading activities, should there be policy or regulatory missteps (for instance, subjecting an illiquid, bespoke product to mandatory trading). In the example where an illiquid product is mandated for trading on platforms, the additional transparency and competitive trading introduced for that illiquid product could reduce trading or hedging activity by buy-side participants, as they seek to avoid revealing market positions or avoid predatory trading. This could be particularly acute for smaller markets where the market is more sensitive to structural changes, as compared to larger markets (Macroeconomic Assessment Group on Derivatives, 2013). As such, the requirements for a trading mandate including the selection of the appropriate products need to take into account the transition effects of platform trading and integration of necessary process changes.

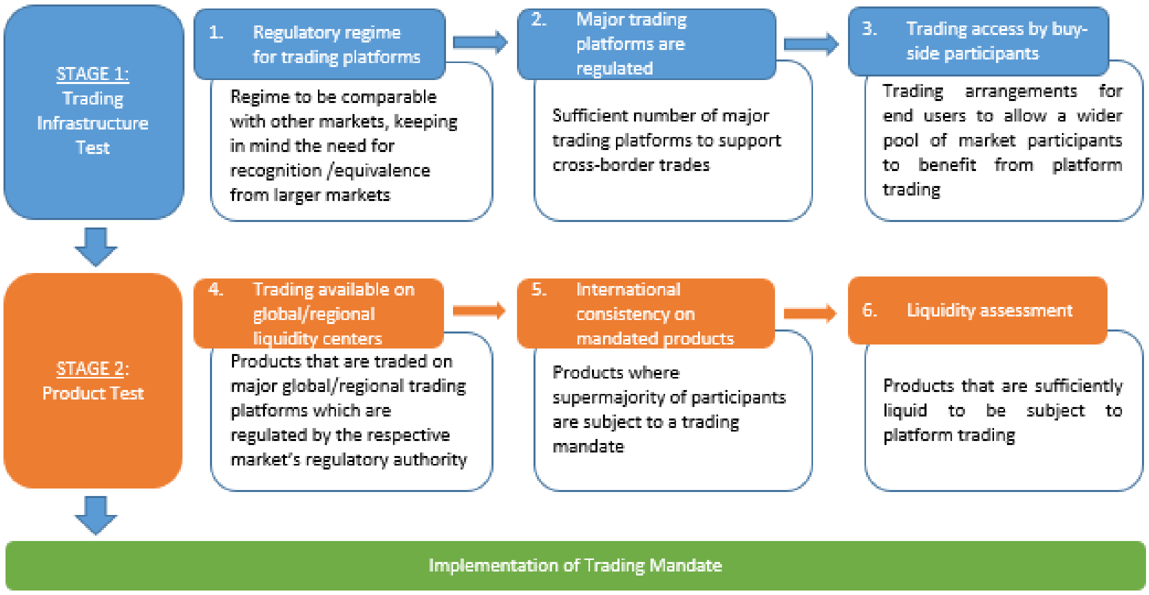
4 ASSESSMENT FRAMEWORK FOR A TRADING MANDATE IN SMALLER MARKETS

4.1 Following from our analysis on the potential impact of a trading mandate in smaller markets, we have proposed a set of criteria for policy makers in assessing when a trading mandate could be implemented. The criteria is bucketed into two parts, as seen in Figure 3 below. The first is an assessment of the readiness of the market infrastructure to support the trading mandate (trading infrastructure test); the second is an assessment of a product's suitability (product test).[13]

[12] Such foreign platform operators would also need to be subject to additional requirements in their home jurisdiction, in order to serve market participants based overseas. Such additional regulatory burden could reduce their incentive to serve smaller markets.

[13] For ease of discussion, we have organised our criteria into a simple stepwise framework, with a logical flow and in no order of importance. In practice, a different flow could prove to be a faster and simpler assessment process without going through all the analysis required.

Figure 3
Possible assessment framework to implement a trading mandate



Stage 1: Trading Infrastructure Test

4.2 A trading mandate would require market participants to execute their OTCD trades on a regulated trading platform. Currently, OTCD trading platforms are mainly available only in jurisdictions which have commenced the trading mandate, (e.g. US and Japan). [14] There are limited regulated OTCD trading platforms elsewhere.

4.3 In smaller markets, a significant cross-border component with large international participation could potentially add an additional dimension to this consideration. While the availability of trading platforms catering to domestic market participants is crucial (such as the setup of SEFs catering to US participants), jurisdictions could also consider facilitating cross-border trading, by also providing for trades executed on foreign trading platforms as having met the trading mandate. Such an approach could facilitate trading between both domestic and foreign participants, in order not to fragment liquidity across geographical lines at the same time not having to wait on the development of domestic infrastructure to consider a trading mandate. There could also be the possibility that domestic trading platforms may require equivalence by foreign regulators in order to cater to cross-border trading.

[14] Under the US SEF regime (which commenced in 2013) and the electronic trading platform (ETP) regime in Japan (which commenced in 2015). There are 24 SEFs in the US (registered and temporary), while there are 7 ETPs in Japan.

Criterion 1: Development of regulatory regime for trading platforms

4.4 In order to provide for availability of trading platforms, the first step is for policy makers to develop their respective regulatory regimes for OTCD trading platforms. Central to this regulatory regime is the possibility of recognition or equivalence with other jurisdictions for their respective OTCD trading platform regime, particularly from the larger OTCD markets. This would ensure that participants in the local market are able to access liquidity pools from these larger markets and vice versa. This is similarly recognised by ISDA (2016) which suggest that mutual recognition of trading platform regimes – albeit in the context of the major markets of the US and the EU – could reduce the risk of market fragmentation across geographical lines.

Criterion 2: Major trading platforms are regulated to cater for cross-border trades

4.5 Following the development of the legal framework for regulation of trading platforms, the next consideration is whether a sufficient number of regulated trading platforms are available for local participants to trade on. In our opinion, only when a number of major trading platforms – i.e. platforms that can provide meaningful connectivity to global or regional OTCD liquidity and properly support cross-border OTCD trading – are regulated by the respective regulatory authority, could policy makers then move on to identify suitable products for a trading mandate. This is key for smaller markets in order to mitigate the impact of geographical fragmentation as discussed earlier in paragraph 3.5.

Criterion 3: Buy-side participants have access to regulated trading platforms

4.6 Our framework next considers whether buy-side participants – such as smaller banks and non-bank participants – are able to access and trade on such regulated trading platforms.[15] As discussed in paragraph 2.18, we consider that buy-side participants stand to benefit most from the implementation of a trading mandate. Hence, markets should ideally commence a trading mandate when buy-side participants have the necessary arrangements to access these regulated trading platforms and benefit from the increased transparency and competition. Duffie et al. (2010) share similar concerns that the use of regulated platforms would not address the lack of transparency and competitiveness if non-dealers have no access to these platforms. This consideration was also observed in the clearing space, where the roll-out of mandatory clearing requirements was hampered by the lack of access for buy-side participants via client clearing services

[15] In the case where a product is largely traded without participation by buy-side participants, this criterion may not be applicable. Policy makers could consider whether a trading mandate on such products could result in market quality improvements for wholesale market participants.

(FSB, 2016). We note that this is a general criterion that may not be applicable only to smaller markets.

Stage 2: Product Test

4.7 A trading mandate would only subject products with a suitable degree of liquidity to be traded on platforms.[16] In addition to the liquidity criteria, our proposed product determination test takes into account other important characteristics in a particular product. It is important for the trading mandate to be confined only to the products which can smoothly transit to platform trading. We recommend that the assessment be made at the individual product-by-product level (e.g. broken down by tenors, currencies), as opposed to an asset class basis. This is because not all products within the same asset class may share the same liquidity characteristics or level of standardisation.

Criterion 4: Product available for trading on regulated trading platforms which are global or regional liquidity centres

4.8 Policy makers could first start by identifying the universe of products that are available for trading on regulated platforms.[17] As these products are already traded on platforms, there would be a ready venue for participants to trade if a mandate is implemented. These products would already have some base level of standardisation and established platform trading protocols. Requiring such products to be traded on platforms would be less disruptive for participants as existing trading practices would not need to be significantly altered.

4.9 As discussed in paragraphs 3.5, it is important for smaller, more open markets with significant volume of cross-border trades to remain connected with the global market for derivatives trading. In order to reduce the risk of market fragmentation, domestic market participants should continue to be able to trade with their global or regional counterparties and access the global or regional liquidity pool. Therefore, policy makers could consider whether their regulated trading platforms include the global or, at least, regional liquidity centres.

4.10 One possible way of satisfying this criterion is to select products which are traded on the major global or regional trading platforms that are regulated by the respective jurisdiction’s regulatory authority.

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[16] Policy makers can also consider a trading mandate on OTCD products that are subject to central clearing as they generally have a certain level of standardization and liquidity. However, there may be products that are suitable for trading but not available for clearing due to the lack of available CCPs.

[17] Such products should typically be sufficiently standardised and liquid for central clearing.

Criterion 5: Main foreign participants are subject to trading mandate in their home jurisdiction

4.11 As discussed in section 3, the issues of regulatory arbitrage and market dislocation as a result of the implementation of a trading mandate are particularly acute for smaller markets, which could be harmful to the proper functioning of their markets.

4.12 One possible approach to address these issues is to identify products where foreign participants, who are subject to a trading mandate in their home jurisdiction, contribute a supermajority (e.g. more than 60%) of a product's volume on the regulated trading platforms. This condition could mitigate the risk of market dislocation, since there are little incentives for domestic participants to circumvent the trading mandate (as the remaining participants not subject to a trading mandate comprise a much smaller liquidity pool).

4.13 In the situation where a product is also widely traded by a broad range of participants globally, there could be scope for regulatory arbitrage and market fragmentation if a stand-alone trading mandate is implemented in a single jurisdiction. To best address the risks of geographical fragmentation and regulatory arbitrage, this may require coordination between jurisdictions at the global level. We note that the Australian regulators have made a similar consideration on the need for international consistency in the implementation of trading mandates

Criterion 6: Sufficient liquidity for platform trading

4.14 Liquidity is a fundamental characteristic to assess if a product is suitable for platform trading. Fulop and Lescourret (2015) also considered liquidity to be a prerequisite for a smooth transition to electronic trading on platforms. Liquidity tends to feature as a concern for participants in smaller markets, where such markets are generally considered less deep and liquid compared to the developed markets in the US and EU.

4.15 While it is commonly agreed that liquidity is an important consideration for a trading mandate, there are two main factors that have to be considered when assessing liquidity: (i) the liquidity pools at which liquidity should be measured – whether global, regional or local levels, or possibly, by activity within the same active time zone; and (ii) the liquidity measures to be used that would satisfactorily address whether a product is sufficiently liquid to feasibly support a trading mandate.

(i) Selection of liquidity pools to be assessed

4.16 In the cross-border, open market for OTCD trading, no jurisdictional boundaries exist. For instance, in the USD IRS market, market participants can access a global liquidity pool and have multiple options to trade with counterparties anywhere in the US, EU or in Asia Pacific. Hence, an argument could be made to assess a product's liquidity at the broadest level, i.e. at the global level. However, data collection may be a challenge, since regulators do not have access to sufficiently granular data sources to measure global liquidity at the product level. While some jurisdictions like the US or Canada provide detailed post-trade information on OTCD transactions – which would form a substantial part of global liquidity – this may not be sufficient to measure liquidity at the global scale.

4.17 At the minimum, regulators can measure local liquidity, via data from their respective TRs. Assessing local liquidity is helpful, as it allows regulators to observe the direct impact of a trading mandate on local participants. However, regional trading activities which contribute to the liquidity may not be captured in the data from the TR. Another perspective on the relevant liquidity pool to assess is to measure the pool of participants that are actively trading at any one time (e.g. common trading hours between jurisdictions in the same region).

(ii) Selecting appropriate liquidity metrics

4.18 Liquidity is a multi-dimensional concept that encompasses various aspects, such as market depth and resilience, breadth, tightness and immediacy of execution. However, narrowing down the large number of available metrics to observe liquidity in a comprehensive yet practical manner is challenging. For example, price impact measures, such as Amihud's price impact measure (2002), may include information on market depth but not necessarily information on market breadth.

4.19 These challenges in applying the liquidity assessment have been faced by some jurisdictions such as the EU[18], where the industry had expressed reservations over the three liquidity metrics in MiFID II[19] used to make determinations of a "liquid market": (i) average daily notional value or turnover; (ii) average number of

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[18] James Rundle and Anna Irrera, Mar 2015, "Five MiFID II pressure points", http://www.efinancialnews.com/story/2015-03-11/mifid-ii-consultation-industry-responses-esma.

James Rundle, Mar 2015, "Transparency rule puts spanner in the bond works", http://www.efinancialnews.com/story/2015-03-04/transparency-rule-puts-new-spanner-in-the-works.

Sarah Basar, Oct 2015, "MiFID II Liquid Bond Definition Causes Debate". http://marketsmedia.com/mifid-ii-liquid-bond-definition-causes-debate/

[19] European Securities and Markets Authority, Sep 2015, Final Report on Draft Regulatory and Implementing Technical Standards MiFID II/MiFIR.

trades per day; and (iii) percentage of days traded. There were also concerns that illiquid instruments may be wrongly deemed liquid.

4.20 After selecting liquidity metrics, the next challenge is to make an assessment of whether a product is liquid – determining thresholds across which products would be deemed sufficiently liquid for trading. This has also proven to be a subject of debate, as observed in the EU. Amongst jurisdictions, it may be counterproductive if each were to use measures that would result in the same product being assessed differently, which may cause further fragmentation of liquidity pools.

A possible liquidity assessment methodology

4.21 We attempt to add to international discussions on liquidity of OTCD by analysing the local liquidity in the Singapore OTCD market. Cognisant of the challenges involved in both the selection of appropriate liquidity metrics and the calibration of thresholds, we adopt a "greedy" approach. Instead of first tackling the issue of choosing the right liquidity metrics and thereafter tackling the issue of calibrating the chosen metrics accordingly to define a liquid product, the "greedy" approach tackles the two problems together by relaxing the requirement to choose the "best" liquidity metrics by employing all available metrics and using a clustering technique to identify thresholds across all metrics. We first select the widest range of liquidity metrics that are observable and can be computed from available data.[20] Thereafter, we adopt a clustering technique to choose appropriate thresholds to assign instruments a liquidity rating.[21] The contracts with the "Liquid" rating would represent the most liquid contracts within a given market, and such contracts could be considered for mandatory platform trading.

4.22 For the purpose of this analysis, we used six months (from 4 January 2016 to 30 June 2016) of foreign exchange ("FX") OTCD data from the DTCC Singapore Trade Repository ("DDRS") that was reported to MAS and employed the proposed liquidity assessment methodology to analyse the liquidity of FX OTCD contracts traded in Singapore. We focused on FX Forwards, given that those form the largest products by notional value in the FX OTCD data reported to DDRS.[22]

[20] We also include market structure information by employing network analysis centrality metrics.

[21] Clustering techniques have been adopted in other economic and financial analysis. See Zhang and Gao (2015), Chan et al. (2012), Leung et al. (2008).

[22] FX Forwards constitute about 67% of the total FX derivatives market in Singapore in Jun 2016. These include both outright forwards and the forward leg of FX swaps.

4.23 We employed a wide range of liquidity metrics, using a total of 12 variables across four categories. These are:

(i) **Market depth**: number of trades, total trading volumes, Amihud's price impact, and intraday volatility;
(ii) **Breadth:** share of interbank trading as a proxy for the share of interdealer trading, ratio of bank participants as a proxy for the ratio of market makers to buy-side participants;
(iii) **Immediacy:** number of counterparties, number of banks as a proxy for the number of market makers, average transaction volume and average trades per participant;
(iv) **Tightness:** Adjusted Jankowitsch, Nashikkar and Subrahmanyam's price dispersion, effective bid-ask spreads.

4.24 We further augmented the liquidity metrics with market concentration and market interconnection metrics (total of 3 variables) to include the effects that market structure can have on liquidity. These metrics are: (i) the mean degree centrality of daily networks, ii) the standard deviation of degree centrality of daily networks, and (iii) the GINI coefficient of the degree centrality of daily networks. Further details on the computation of the liquidity metrics are included in **Appendix 1**.

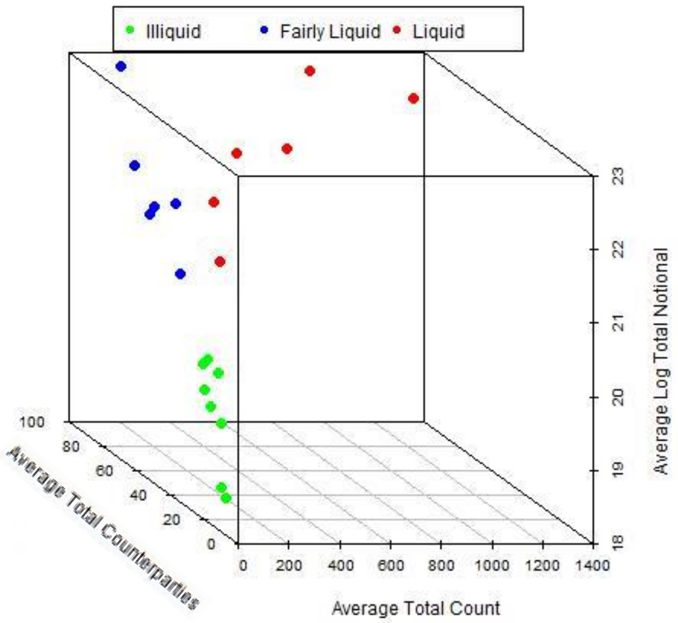
4.25 The data contained approximately 2.5 million FX Forwards transactions that were executed within the six months' time period. To improve data quality, we did sequential operations that either appended data, rebased currencies, removed duplicated trades or removed trades with important economic terms missing. We also focused on the top 20 currency pairs traded, which covered over 97% of all transactions, and only one-month contracts, to control the maturity variations that may affect the analysis. The data cleaning methodology is set out at **Appendix 2**.

4.26 The total notional value of all FX Forward transactions in this time period after the cleaning process amounted to S$6.6 trillion, traded by over 2,300 counterparties, of which approximately 590 were banks. This amounted to an average of over 250 trades per counterparty with an average notional of S$11 million per trade.

4.27 We then computed the daily values of each liquidity indicator for each currency pair and computed its six-month average. **Appendix 3** gives some examples of the six month average values of the liquidity metrics for a select group of FX Forward contracts.

4.28 We selected the simple K-Means Clustering Algorithm to conduct the clustering.[23] A total of three clusters were chosen, in which we assigned three ratings; (i) Illiquid, (ii) Fairly Liquid, and (iii) Liquid. We present a visualisation of the resulting clusters (conducted using all 15 liquidity metrics) in three selected dimensions (Average Count, Average Number of Counterparties and Total Notional) in Figure 4 below.

Figure 4
Visualisation of Clusters in Three Dimensions



Source: DTCC Data Repository Singapore (DDRS), MAS Calculations

4.29 The centroid of the "Liquid" cluster was found to have an average total count of approximately 650 trades a day, an average of approximately 70 counterparties a day and an average total notional of approximately S$4.5 billion traded a day.[24] According to the BIS Triennial Survey 2016, an estimated daily average of US$105 billion of outright forwards are traded in Singapore. Hence, the

[23] The K-Means Algorithm is a technique that attempts to find clusters by minimizing the intra-cluster sum-of-squares variances while maximizing the inter-cluster sum-of-squares variances. The number of clusters is key parameter for the model that would affect the total sum-of-squares and between sum-of-squares within the clusters. We chose the number of cluster heuristically, from the "elbow" method in a scree plot. Further details on the clustering algorithm and our methodology can be found in Appendix 3.

[24] A centroid is the centre of a mass of a geometric object. In this case, the centroid would be the centre of mass of a 15-dimensional hypersphere. The centroid represents the average of the within-cluster ranges.

S$4.5 billion notional would correspond to about 3% of the total FX Forwards market in Singapore and approximately 9% of total daily average notional volume of one-month outright forwards across all currency pairs traded in Singapore.[25]

4.30 In determining the threshold conditions for each liquidity metric, we used the within-cluster range of the “Liquid” cluster centroid. For example, we found that the range for the average total daily counterparties of a “Liquid” product was between 49 to 98 unique counterparties a day. For a product to be assigned the “Liquid” rating, it would have to fall within all the “Liquid” ranges of all 15 variables.

Limitations of the proposed liquidity assessment methodology

4.31 There are some drawbacks to our proposed liquidity assessment methodology. First, the analysis relies on the strong assumption that there are liquid products existing in the market. While the clustering technique may identify the most liquid contracts *within* a given defined market, it does not suggest that a contract is liquid enough to be subject to the trading mandate if that entire market is on the whole illiquid. According to the BIS Triennial Central Bank Survey for 2016, the combined interest rate (“IR”) derivatives and FX derivatives turnover in the US and UK form almost 64% of global turnover (by comparison, Singapore turnover forms only 6%). Correspondingly, the turnover across the specific derivatives asset classes in smaller OTCD markets is significantly less than in the UK and US. For example, Singapore’s turnover of OTC single currency IR derivatives is approximately 20 times smaller than the UK and US, while the turnover of OTC FX derivatives in Singapore is approximately 4.7 times smaller than UK and 2.5 times smaller than US.[26] In our view, further work is needed to determine the minimum absolute market size which could viably support a trading mandate, or alternatively, the development of a more objective liquidity threshold, in which policy makers and market participants can assertively conclude that a particular products would be considered liquid and suitable for trading on platforms.

4.32 Second, the thresholds found by clustering are specific to the scope of the particular market selected. For example, in our analysis, we relied on one-month FX Forwards and the thresholds may not be applicable to FX Swaps, FX Options or to other asset classes due to the differences in the underlying characteristics between and even within each asset class. For example, should the total notional of IR derivatives traded be larger than the total notional of FX derivatives traded,

[25] We estimate that about S$51 billion of all FX Forwards derivatives traded daily are one-month contracts.

[26] In 2016, the total turnover of OTC interest rate derivatives are US$58 billion for Singapore, US$1.18 trillion for UK and US$1.24 trillion for US. The total turnover of OTC foreign exchange derivatives are US$517 billion for Singapore, US$2.43 trillion for UK and US$1.27 trillion for US.

one should not draw the false conclusion that IR derivatives are in general a more liquid asset class. Similarly, the total notional of FX Swaps may not be directly comparable to the total notional of FX Options.

4.33 This is especially important in smaller markets, where trading activity across the various derivatives asset classes differs widely from the major markets in US, UK and Japan. Based on the BIS Semi-annual OTC Derivatives Statistics for 2H 2015, IR Derivatives formed 78%, FX Derivatives formed 14% and Credit Derivatives formed 3% of total outstanding gross notional of OTCD.[27] In comparison, derivatives traded in Singapore are almost equally split between IR derivatives and FX derivatives, suggesting that proportionally more FX derivatives trading (and proportionally less IR trading) is conducted in Singapore as compared to major markets such as UK and US.

4.34 Third, although not intended to capture causality effects, the proposed methodology does not assess whether a trading mandate could lead to an improvement in liquidity in smaller markets. Should a trading mandate lead to sufficient pooling of activity and to liquidity gains such as that recorded in the US (Benos et al., 2016), the thresholds set by this methodology may be too stringent and exclude less liquid contracts that may benefit from such pooling effects.

4.35 The availability of OTCD data from smaller markets which have implemented a trading mandate will prove to be useful case studies to better understand and analyse the impact on liquidity conditions for mandated contracts. Such case studies could help to quantify the potential gains in liquidity and create a better understanding of the minimum liquidity of the market on the whole to support a trading mandate. This would help to overcome first two important limitations to the proposed methodology.

5 POST-TRADE PUBLIC DISSEMINATION REGIME AS A POSSIBLE INTERIM MEASURE

5.1 In sections 3 and 4, we explored how a trading mandate could be implemented which could improve both pre- and post-trade transparency. To improve post-trade transparency by disseminating granular post-trade information, we set out two options: (i) the trading mandate, where trading platforms publish information of trades concluded on the platforms; or (ii) the

[27] Approximately 1% are equity-linked derivatives and 4% are commodity and other type of derivatives.

public dissemination of anonymised trade-by-trade information held in TRs, obtained from reporting mandates.

5.2 As progress for the implementation of reporting mandates are comparably more advanced in most jurisdictions than the trading mandate, the option of publishing post-trade TR data could bring transparency benefits within a shorter lead time. While more granular post-trade information is not a direct replacement for pre-trade information obtained through the trading mandate, it nonetheless could provide useful inputs for market participants in their trading and risk management decisions.

5.3 Globally, public dissemination of trade information has only been implemented in the US and Canada.[28] We have also observed that while many jurisdictions have implemented their respective reporting mandates, most have not published transaction-level TR data, such as in the EU, Japan and Australia. Instead, TR data is published in aggregated form in these jurisdictions.

Costs and benefits of public dissemination of transaction-level TR data

5.4 Post-trade information has a wide variety of uses (IOSCO, 2010), and in general, could lead to fairer and more efficient markets. It plays an important role in the price discovery process, by informing participants of the recent prices of similar historical transactions. Post-trade information also reduces information asymmetries between dealers and buy-side participants, which in general should lead to fairer market practices. Market participants could also use the information to monitor the quality of execution and for marked-to-market valuation purposes.

5.5 The main concern with post-trade dissemination of transaction-level information is the possibility that published data could compromise the identities of counterparties or reveal trading strategies, notwithstanding the anonymity measures (Landier and Thesmar, 2014; Chen et al., 2011). Chen et al. (2011) also recognised that large trades could be impacted in particular, if transaction information is released immediately, and recommended publication delays and the setting of large trade thresholds. Anonymity safeguards currently in place in the US

[28] Since Dec 2012, the CFTC has implemented real-time public dissemination of swap transactions, with the objective of promoting transparency and enhance price discovery in the swaps market. The US SEC, in 2015, also adopted public dissemination requirements for securities-based swaps, alongside its reporting requirements. In Canada, securities regulators in Ontario, Quebec and Manitoba have commenced their public dissemination regime since July 2016.

and Canada include disseminating information on an anonymised basis[29], delayed publication and the rounding of notional amounts according to prescribed convention. If these safeguards do not adequately protect anonymity, it could in turn have an undue impact on market participants' willingness to enter into transactions or hedge risks.[30] IOSCO (2015) also cited the potential adverse impacts of post-trade transparency on liquidity, as a result of the potential of the published data to reveal counterparty identities or through the reduction of dealer activity.

5.6 The literature regarding post-trade transparency measures have mostly focused on studying the effects in OTC bond markets and the closely related CDS markets. This is largely due to the longer operating history of the Trade Reporting and Compliance Engine ("TRACE") system in the US, which has been in place since 2002.

5.7 Several studies have found that post-trade transparency in the OTC corporate bond markets have led to a reduction in transaction costs and reduced information asymmetries in the OTC corporate bond market (Bessembinder et al., 2006; Edwards et al., 2007; Goldstein et al., 2006). However, Asquith et al. (2013) and Goldstein et al. (2006) have also concluded that the effects on infrequently traded bonds may not lead to the same level of transaction cost savings from post-trade transparency compared to more frequently traded bonds.

5.8 In the CDS market, despite initial concerns over post-trade transparency (e.g. Avellaneda and Cont (2010)), research has showed that post-trade transparency of CDS in the US and UK did not have a negative market impact. IOSCO (2015) and staff of the Division of Trading and Markets and the Division of Economic and Risk Analysis of the US Securities and Exchange Commission (2014) found that the introduction of post-trade transparency for certain CDS products did not substantially affect market activity. Similarly, Benos et al. (2013) studied the voluntarily reported post-trade data of UK's CDS market, and concluded that no significant differences in price dispersion were observed across different market participant types in the relatively illiquid CDS market in UK. On the other hand, Loon and Zhong (2016) showed significant liquidity improvements following the introduction of public dissemination of CDS transaction information in the US.

[29] Certain transactions are also excluded from the public dissemination if they do not enhance the price discovery process, such as transactions which are not concluded on an arm's-length basis (e.g. inter-affiliate transactions or trades resulting from portfolio compression).

[30] For instance, some predatory trading strategies exploit the information of other market participants' trading positions, and attempts to profit off this information (Brunnermeier and Pedersen, 2005; Cai, 2009).

A possible model for a post-trade transparency regime in smaller OTCD markets

5.9 The increased possibility of counterparty identities and investment strategies being compromised through the dissemination of transaction information is a key consideration in designing a possible regime in smaller OTCD markets. Apart from the usual anonymity precautionary measures observed in the CFTC's post-trade transparency regime (such as notional rounding, capping of large trades above a notional threshold), we also suggest a longer publication delay of say one week, which could be reduced over time should circumstances permit it. A longer publication delay could mitigate the possibility of another market participant acting on the disclosed transaction information. In addition, should policy makers be concerned over the possible market impact of the public dissemination of very infrequently traded contracts, it could be possible to limit the public dissemination regime to the more liquid products in the respective jurisdictions[31], or more simply, restrict disclosure to the most traded products (e.g. the top 100 most traded products by trade count).

5.10 If confidentiality still remains a concern, another model of public dissemination would be to adopt the TRACE model[32] of publishing end-of-day price and volume information for standardised OTCD products at the aggregate level. The composite price and volume disclosures would be calculated and disclosed in lieu of disseminating trade-by-trade information. However, this model could be challenging to implement in the OTCD market, because OTCD contracts are more bespoke compared to the OTC corporate bond market.

5.11 In our opinion, an effective and meaningful post-trade public dissemination regime is premised on the reporting of high quality TR data. This would necessitate industry and regulatory effort to ensure that reported TR data is complete and accurate, with minimal data gaps. Depending on the level of data cleaning required, the drive to improve data quality could be a significant undertaking on its own, which could render the public dissemination regime a less ready solution. Finally, we also note that dissemination of anonymised trade-by-trade TR data is not mutually exclusive to a trading mandate; both measures could be implemented in tandem, as done so in the US.

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[31] This is a similar phased approach adopted under the TRACE transparency regime, which initially started with the largest investment grade bonds. In Europe, MiFID II would similarly require only liquid products to be subject to the transparency regime.

[32] FINRA TRACE Market Aggregate Information: http://www.finra.org/marketdata/bonds/traceaggregates.

6 CONCLUSION

6.1 In this paper, we propose a model of analysing the effects of a trading mandate in smaller OTCD markets. For smaller jurisdictions that have already implemented the reporting and clearing mandates, we propose that if a trading mandate is to be implemented, it should be done so as to yield the specific market improvements in: (i) improved pre-trade transparency for market participants; (ii) greater liquidity pooling for more efficient market functioning and improved liquidity resilience; and (iii) fairer trading practices governed by platform trading rules and surveillance. However, policy makers should be mindful of the risks of liquidity fragmentation and regulatory arbitrage resulting from the introduction of a trading mandate, which may be particularly challenging for smaller OTCD markets.

6.2 With these objectives in mind, we propose a two-stage assessment framework for determining the suitability of a trading mandate in smaller OTCD markets. The first stage of the framework is designed to ensure the necessary trading infrastructure is in place, which could connect domestic market participants with the global or regional OTCD liquidity pool. The product test in the second stage then seeks to identify suitable products which can successfully shift to platform trading.

6.3 While the framework we put forward assumes a decision based on current state of the market, we note that the framework lacks forward-looking factors such as the potential impact of liquidity in smaller markets and the changes in market structure. More research is needed before such factors can be feasibly incorporated, and to also assess post-implementation effects to help inform decision-making. Empirical research – should data availability issues be resolved – could be done to study the effects of a trading mandate in relatively smaller OTCD markets (such as Japan or Mexico), to analyse whether the improvements in market liquidity are as pronounced as the impact observed in the US. Further, such empirical research can help to characterise the minimum liquidity conditions necessary to support a trading mandate.

6.4 More work can also be done to assess the implications of changes to market structure that may result from a trading mandate implementation. Currently, research suggests the OTCD market structure is segregated into two tiers: the inter-dealer market (or dealer-to-dealer market, "D2D") and the dealer-to-client market ("D2C") (see IOSCO, 2012; Chen et al., 2011; Atekson et al., 2013; Colin-Dufresne et al., 2016).[33] Given that research has shown the potential of a trading mandate to reduce intermediation chains, and the trend towards electronification of D2C markets, we posit that the D2C market structure could evolve into the all-to-all trading models, where buy-side participants can entirely bypass dealer intermediation to directly transact with other buy-side participants (i.e. client-to-client, C2C).

6.5 Throughout this paper, the subject of fragmentation has largely focused on *geographical* fragmentation. However, the current market structure of multiple trading platforms could in theory lead to the fragmentation of liquidity across multiple trading platforms (and clearing houses)[34], especially if access to platforms is costly to market participants. While the trading mandate itself is agnostic to existing competition, should there be only one platform available to market participants, the mandate could help reinforce the monopoly. A related market structure topic that could be further studied is whether the trading mandate could trigger or catalyse market consolidation as a result of liquidity convergence.

6.6 In assessing the suitability of a product for trading on platforms, the liquidity assessment is a key, yet difficult to judge, condition required to make a successful determination. To address the issues of selecting the appropriate liquidity metrics and calibrating liquidity thresholds, we put forward a possible liquidity assessment methodology. We used a clustering technique employing a wide range of liquidity metrics (i.e. 12 liquidity metrics and 3 other market concentration/interconnection metrics). The most liquid products in a given market could then be identified as contracts found within the "Liquid" clusters.

6.7 We also discuss the limitations of our proposed methodology and the ways in which to overcome them. Future case studies of smaller markets which have implemented a trading mandate can help quantify the potential gains for mandated contracts, and create a better understanding of the minimum liquidity required to support a trading mandate. Additionally, further research and development of the proposed methodology can be done to allow for comparability

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[33] Even in the US, where the trading mandate implementation is most advanced, the model has largely retained the D2D and D2C market structure (Giancarlo, 2015). This could be due to the lack of available agency trading models, which would replace the principal-based trading models. This, as yet, has not taken off in the liquid US OTCD markets, with agency services accounting for a small percentage of trades and the low utilisation of central limit order books (Madigan, 2015).

[34] Some observers have been discussing the merits of SEF aggregation services (see for example DeCovny, 2014 and Davidson, 2011), in response to market fragmentation in the trading of swap contracts across multiple SEFs. In the clearing or CCP space, market fragmentation has also resulted in a real economic impact, in the form of the LCH-CME basis spreads (see Becker, 2015 and Smith, 2015).

across products within a given asset class, such as grouping products that share similar economic uses. This could help in the prioritising of products that are suitable to be subject to a trading mandate.

6.8 As an alternative measure to improve market transparency, we discuss the costs and benefits of the public dissemination of transaction-level TR data, and propose two possible operating models for a post-trade transparency regime. Given the challenges in determining an objective threshold or definition of a "liquid" product, the disclosure of anonymised transaction information, albeit with a time lag, could instead allow for a market-determined solution as to whether a particular product is liquid and suitable for trading on platforms. Such information could also better inform market participants on the viability of platform trading, and allow market forces to determine where and how particular products should be traded.

6.9 Finally, given our analysis that much of the G20 objectives of improving transparency, mitigating systemic risks and protecting against market abuse could largely be obtained from the reporting, clearing mandates and margin requirement for non-centrally cleared derivatives, implementation of these reforms should remain the key priorities for policy makers in smaller OTCD markets. Building upon these key foundations, policy makers could then move on to developing the regulatory regimes for trading platforms, to connect their domestic participants to the global market for derivatives trading. As a supplementary measure, post-trade anonymised transaction information from the TR could be disseminated to improve post-trade market transparency and inform any voluntary, market-driven shift towards trading on platforms.

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APPENDIX 1: COMPUTATION AND INTERPRETATION OF LIQUIDITY METRICS

Market Depth

- Number of trades: Calculated as the total number of trades of contract i on day t. We associate a contract with higher liquidity as a contract with a greater number of daily trades and vice-versa.

- Total trading volume: Calculated as the summation of the total notional values of all contracts, converted to Singapore Dollars ("SGD") based on daily close exchange rates from Bloomberg. This was computed on a daily basis for each contract. We associate a contract with higher liquidity as a contract with greater total daily trading volumes and vice-versa.

- Amihud's Price Impact: Defined for each contract i on day t as,

$$Amihud_{i,t} = \frac{1}{N_{i,t}} \sum_{j=1}^{N_{i,t}} \frac{|R_{i,j}^t|}{V_{i,j}^t}$$

  where $N_{i,t}$ is the number of i contracts traded on day t, $R_{i,j}^t$ is the percentage price change for the jth trade and $V_{i,j}^t$ is the notional size of the jth trade (in SGD millions). We associate a contract with higher liquidity as a contract with a lower Amihud Price Impact and vice-versa.

- Intraday Volatility: Calculated as the simple sample variance of daily prices of contract i on day t. We associate a contract with higher liquidity as a contract with a lower intraday volatility and vice-versa.

Market Breadth

- Share of interbank trading: Calculated as the total notional value of contract i on day t traded between banks divided by the total trading volume contract i on day t. We associate a contract with higher liquidity as a contract with a lower share of interbank trading and vice-versa.

- Ratio of bank participants: Calculated as the total number of banks which had made at least one trade of contract i on day t divided by the total number of participants who have made at least one trade of contract i on day t. We associate a contract with higher liquidity as a contract with a lower ratio of bank participants and vice-versa.

Immediacy

- Number of market participants: Calculated as the total number of participants who have made at least one trade of contract i on day t. We associate a contract with higher liquidity as a contract with a greater number of market participants and vice-versa.

- Number of banks: Calculated as the total number of banks which have made at least one trade of contract i on day t. We associate a contract with higher liquidity as a contract with a greater number of bank participants and vice-versa.

- Average transaction volume: Calculated as the average notional per trade for contract i on day t. We associate a contract with higher liquidity as a contract with a greater average transaction volume and vice-versa

- Average trades per participants: Calculated as the average number of trades for contract i on day t per market participant. We associate a contract with higher liquidity as a contract with a greater average number of trades per participant and vice-versa.

Tightness

- Adjusted Jankowitsch, Nashikkar and Subrahmanyam's Price Dispersion: Defined for each for contract i on day t as,

$$JNSdisp_{i,t} = \sqrt{\sum_{j=1}^{N_{i,t}} \frac{V_{i,t,j}}{V_{i,t}} \left(\frac{P_{i,t,j} - \overline{P_{i,t}}}{\overline{P_{i,t}}} \right)^2}$$

where $N_{i,t}$ is the number of i contracts traded on day t, $P_{i,t,j}$ is the executed price for the trade j, $\overline{P_{i,t}}$ is the average executed price of contract i on day t, $V_{i,t,j}$ is the notional size of the trade j (in SGD millions) and $V_{i,t}$ is the total notional size of contract i on day t.[35] We

[35] We adopt this version of the JNS price dispersion from Benos, Payne and Vasios (2016) as it relies only on post-trade information and does not require the pre-trade mid-quote as in the original dispersion measure proposed by Jankowtsch et al. (2011).

associate a contract with higher liquidity as a contract with a smaller Adjusted Price Dispersion and vice-versa.

- Effective Bid-Ask Spreads: Defined for each for contract i on day t as,

$$ebas_{i,t} = \frac{\bar{p}_{i,t}^{sell} - \bar{p}_{i,t}^{buy}}{1/_2\left(\bar{p}_{i,t}^{sell} + \bar{p}_{i,t}^{buy}\right)}$$

where $\bar{p}_{i,t}^{sell} = \frac{1}{n_{i,t}^{sell}} \sum_{j=1}^{n_{i,t}^{sell}} p_{i,t,j}^{sell}$ and $\bar{p}_{i,t}^{buy} = \frac{1}{n_{i,t}^{buy}} \sum_{j=1}^{n_{i,t}^{buy}} p_{i,t,j}^{buy}$ refer to the average sell and buy prices of contract i on day t respectively. We associate a contract with higher liquidity as a contract with a smaller effective bid-ask spread and vice-versa.

Market Interconnectedness

- Mean Degree Centrality: Calculated as the simple daily average of the degree distribution of all counterparties trading contract i on day t. We associate a contract with higher liquidity as a contract with a greater mean degree centrality and vice-versa.

- Standard Deviation of Degree Centrality: Calculated as the square root of the sample variance of the degree distribution of all counterparties trading contract i on day t. We associate a contract with higher liquidity as a contract with a smaller standard deviation of degree centrality and vice-versa.

Market Concentration

- GINI Coefficient of the Degree Centrality: Defined for each for contract i on day t as,

$$degreeGINI_{i,t} = \frac{\sum_{j=1}^{n_{i,t}} \sum_{k=1}^{n_{i,t}} |x_{i,t}^{j} - x_{i,t}^{k}|}{2n_{i,t} \sum_{j=1}^{n_{i,t}} x_{i,t}^{j}}$$

where $x_{i,t}^{j}$ refers to the degree centrality of counterparty j for contract i on day t. We associate a contract with higher (lower) liquidity as a contract with a GINI coefficient of the degree centrality closer to zero (one).

APPENDIX 2: DATA CLEANING METHODOLOGY

The data from 4 Jan 2016 to 30 Jun 2016 contained approximately 2.5 million FX forwards that were executed within the same time window.

To clean the data, we executed the following procedure sequentially:

1) Removed duplicate trades by identifying duplicated Unique Transaction Identifiers/Unique Swap Identifier/internal trade codes. This may not remove duplicate trades where counterparties report the trade identifier using different codes. We do not attempt to identify potentially duplicate trades by using other terms of the contract.
2) Remove trades with missing price data.
3) Remove trades with missing execution dates or with execution dates outside the time window of interest.
4) Retained only trades where the tenor of the trade is close to or equal to 30 days (one-month).[36] Removed trades where tenor is missing or where the tenor is negative.
5) Removed intraparty transactions where counterparty 1 is the same as counterparty 2.
6) Remove trades where the currency pair of the contract is not amongst the top 20 most traded currency pairs (within the entire time window of interest, based on total volume traded).

The number of data points removed at each step is detailed in Table 1 below.

Table 1: Data Cleaning Procedure

Cleaning operations	# Observations
Initial values	2,471,162
Duplicated trade identifiers	29,247
Missing price data	11,910
Missing execution date or execution date not in time frame	504,773
Tenor not 1M or missing or implausible maturity dates	1,305,465
Intraparty Transactions	8
Non-top 20 currency pairs	18,093
Final Number of Transactions	601,009

[36] We calculated the tenor of each contract based on the number of days between the maturity date of the contract and the effective start date of the contract. Due to the day count differences between contracts, the inclusion of holidays and weekends, contracts deemed as one-month contracts could have tenors from 26 to 38 days.

APPENDIX 3: SUMMARY STATISTICS AND CLUSTERING METHODOLOGY

We calculated the six month average of the daily values of each liquidity metric. We highlight an example of those calculations in Table 2 below.

Table 2: Six Month Average Computations of Liquidity Metrics

Six month average of:	USDSGD	EURUSD	USDCAD
Number of Trades Daily	95	88	16
Total Daily Notional Value (S$ billions)	1.9	3.2	0.31
Number of Counterparties	66	74	19
Number of Banks	27	31	9
Daily Average Number of Trades Per Counterparty	1.4	1.2	0.9
Bank-to-Nonbank Ratio	0.4	0.4	0.5
Daily Average Trade Notional Per Counterparty (S$ millions)	22	41	19
Daily Effective Bid-Ask Spread (%)	0.1	0.2	0.1
Daily Amihud Price Impact (% per S$ million)	39	36	17
Daily Adjusted JNS Price Dispersion (%)	0.1	0.1	0.1
Daily Price Realized Standard Deviation (%)	0.2	0.2	0.2
Daily Average Degree	1.7	1.6	1.2
Daily Realized Standard Deviation of Degree	1.7	1.5	0.6
Daily GINI coefficient of Degree	0.34	0.32	0.15

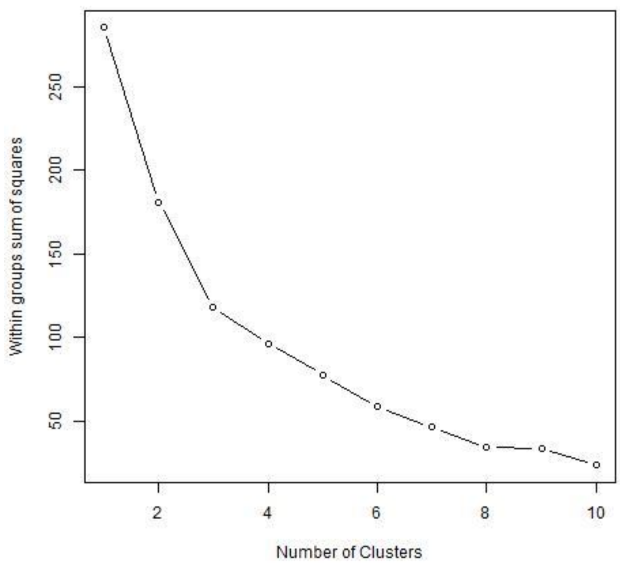
Prior to clustering, the variables were all standardized to zero mean and unit variance. The clustering algorithm of choice was the K-Means Algorithm because of its simplicity and ease of interpretation. K-Means Algorithm is a technique that attempts to find clusters by minimizing the intra-cluster sum-of-squares variances while maximizing the inter-cluster sum-of-squares variances.

The algorithm follows the following steps:

1) Initialize with K points into the N-Dimensional space of objects that are being clustered.
2) Assign each object to a group that has the nearest centroid, based on the squared Euclidean distances.
3) When all objects are assigned, recalculate the positions of the K centroids to the centre of each of K groupings.
4) Repeat steps 2 and 3 until the centroids stabilise.

The number of clusters is key parameter for the model that would affect the total sum-of-squares and between sum-of-squares within the clusters. We chose the number of cluster heuristically, from the "elbow" method in a scree plot – 3 clusters was chosen (Figure 5).[37]

Figure 5
Scree Plot of K Means Clustering



After the number of clusters was determined, we then assigned each cluster a liquidity rating by ranking each cluster centroid according to the overall liquidity ranking score. We did this by first ranking each cluster across each liquidity metric based on our interpretation of the directionality of each liquidity metrics (Appendix

[37] A scree plot plots the total within-cluster variances against number of clusters used. The "elbow" method is a heuristic approach to choose the number of cluster where increasing the number of clusters no longer yields a substantial decrease in the total within-cluster variances. In this case, 3 was chosen as the appropriate number of clusters.

1). Thereafter, we tabulated the overall ranking for each cluster and assigned each a liquidity rating according to its overall ranking (Table 3).

Table 3: Ranking of Clusters according to Liquidity Metrics

Liquidity Metric (Rank 1 (Most Liquid) - Rank 3 (Most Illiquid)	Cluster 1	Cluster 2	Cluster 3
Total Count	2	1	3
Total Counterparties	2	1	3
Total Notional	2	1	3
Average Trades	2	1	3
Number of Banks	2	1	3
Interbank Share of Trading	3	1	2
Ratio of Banks to buy-side participants	1	2	3
Average Trade Notional	1	3	2
Effective Bid-Ask Spread	2	1	3
Amihud Price Impact	3	2	1
JNS Price Dispersion	2	1	3
Intraday Volatility	1	3	2
Average Degree	2	1	3
Standard Deviation of Degree	2	3	1
GINI Coefficient - Degree	2	3	1
Overall Score (Simple Summation)	29	25	36
Overall Ranking (Lower represents higher liquidity)	**Fairly Liquid**	**Liquid**	**Illiquid**

While the K-Means Clustering yielded satisfactory results in identifying appropriate clusters, the algorithm could also be distorted by high correlation between variables or by the high dimensionality of the data.[38] Although the clustering was done on 15 variables and may not be considered "high dimension" data, we first investigated whether the variables were indeed highly correlated and then performed dimensionality reduction to investigate whether the centroids remained stable with fewer variables. Furthermore, we also tested to see whether the K-Means algorithm could be further supplemented by other clustering techniques (such as a hierarchical agglomerative clustering method) and whether the algorithms converged to similar clusters. This would help to resolve issues with high dimensionality distortion of distance measures.

[38] Commonly referred to as the "curse of dimensionality", in a high-dimension space, data points become increasingly sparse relative to the volume of space formed by the number of dimensions. As a result, simple distance metrics such as Euclidean distances may not be able to capture contrasts between distances of different data points and as such, all data points appear of similar distance to one another (Aggarwal et al., 2001).

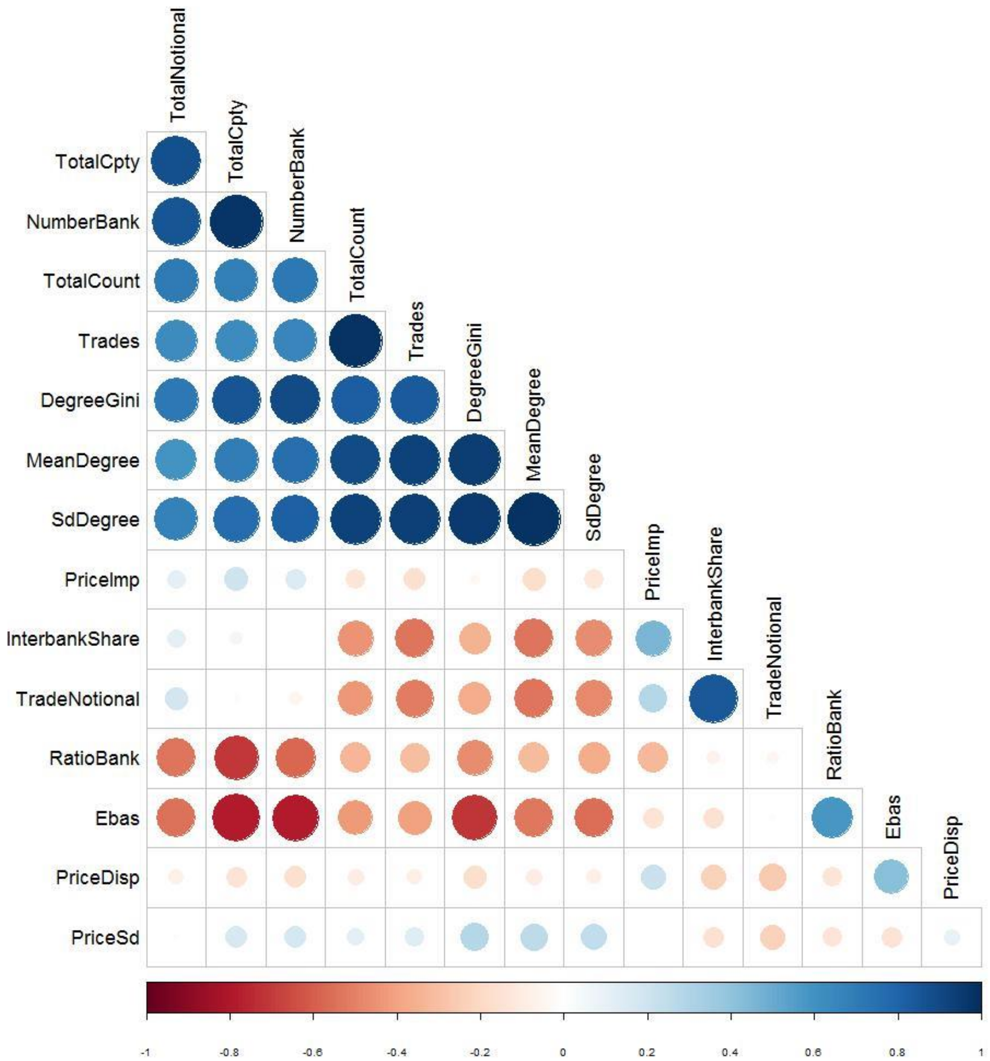
The correlation matrix of the variables highlights that there is indeed high correlation between variables, although this is to be expected as all the variables were chosen to conceptually include some aspect of liquidity (Figure 6). Interestingly, we find that the GINI coefficient and standard deviation of degree centrality are highly positively correlated with simpler metrics of liquidity (such as size and total counterparties) but negatively correlated to price impact and spread metrics (such as effective bid-ask spreads) highlighting that market structure metrics can be informative of liquidity conditions.

To resolve the correlation effects and to reduce the dimensionality of the data set, we conduct a principal component analysis (PCA) on the variables to reduce the 15 variables into six principal components.[39] These six principal components accounted for 95% of variation in all the 15 variables. Clustering on the six orthogonal principal components yielded similar results - a total of three clusters were chosen, with all observations assigned the same clusters as with the 15-variable clustering without dimensionality reduction.[40]

[39] PCA would also remove correlation effects from the variables as the principal components are orthogonal.

[40] PCA has been shown to result in efficiency gains and cluster accuracy for K-Means Clustering (Ding and He, 2004). The Rand index is a measure of similarity between two data clusterings. A Rand Index of 0 is total disagreement between two clusterings while a Rand Index of 1 represents complete agreement between two clusterings. The Rand index between the K means clustering prior to PCA dimensionality reduction and K means clustering after PCA dimensionality reduction is 1.

Figure 6
Correlation Plot of Liquidity and Network Centrality Indicators



Further, we also test to see if a K-mediods clustering method and an average linkage hierarchical clustering method would yield similar clusters to the simple K-means method. The K-mediods clustering method based on the Manhattan distance measure resulted in the same clusters as the K-means method with a Rand index of 1. The average linkage hierarchical clustering method resulted in a slightly smaller "liquid" cluster, and could not discern between "illiquid" and "fairly liquid" clusters. Nonetheless, all the products assigned the "liquid" cluster in the hierarchical clustering method was also assigned into the "liquid" cluster in the simple K-means method. The Rand index between the average linkage hierarchical clustering results and the K-Means clustering results were 0.8.

For this analysis, we used an arbitrary six month window to compute the averages. Hence, the cluster centroids and ranges could potentially be sensitive to the methodology used in calculating the six month averages. Therefore, we tested for cluster stability when using different time windows and frequencies. Using one month windows and three month windows, we found that the cluster centroids did not change materially and the liquidity assessments stayed relatively consistent. Although we have found the centroids to be rather stable even if we were to use higher frequency windows, there is no assurance that the centroids may not be prone to sudden structural shifts. To err on the side of caution, we suggest to take the longest possible time period available and to potentially use a moving average method of computation. This would limit the effects of volatile swings in monthly trading volumes in calibrating the cluster thresholds.