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Foresight

Economic impact assessments of proposals for computer trading

In association with

London Economics

The Future of Computer Trading in Financial Markets

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Contents

Executive summary

Approach

The present report provides an evidence-based analysis of a number of measures targeted at computer trading. Some of these measures were included in The European Commission' proposal of 20th October 2011 for a revised Directive on markets in financial instruments (MiFID II The impact assessments presented in the report follow the EC Impact Assessment Guidelines (see p. 15 for details).

In the present context, the intuition behind this approach is as follows. First, any proposal which changes the risk of adverse selection faced by providers of liquidity in trading markets, including HFT firms, will affect the liquidity of the market(s) in which the measure is applied. Such a change in the risk of adverse selection will impact on trading costs as liquidity providers adjust the bid-ask spreads they deem necessary to protect themselves against adverse market developments. Thus, the implementation of any of the proposals in a particular trading market will affect the bid-ask spreads of the securities traded in that market.

Second, changes in the bid-ask spreads affect the cost of capital of businesses relying on funds raised in the markets in which the policy measures are being implemented.

Third, changes in the cost of capital affect the level of business investment and hence the level of economic activity.

Overall, therefore, this causal chain links the proposals under consideration, which relate to financial intermediation, to the wider economy.

Full details of the analytical model for the impact assessment are provided from page 17 onwards.

Key results of impact assessments

Based on the approach outlined above, the analysis undertaken yielded the following key results.[1]

Increase in tick size

An increase in tick size is motivated by a desire to improve *inter alia* liquidity. Such an outcome may come about if tick sizes are presently too small.

[1] Exhaustive results, relating to all proposals considered, provided in subsequent chapters.

However, the evidence base considered, which includes empirical work in a computer trading environment, suggests that increases in tick sizes would lead to increases in bid-ask spreads. This would be deleterious to the economy insofar as wider bid-ask spreads are linked to higher trading costs and the cost of capital, and in turn lower rates of business investment and overall economic activity.

Quantitatively, a reversal of the tick size reductions piloted on European trading venues in 2009 (including, BATS and Chi-X) is associated with a cumulative loss in EU27 GDP (at constant prices) over a period of 10 years of €60bn.

Control by regulators of algorithms

The aim of regulatory control of algorithms is to ensure that no “rogue” algorithm could create havoc in financial markets. If effective, this would reduce the risk faced by liquidity providers and hence reduce bid-ask spreads relative to a situation where such a risk of rogue algorithms is very real. Stakeholders all agreed that it would not be possible for regulators to undertake in-depth reviews and analysis of the many different algorithms being used. However, many stakeholders were of the view that a more robust regulatory approach to ensuring that algorithmic trading firms properly test the robustness and resilience of their algorithms (with a clear audit trail of the testing and assessment undertaken) would be feasible and beneficial.

Based on an analysis of developments of bid-ask spreads around the so-called flash crash, the impact of regulatory control of algorithms through the approach put forward by stakeholders is likely to be small, boosting EU27 GDP (at constant prices) in the long run in the order of 0.1%.

Affirmative obligations for market makers

A maximum spread width (MSW) rule is considered as the affirmative obligation for liquidity providers. However, stakeholder consultations suggested significant difficulties associated with enforcing such an obligation on high frequency trading firms due, among other things, to the losses they would incur by providing liquidity during times of market stress.

Circuit breakers

The evidence base considered is unclear on the costs and benefits of harmonised circuit breakers.

Theoretically, the impact of harmonised circuit breakers on bid-ask spreads is ambiguous because it may be associated with higher or lower risk for liquidity providers.

On the one hand, harmonisation is beneficial because the alternative may lead to an increase in adverse selection risk for liquidity providers operating on (satellite) trading venues when a circuit breaker is active on the main exchange.

On the other hand, harmonisation may have unintended consequences despite being motivated by a desire to dampen the deleterious impacts of trading at times of market stress. In the main, liquidity providers may face greater costs than benefits arising due to trade interruptions.

Empirically, it is difficult to distinguish the relative merits of harmonised versus disharmonised circuit breakers because no studies have been carried out on this topic.

Slowing down the market

Two proposals for slowing down the market are considered: a) establishing minimum resting times; and b) replacing continuous trading markets with randomised stop auction. The motivation behind these measures is that by slowing down the pace of trading, a level playing field between computer traders and others would be established.

However, stakeholder consultations revealed a consensus that these proposals would only serve to increase the risk of adverse selection for liquidity providers, and thereby lead to an increase in bid-ask spreads and a reduction in economic activity.

Order cancellation penalties

In principle, the introduction of order cancellation penalties should reduce the volume of orders (and cancellations) as the net benefit of submitting orders followed by very rapid cancellation decreases, especially for orders which are submitted well outside prevailing trading ranges and have a low probability of being executed.

The impact on bid ask-spreads will depend on the extent to which effective liquidity is impacted by such the introduction of order cancellation penalties. However, in the absence of solid empirical evidence and even comprehensive theoretical analysis of the effect of such measures, it is not possible at this stage to determine how bid-ask spreads will change.

Strengthening real-time surveillance

There exists a large body of literature showing that maintaining market integrity is critical to ensuring high quality markets. Importantly, in the current context, the mechanisms identified through this literature suggest how maintaining market integrity feeds through to bid-ask spreads and, through the causal links described above, eventually to economic activity.

Quantitatively, conservative estimates for the impact of the Markets Abuse Directive (MAD) and Transparency Directive (TPD) on bid-ask spreads are used as a yardstick for the effect of strengthening real-time surveillance. These suggest a cumulative gain in EU27 GDP (at constant prices) over a period of 10 years of €25bn.

Priority rules

Priority rules consist of randomised ranking of orders received within a given timeframe with minimum resting times and/or order cancellation penalties.

These measures are similar to the measures relating to the slowing down of the market, except that they are squarely focused on establishing a level playing field between market participants rather than slowing the speed of trading.

Similar to measures relating to slowing down the market, stakeholder consultations revealed that the impact of priority rules would be to widen bid ask spreads leading to negative impacts on economic activity due to adverse selection risk for liquidity providers.

Make-take fees

The impact assessment of make-take fees evaluates switching from a fee schedule which sees the taker face a larger fee burden than the maker (i.e., in which maker rebates are offered) to a schedule that sees the maker face the same fee burden as the taker, holding the take fee constant.

The motivation for evaluating this proposal is to assess the significant monetary transfers maker rebates constitute from trading venues to traders submitting limit orders.

The evidence base considered does not suggest any benefits resulting from this policy change. But, costs would accrue to stakeholders, as higher make fees are associated with wider bid-ask spreads.

Introduction

Purpose of the study

The European Commission' proposal of 20th October 2012 for a revised Directive on markets in financial instruments (MiFID II)[2] sets out in articles 17 and 51 a number of proposals which will affect directly algorithmic trading.

In short, according to article 17, investment firms that engage in algorithmic trading shall:

- Ensure that its trading systems are robust and do not send erroneous orders and do not contribute to disorderly markets (art. 17.1);

- Provide, at least annually, detailed information to the relevant Competent Authority a description of the nature of the algorithmic trading strategies, details of the trading parameters or limits, key compliance and risk controls, etc. Further information may be sought by the Competent Authority during the year (art 17.2);

- Ensure that algorithmic trading strategies provide liquidity at competitive prices on an on-going and regular basis to trading venues to which they send orders and through which they execute transactions (art. 17.3);

Investments firms, that provide direct electronic access to trading venues to firms using algorithmic trading strategies, shall have proper control and risk management systems (art. 17.4). Similar obligations apply to investment firms acting as a general clearing member for other persons (art 17.5).

Moreover, article 51 specifies that Member States shall require regulated markets to:

- Ensure that their trading systems are resilient, have sufficient capacity to deal with peak order and message volume, operate in orderly trading under conditions of market stress, are fully tested and provide for effective business continuity (art. 51.1);

- Ensure that robust and effective systems are in place to reject orders which exceed predetermined volume and/or price thresholds or are clearly erroneous and to halt trading during a short period if significant price movements occur and cancel, vary or correct trades in exceptional cases (art. 51.2);

- Ensure that their systems prevent algorithmic trading from creating or contributing to disorderly trading conditions, including limits to the ratio of unexecuted orders to

[2] European Commission, Proposal for a Directive of the European Parliament and of the Council on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council, Brussels, 20 October 2010, COM(2011) 656 final, 2011/0298 (COD)

transactions, limits to the order flow if there is a risk of system capacity being reached and limit the minimum tick size (art. 51.3);

- Ensure that only authorised investment firms are permitted to provide direct electronic access and that they retain responsibility for order and trades executed using such direct access and that regulated markets have proper rules and systems in place to distinguish and stop, if necessary, orders or trading by persons using the direct electronic access separately from orders or trading by the investment firm providing the direct electronic access (art. 51.4);

- Ensure that regulated markets' rules and fees for co-location are transparent, fair and non-discriminatory (art. 51.5);

- Ensure that regulated markets provide upon request to the relevant competent authorities for monitoring purposes data relating to the order book or access to the order book (art. 51.6);

In addition, according to article 51.7, The Commission shall be empowered to adopt delegated acts to:

- Ensure that trading systems of regulated markets are resilient and have adequate capacity (art. 51.7(a));

- Set out conditions under which trading should be halted if there is a significant price movement in a financial instrument on that market or a related market during a short period (art. 51.7(b));

- Set out the maximum and minimum ratio of executed orders to transactions that may be adopted by regulated markets and minimum tick sizes that should be adopted (art. 51.7(c));

- Establish controls concerning direct electronic access (art. 51.7(d));

- Ensure that co-location services and fee structures are fair and non-discriminatory (art. 51.7(e));

The present report assesses the economy-wide impact of a number of measures targeting computer trading which have been put forward either as part of MiFID II or by policy-makers, commentators and others. These measures relate to the following aspects of securities trading:

- Increase in minimum tick size (relates to art. 51.3 of MiFID II)

- Regulation of algorithmic trading (relates to art. 17.2 of MiFID II)

    - Under the proposed measure, regulators will review and stress test algorithms before they can be used in trading

- Measures to stabilise the market during rapid and large price movements - circuit breakers (relates to art. 51.2 of MiFID II)

    - The present analysis discusses the impact of harmonised versus unharmonised circuit breakers with harmonisation relating to both the activation of the circuit breakers and the length during which they are in force across related cash markets and related cash and derivatives markets.

- Imposition of Minimum obligations for market makers (relates to art. 17.3 of MiFID II)

- Establishment of specific priority rules or an order preference to establish a level playing field between algorithmic traders and other traders

    - The specific measure considered is randomised ranking of orders received within given timeframe with minimum resting times and/or order cancellation penalty (art. 51.7(c)

- Measures to slow trading in the market

    - Two specific proposals are considered. They concern the imposition of a minimum resting time and the replacement of continuous market trading with a randomised stop auction

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- Strengthening real-time market abuse surveillance

- Introduction of a European limit order book to replace the exchange order book

- Symmetric make-take fees

    - The analysis focuses on the impact of a switch from a maker-taker fee schedule (in which the taker faces a larger fee burden than the maker) to as symmetric fee schedule

- Internalisation

    - The analysis examines the implications of an increase in pre/post-trade transparency of dark pools in times of market stress

Key causal linkages in the analytical framework used for the analysis

The causal chain through which the policy measures listed above may impact the broader economy is described succinctly below and the following chapter provides a more extensive discussion of the causal chain which comprises three key stages.

- First, any measure which changes the risk of adverse selection faced by providers of liquidity in trading markets, including HFT firms, will affect the liquidity of the market(s) in which the measure is applied. Such a change in the risk of adverse selection will impact on trading costs as liquidity providers adjust the bid-ask spreads they deem necessary to protect themselves against adverse market developments.

Thus, the implementation of any of the measures listed above in a particular trading market will affect the bid-ask spreads of the securities traded in that market.

- Second, changes in the bid-ask spreads in turn affects the cost of capital of businesses relying on funds raised in the markets in which the policy measures are being implemented.

- Third, changes in the cost of capital in turn affects the level of business investment and hence the overall level of economic activity.

Research approach

In the present study, the general approach to assessing the economy-wide impact of any of the measures above is to determine first qualitatively and, whenever possible, quantitatively, the impact of these measures on the cost of trading of various financial instruments and, hence, on the cost of capital of entities raising funds through the issuance of the various financial instruments.

Not only do increases in trading costs impact on business investment but, they also impact on the returns of the portfolios of savers and hence reduce the incentive to save. Any policy-induced changes in bid-ask spreads will be reflected in the price of new securities and hence will not affect savers' returns from these new securities. However the returns on the stock of existing securities will be clearly impacted. In fact, the economy-wide impact of a policy-induced widening of bid-ask spreads is similar to that of a financial transactions tax.[3]

It is important to note that the present report does not examine in detail the implications of the various potential policy measures for the micro-structure of the trading markets and computer trading. However, building on existing literature, the study aims to assess qualitatively and, when possible, quantitatively, the wider economic impacts. Many studies have focused on the former impacts while none, to our knowledge, have assessed the latter.

The key sources of information used in the impact assessments are findings from the academic and quasi-academic literature, views and opinions shared by a number of stakeholders during a consultation process undertaken as part of the project and a qualitative analysis of particular events that have occurred in different trading markets such as the so-called flash-crash of 6 May 2010, the introduction of different trading tick sizes in various markets, and other events.

In total, 18 stakeholders accepted to provide their views on the various measures being assessed in the present report. This stakeholder group comprises academics, representatives of HFT firms, investment banks, buy-side firms, trading venues and technology providers.

Structure of the report

The present report is structured as follows:

[3] See, for example, Matheson (2011).

- The next section discusses briefly the nature of an EC-type impact assessment.
- The subsequent section sets out the precise analytical framework used for the assessment of each of the policy measures listed above.
- The sections thereafter present the impact assessments of the various policy measures.

A short note on EC-type impact assessments

The EC's Impact Assessment Guidelines (2009) specify that any impact assessment should assess the impacts of policies as net changes compared to a "no policy change" scenario or baseline scenario.

This "no policy change" baseline scenario, however, should include all announced policy changes which will shape the policy environment, and the economic and financial conditions upon which they will have an impact.

The three major steps in an EC impact assessment include:

- The identification of economic, social and environmental impacts
- A qualitative assessment of the more significant impacts
- An in-depth qualitative and quantitative analysis of the most significant impacts

Identification of economic, social and environmental impacts

With regards to the various impacts to be assessed, the impact assessments in the present report focus on the economic impact. The precise nature of this impact is discussed in greater details in the next section.

According to the EC impact Assessment Guidelines, it is important to identify those impacts, which inside and outside the EU are likely to occur as a consequence of implementing a particular policy, law or regulation. In order for the impact assessment to be complete, it is necessary to consider whenever possible all intentional impacts and effects, and to the extent possible, potential unintended impacts and effects.

In the impact assessments we rely on the existing literature and the information provided by stakeholders during the consultation process to draw out the potential impacts.

As part of an EC impact assessment, it is essential to identify the various stakeholder groups that are impacted by the policy and assess, for each group, the main effects. For the purpose of the present analysis we distinguish a number of major groups of stakeholders.

- The first group comprises all the market participants.
- The second group consists of the trading venues.

- The third group comprise regulators of trading markets.
- The fourth group includes final users of funds raised in capital markets, typically businesses.
- The fifth group is comprised of savers in the economy. For simplicity we assume that households are the only source of net savings to the economy but, obviously, in a globalised world, foreign savings are also important.

A high level qualitative assessment of the impacts

Once a baseline for the assessment has been established and the most important groups of stakeholders have been identified, an EC-type impact assessment describes qualitatively the expected impacts for each group of stakeholders, sometimes using a summary table showing not only the direction of the impact but also providing an assessment of the likely magnitude of the impact. Such a qualitative assessment is particularly important in cases when it is not possible to quantify the impact.

In-depth analysis of the most significant impacts

This is the most important part of an EC impact assessment and, to the extent possible, the analysis should provide quantitative estimates. The quantification is typically undertaken for a number of years and the resulting annual benefit and cost estimates are reduced to a net present value figure using a discount rate of 4%.

The approach taken in the present impact assessment is to derive, whenever possible, quantitative estimates of the economy-wide impacts.

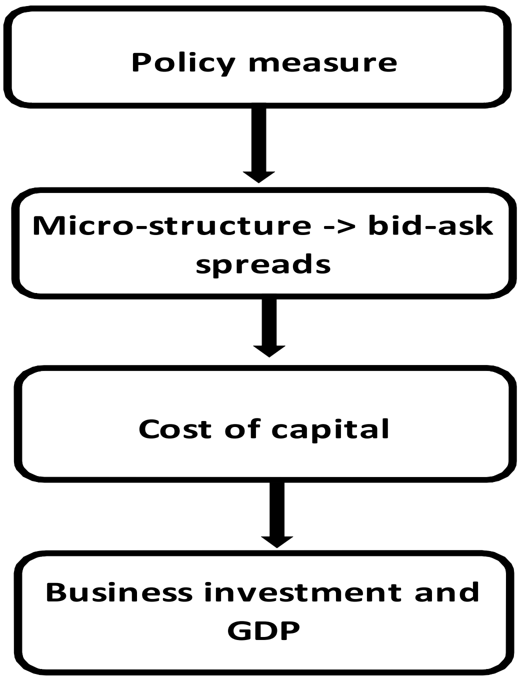
Because most of the information is available only for equity trading, the analysis addresses only this asset class.

The analytical model for the impact assessment

Overview

The present section sets out the analytical framework used for the economic assessment of the various measures listed in the introduction. As already noted in the introduction, the framework uses a 4-part causal chain represented diagrammatically below. It is the same analytical framework which was used in the 2002 study by London Economics for the European Commission DG Internal market and Services on the Quantification of the Macro-Economic Impact of Integration of EU Financial Markets and which had been peer reviewed by the European Central Bank and academics.

Figure 1: Diagrammatic representation of the causal chain in the analytical framework used for the impact assessment



Source: London Economics

Bid-ask spreads – a key transmission mechanism

The total trading cost of a security on an organised market such as a stock exchange consists of explicit costs such as trading, clearing and settlement fees and membership fees and implicit trading costs. Among the latter, the academic literature typically distinguishes two cost components, namely the bid-ask spread and the market impact.

Spreads can be thought as the price of immediacy in security markets (Demsetz, 1968).

Suppliers of immediacy, such as market-makers or more generally liquidity providers, are traders who stand ready to trade at prices they quote. The demanders of immediacy are traders who place market orders to trade immediately. Immediate sales are usually made at the bid price and immediate purchases are usually made at the ask price. Thus, the spread between the bid and ask price can be thought of as the economic cost of providing this immediacy.

A related explanation of market spreads assumes the presence of asymmetric information. A supplier of immediacy faces the risk that a bid or ask will be accepted by someone with superior information. Informed traders buy at the ask price if they have information justifying a higher price, and sell at the bid if they have information justifying a lower price. When the information becomes known, informed traders gain at the expense of suppliers of immediacy. As Bagehot (1971) first noted, if suppliers of immediacy are to avoid losses, uninformed traders must pay a spread sufficient to compensate suppliers of immediacy for losses to informed investors.

The original studies analysing the determinants of bid-ask spreads focused on traditional, non-electronic markets. The advent of algorithmic and computer trading in an environment in which new information can be processed and acted on at extremely rapid speed, has raised risk of adverse selection faced by liquidity providers even more (Agatonovic et al.(2012)).

There exist a large body of literature examining empirically the main determinants of bid-ask spreads. All the studies in this field find that the bid-ask spread of a particular security is a function of the liquidity or market depth in that security and the volatility of the security's return.

Other factors which contribute to explain differences in bid-ask spreads across securities and trading venues include the market capitalisation of the security, the total market capitalisation, trading venue governance rules, regulation, etc. (Branch and Freed (1977), Demsetz (1968), Domovitz et al. (2000), Jain (2001), Stoll (1978), Stoll (2000), Tinic and Wood (1972), etc.).

The key explanatory factors for the purpose of the present analysis are:

- the negative relationship between liquidity (market depth) and the level of bid-ask spreads
- the positive relationship between volatility and the level of bid-ask spreads

The impact analysis either infers from other studies the direct effect on bid-ask spreads of specific policy measures or traces the ultimate impacts through the potential policy effects on volatility and liquidity.

Finally, studies such as those by Demsetz et al. (2000) have shown that there exists an inverse relationship between bid-ask spreads and trading volume. Lower bid-ask spreads stimulates trading and vice-versa.

While all the studies above focused on US markets, the 2002 London Economics study, focusing mainly on European markets, found similar results for the early 2000s. The results of this study and a later update are used in the quantification of the impact of various policies.

As in the case of US studies, the London Economics study found empirically that the bid-ask spread is negatively related to market depth and positively related to volatility (equation (1)) and trading turnover is negatively related to the bid-ask spread (equation (2)). For detailed result of the empirical estimation, please refer to the annex on the 'Estimation of trading costs and trading turnover'.

(1) Δ Effective bid-ask spread[4] in % = -0.0120 Δ Market Depth + 0.3656 * Δ Volatility,

where Market Depth is equal to Total Market Capitalisation (in € trillion) and Volatility is the standard deviation of a stock's return over a period of a month expressed as a percentage of the average price during the month.

(2) Δ Trading Turnover = -4.8225 Δ Effective bid-ask spread + 0.1483 Δ Market Depth + 15.7095 * Δ Volatility,

where Trading Turnover is the ratio between trading volume and market capitalisation

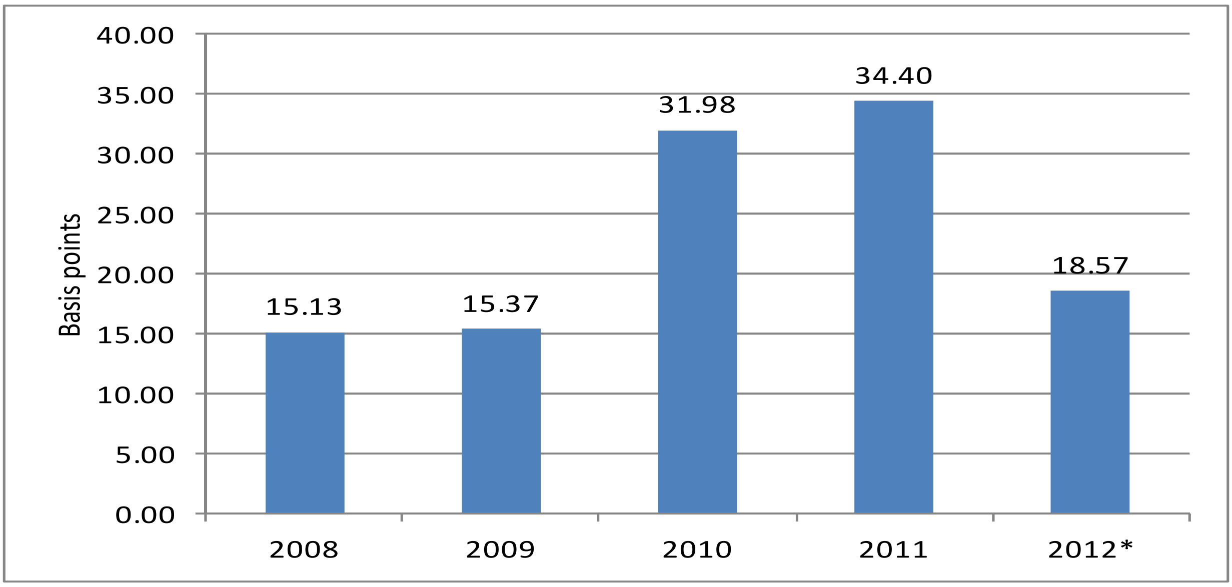
The figure below shows that the average EU-wide European bid-ask spread has varied significantly in recent years, standing at 19 basis points in the first 4 months of 2012, down from 34 basis points in 2011.[5]

[4] The effective bid-ask spread is defined as 2* I Price –the quoted mid-point I / Price. As many transactions take place inside the quoted spread, the quoted spread may overstate trading costs. A preferred measure of the trading cost is the effective bid-ask spread. This is because this measure potentially captures the fact that large trades, that exceed the volume of securities the market is willing to trade at the quoted bid and ask prices, may move prices in the direction of the trade, i.e. the market impact effect. Therefore, the effective percentage spread is preferred as a measure of trading costs because it incorporates both the impacts of market spreads and market impact on trading costs, even if it does not disentangle the two effects.

[5] The data used for the analysis is sourced from Bloomberg, which provided stock- and venue-specific information for the period ranging 1st January 2001 to 30th April 2012. The sample considered in the analysis was selected in order to represent the largest (or, most liquid) equities. The motivation for choosing these equities was to focus in on bid-ask spreads representing venue characteristics and avoid capturing characteristics of individual equities that are outside of the scope of this study. The 50 largest equities on the set of Euronext exchanges, the London Stock Exchange and Deutsche Börse and the 20 largest equities from the other European regulated markets were selected. These other venues include Athens Exchange, BME (Spanish Exchanges), Borsa Italiana, Bratislava Stock Exchange, CEESEG – Budapest, CEESEG – Ljubljana, CEESEG – Vienna, Irish Stock Exchange, NASDAQ OMX Riga, NASDAQ OMX Nordic – Copenhagen, NASDAQ OMX Nordic – Helsinki, NASDAQ OMX Nordic – Stockholm, Tallinn Stock Exchange, NASDAQ OMX Vilnius and Warsaw Stock Exchange.

The method for selecting stocks was based on companies' average market capitalisation over the period 1st January 2006 - 31st December 2009. Additionally, the 50 most liquid stocks from the multilateral trading facilities, BATS and Chi-X Europe, were chosen by trading volume . The frequency of the stock-specific data is monthly. Given this sample, an average quoted and effective spread was calculated for each trading venue by year. In order to calculate the EU average spread, the spread for each venue was weighted by the fraction of total transactions undertaken by that venue to the total transactions undertaken across all 23 venues per year. Information on total transactions for the trading venues was collected from the Federation of European Stock Exchanges (FESE).

Figure 2: EU average effective bid-ask spread based on the volume-weighted bid-ask spreads across European trading venues



Source: London Economics based on data from Bloomberg and the European Federation of Stock Exchanges (FESE)

Cost of equity capital and bid-ask spread

One of the main conclusions of the body of literature on securities market microstructure is that asset returns are increasing in trading costs (Amihud and Mendelson (1986), Amihud and Mendelson (1991), Aiyagary and Gertler (1991), Vayanos (1998)).

Intuitively, in a world where trading is costly, investors require higher returns as a compensation for higher trading costs. This translates as higher financing costs for firms. The key implication of this relationship is that by lowering the opportunity cost of capital, liquidity-increasing policies may further increase capital accumulation, and employment and growth.

The 2002 London Economics study updated and expanded the Domowitz and Steil (2001) study by re-estimating the relationship between trading costs (TC) and the cost of equity capital at the company level using microeconomic data.

The final reduced form equation derived from the econometric estimation of the model of the cost of equity capital (COE) is given below:

(3) $\Delta \text{ COE} = 0.5734 * \Delta\% \text{ TC}$

For example, a reduction of 5 basis points in trading costs relative to a baseline level of 19 basis points would yield a reduction in the cost of equity capital of 16 basis points. See the annex on the 'Estimation of impact on cost of capital' for details.

For the purpose of the analysis, two bid-ask spread baselines will be assumed, namely 19 basis points and 33 basis points, the averages for 2009 and 2010.

Equity capital and cost of funds for businesses

Obviously, the total impact on the cost of funds for business of any policy affecting the bid-ask spreads depends not only on the impact on the cost of equity capital but also on the share of equity financing in total business funding.

The table below shows that equity finance accounted for 60% of new funds to businesses in 2011 and about 37% on average over the period 2002-2007.

Table 1: Share of debt securities, loans and equity in net funds raised by non-financial corporations, 2002-7 and 2011

	Share in total funds raised	
	Average 2002-2007	2011
Debt securities (DS)	3.9%	3.2%
Loans (L)	59.0%	36.8%
Equity (E)	37.1%	59.9%

Source: London Economics analysis of Eurostat data

The overall change in the cost of business funds is a weighted average of the changes in the cost of debt, equity and loan funding, with the weights of each source of funds being equal to the share of the three instruments in new funding.

(4) $\Delta CoF = (1-wL-wE) * \Delta CoDS + wL * \Delta CoL + wE * \Delta CoE$,

where wL and wE are respectively the shares of loan finance and equity finance in new funding to business and CoF, CoDS, CoL and CoE are respectively the total cost of business finance – the cost of debt securities finance, the cost of loan finance and the cost of equity finance.

Under the assumption that the cost of debt securities and loans does not change when the cost of equity capital changes because of an increase in trading costs, the change in the cost of funds caused by a change in trading costs is given by equation (5).

(5) $\Delta CoF = wE * (0.5734 * \Delta\% \ TC)$

For the purpose of the quantitative analysis, the share of equity finance will be assumed to remain at 60% due to the fact that bank lending will remain constrained over the foreseeable future.

Cost of funds, capital formation and GDP

The last element in the quantitative analysis is the assessment of the impact of a change in the overall cost of funds for business on capital formation (i.e., business investment in structures, plants and equipment)

The previous London Economics study showed that, in the long run, a permanent reduction in the cost of funds of 10 basis points raised the level of GDP (at constant prices) by 0.25% and the level business investment by 0.9%.[6] The new long-run equilibrium was attained in year 9 of a 12 year simulation period..

Thus, the final three equations required for the quantitative analysis of the economy-wide impact of any of the policy measures listed earlier in the report are the following:

(6) % GDP (in constant price) = 0.025 * ΔCoF

(7) % Businv (in constant prices) = 0.090 * ΔCoF

Finally, substituting equation (5) into equations (6) and (7) yields the complete reduced form linking changes (in percentage) of GDP (at constant prices) and business investment (at constant prices) to changes in bid-ask spreads in trading markets.

(8) % GDP (in constant price) = 0.025 * wE * (0.5734 * Δ% TC)

(9) % Businv (in constant prices) = 0.13 * wE * (0.5734 * Δ% TC)

Impact on saving returns

The impact on households' saving returns is simply the change in bid-ask spreads times the overall value of equity assets owned by households at the time the various policies are implemented.

As already noted earlier, changes in bid-ask spreads impact only on the returns of the equity portfolio held by households at the time the policy is introduced.

As soon as the household portfolio is fully traded in the market, the changes in returns are crystallised as the buyers of the equities sold by the households (possibly other households) will adjust the price they are willing to pay for the equities in light of the changes in trading costs.

As no good data exists on the churn frequency of households' equity portfolios, it is impossible to pinpoint the time at which the impact of changes in bid-ask spreads is crystallised in equity prices. Therefore, this aspect is discussed only qualitatively in the impact assessment.

Trading volumes

As was noted earlier, trading volumes increase when bid-ask spreads decrease, *ceteris paribus*, and vice versa. Changes in trading volume will impact the trading venues' revenues

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[6] These reduced form estimates are derived from simulations undertaken with the macroeconomic model of Oxford Economics. See the annex of 'Simulation results' for details.

and the trading venues may aim, for example, to offset any decrease in trading revenues due to declines in trading volume through higher explicit fees.

As a result, a feedback loop running from changes in trading costs to changes in trading volume to changes in explicit trading fees may exist.

However, it has proven impossible to quantify the magnitude of such a feedback loop as most trading organisations do not publish separately trading income broken down by trading venue in the case of multiple venue owners and broken down between trading fees and other trading income which does not vary one-to-one with trading volumes (such as annual fees and charges, etc.).[7]

The baseline and quantifying the impact

To recap, the following assumptions are used in the quantitative assessment:

- Bid-ask spreads in the baseline: two baseline spreads will be used: 19 basis points and 33 basis points

- Weight of equity finance in the cost of funds to businesses: 60%

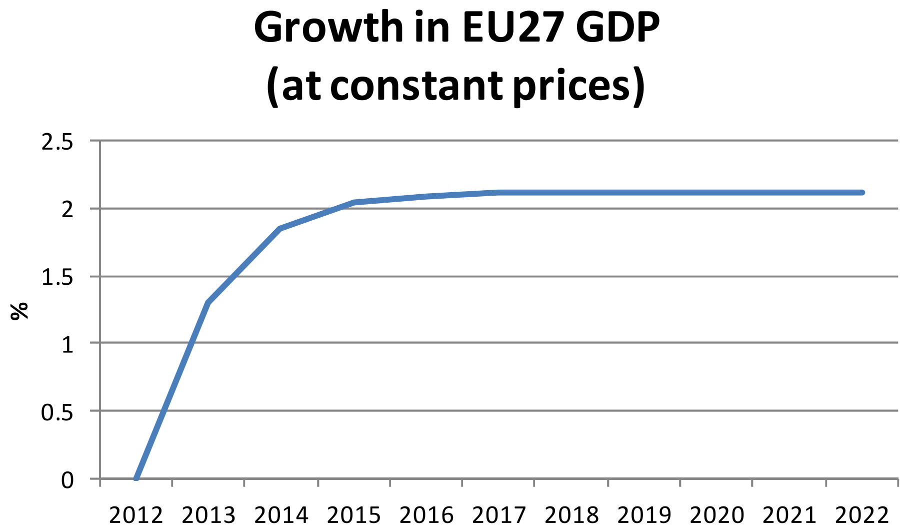
- Partial adjustment to new long-run level for GDP and business investment in constant prices : 8 years

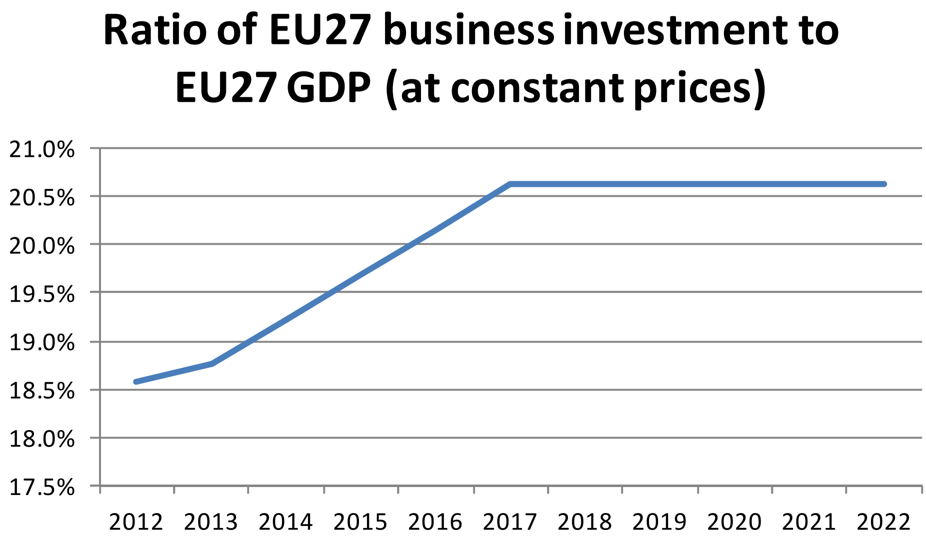
- Discount rate of 4% to compute the net present value of changes in GDP and business investment in constant prices.

- In addition, in the baseline, growth in EU27 GDP at constant prices is projected to gradually rebound to a long-rate of 2.1% (based on the latest medium-term IMF projection) and the ratio of EU27 business investment to EU GDP is projected to return gradually to an average ratio of 20.6% observed over the period 2000-2007.(see figure overleaf). These last two assumptions are required to generate a baseline EU27 GDP and EU27 business investment paths which can be used to quantify the impacts.

[7] See, for example, FESE's 2010 European Exchange Report

Figure 3: Baseline projections of growth in EU27 GDP at constant prices and ratio of EU27 business investment to EU27 GDP at constant prices





Source: London Economics based on data from April 2012 IMF World Economic Outlook

Increase in tick size

The policy proposal to be assessed involves an increase in tick sizes. This would improve liquidity if tick sizes are too small and may reduce price volatility as with wider tick sizes, there is more scope for changes without moving through a price point.

It should be noted that tick sizes were reduced and partially harmonised across trading venues in Europe in 2009 and 2010 following the initiative of the European Federation of Stock Exchanges (FESE). As of September 2011, three different tables of tick sizes are in use in Europe (FESE 2011).

Theoretical background

When tick sizes are very small, liquidity is spread over a large number of price points which may imply that posted liquidity may no longer be there when an order reaches the market. Thus, small liquidity induced by small ticks may prove more ephemeral than deeper liquidity within wider tick sizes.

Moreover, *when tick sizes are very small, the cost of setting a new best bid/offer is small and so large orders are more prone to being "stepped ahead of". This reduces the incentives to display size in the public markets, continuing the trend towards smaller order and trade sizes and more frequent data updates. Lower liquidity (shorter queues) at each price point, combined with a number of competing order books for security might dilute the incentives to leave orders in the market for a period of time so as to reach the front of queue – and without such an incentive orders will tend to have shorter duration- once again fuelling faster market data update rates* (Turquoise, 2011).

Results of empirical studies

All empirical studies focusing on tick size changes on various trading venues in the last two decades find that narrower tick sizes reduce bid-ask spreads (see table). These tick size changes involved movements away from relatively wide ticks in an environment in which computer trading did not yet play the role it does nowadays and the average trade size was higher than nowadays.

The only major dissenting study is a theoretical study using representative agent-based modelling to assess, in an ex-ante context, the implications of reducing tick sizes on Nasdaq.

Table 2: Summary of studies of impact of changes in tick size on bid-ask spreads

Authors	Event	Bid-ask spread	Market Depth	Volatility
Darley and Outkin (2007)	Agents based modelling of impact planned reduction in tick size from$1/8 to $1/16 by NASDAQ IN 1997	Increase in bid-ask spread		
Ahn, Cao and	Reduction of tick size from C$0.125 to C$0.050 for all	Reduction in bid-ask		

Authors	Event	Bid-ask spread	Market Depth	Volatility
Choe (1998)	stock traded at or above C$5 on Toronto Stock Exchange in 1996	spread		
Ahn, Cai, Chan, Hamao (2007)	Reduction in tick size on Tokyo Stock Exchange in 1998	Reduction in bid-ask spread		
Aitken and Comerton-Forde (2005)	Reduction in tick sizes on the Australian Stock Exchange	Reduction in bid-ask spread except for group of higher priced stocks with low liquidity		
Chakravarty, Wood and Harris (2001)	Adoption of decimalisation on NSYE in 2001	Reduction in bid-ask spread	Reduction in depth	
Chung and Ness (2001)	Adoption of $1/16 tick size by NASDAQ	Significant reduction in bid-ask spread, decline is the largest during the last trading hour		
Chung and Chuwonganant (2004)	Adoption of $1/16 tick size by NASDAQ	Significant reduction in bid-ask spread once Order handling Rule had been changed as well to provide for greater competition between liquidity providers		
Furfine (2003)	Decimalisation of ticks on NYSE in 2001	Reduction in average bid-ask spreads with largest declines observed for most actively traded stocks		
Gibson, Singh and Yerramilli (2003)	Adoption of $1/16 tick size by NASDAQ	Significant reduction in bid-ask spread		
Goldstein and Kavajecz (2000)	Adoption of $1/16 ticks by NYSE in 1997	Significant reduction in bid-ask spread	Depth declined	
Ronen and Weaver	Adoption of $1/16 tick size market-wide by American Stock Exchange in May 1997	Decrease	No changes	Significant decrease in daily and transitory volatility

Authors	Event	Bid-ask spread	Market Depth	Volatility
Van Nesse, Van Nesse and Prutt	Adoption of $1/16 tick on AMEX, NASDAQ and NYSE	Decrease in bid-ask spread	Decrease on AMEX and NYSE, increase on NASDAQ	

Source: London Economics

More recently, as part of a pilot to test the FESE tick tables, BATS undertook a detailed analysis of the inside spread ((offer-bid)/midpoint) and inside depth (total size available at the best bid and best offer expressed in notional terms) of four groups of stocks which underwent tick size changes through June 2009 (BATS, 2009).

The average bid-ask spread declined markedly in percentage terms in all four cases in the week during which the tick size reduction was implemented relative to the previous week and so did inside depth (see table below).

Table 3: Results of tick size reduction pilots

Week prior	Change during the pilot period relative to week prior		
Spread in basis points	Spread in basis points	Spread in percentage	Inside depth in percentage
Group 1: 17.3	-8.9	-51%	-74%
Group 2: 8.5	-2.7	-32%	-39%
Group 3: 25.8	-10.2	-40%	-51%
Group 4: 10.6	-2.9	-27%	-51%

Source: BATS (2009)

The results reported in the table above suggests that even in an environment in which computer trading is very active, reductions in tick sizes do reduce bid-ask spreads. But, they also reduce liquidity as evidenced by the reduction in inside depth.

Qualitative assessment

The results from the BATS analysis and the literature review strongly suggest that increases in tick sizes would increase bid-ask spreads.

This will impact negatively the end-users of funds raised in capital markets and savers.

It will also likely reduce overall trading volume as higher bid-ask spreads tend to discourage trading. This in turn will affect negatively trading venues.

The impact on traders is less clear-cut. As market depth within a tick size may increase, this could prove beneficial to some traders as it reduces the risk of “being stepped ahead of” mentioned above.

Quantitative assessment

In order to undertake the quantitative assessment, a judgement must be made about the size of the tick increase. For operational purposes, the increase in the tick size is assumed to be of the same order of magnitude as the tick size reduction analysed by BATS. This allows one to use the changes in spreads observed in the BATS analysis (with the opposite sign) in the quantitative assessment.

For simplicity, the average percentage change in spread size across the four groups, namely 37%, is used in the quantitative impact assessment model described in the previous chapter.

Relative to the EU27 average spreads of 19 and 33 basis points in the baseline, this implies an increase of 7 and 12 basis points respectively.

If such an increase were to be sustained, ceteris paribus, the long-run level of EU27 GDP in constant prices would be lower by 0.3% and 0.5% respectively, and the long-run level of business investment would be lower by 1% and 2% respectively.

In net present value terms, the cumulative loss in EU27 GDP (at constant prices) over a period of 10 years would be €60 billion.

Control by regulators of algorithms

Theoretical background

The policy would aim to ensure that no “rogue” algorithm could create havoc in financial markets, thus reducing the risk faced by liquidity providers and hence reducing the bid-ask spread relative to a situation where such a risk of rogue algorithm is very real.

Many stakeholders consulted during the study indicated that it would not be physically and technically possible for regulators to review in detail all the algorithms used by traders.

According to stakeholders, a much better approach would be to ensure through regulation and enforcement (even more than is currently the case) that traders bringing new algorithms to market have adequately tested and assessed the robustness of the new algorithms, and there is an audit trail of the checking and testing undertaken by the trader.

Many observers have the “Flash Crash” of May 6, 2010 in mind. One particular algorithm played a key part during this event, although it is not clear that one could categorise that particular algorithm as being a rogue one (Chakarvarty et al. 2011, Kirilenko et al. (2011) and . CFTC/SEC (2010). Nevertheless many wish to avoid a repeat, at least to the extent possible, of such an episode in the future.

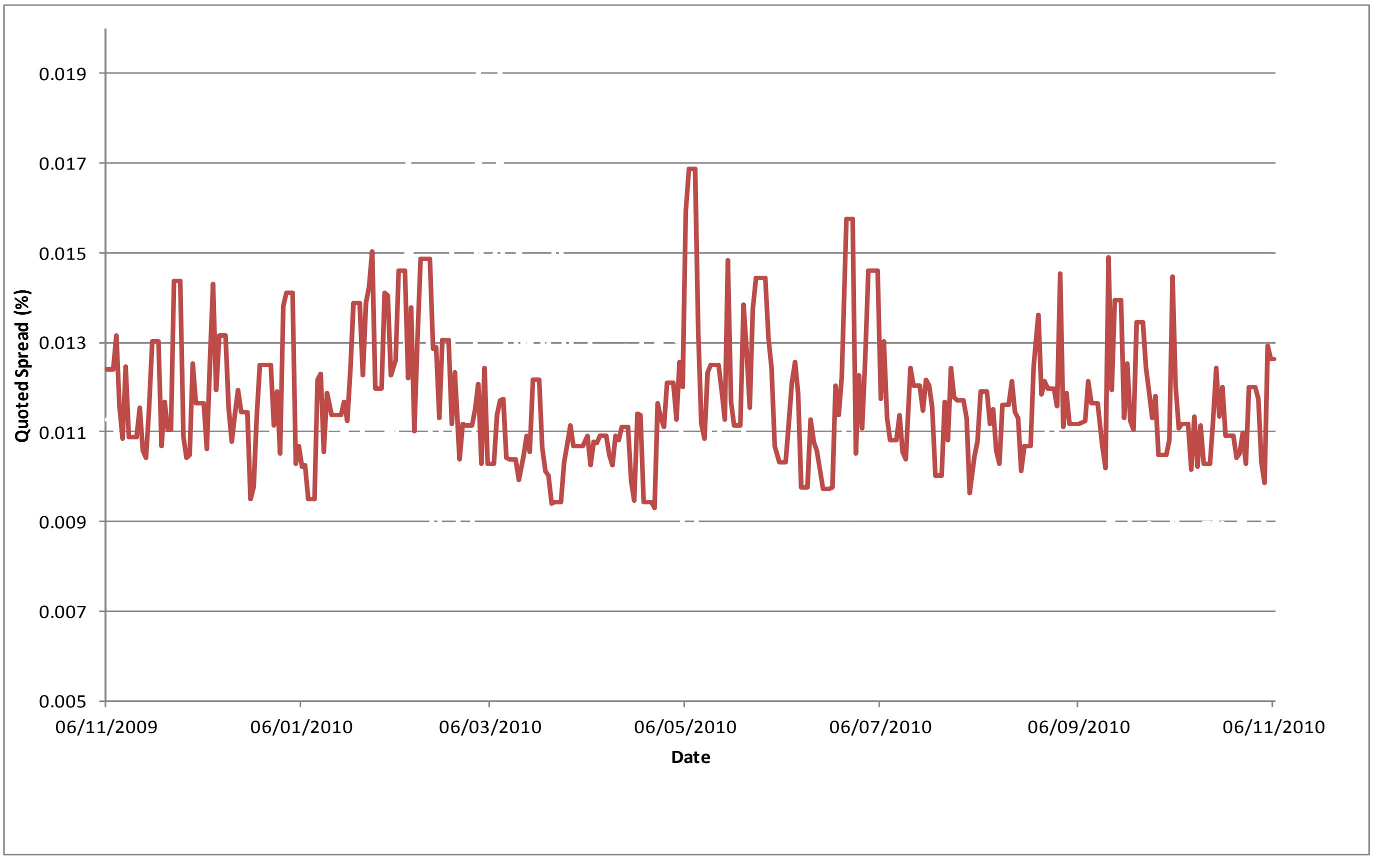
Results of empirical studies

To our knowledge, there exist no studies which aim to assess empirically the impact of a policy reducing the risk to markets of being impacted by rogue algorithms.

A detailed review of the daily average bid-ask spreads in the USA shows that, just prior to the crash, the spread was in the range 9 to 10 basis points and, in the immediate aftermath of the flash crash, it increased to about 12 to 13 basis points.

Therefore, one could make the argument that the flash crash increased bid-ask spreads by a few basis points. At issue, however, is whether the increase is long lasting but cannot be easily observed in the data because of other developments or the impact was only transitory. An in-depth analysis of spreads of stocks affected to a different degree by the flash crash may provide an answer to this question but such a study is well beyond the scope of the present impact assessment.

Figure 4: Average bid-ask spread in the US (BATS, Nasdaq and NYSE) before and after the flash crash of 6 May 2010



Source: London Economics analysis of Bloomberg bid-ask spread data for BATS, Nasdaq and NYSE

Qualitative assessment

The data presented in the figure above suggest that the impact on bid-ask spreads of any measure taken to reduce the potential for a rogue algorithm to create havoc with markets is likely to be small.

This may be the case because either market participants feel that, in general, the likelihood of a repeat event is very small and are comforted by the fact that there exists a clear process for breaking trades that go through during such disruptions, or the actual impact on bid-ask spreads is swamped by other developments and cannot be quantified by simply looking at the data.

Quantitative assessment

The figure above suggests that, possibly, bid-ask spreads could be 3 basis points lower if the risk caused by potential rogue algorithms is largely eliminated. The lower bid-ask spread will boost the level of EU27 GDP (at constant prices) in the long run by a small 0.1%.

Overall, for the impact to be felt more significantly, the effect of the policy would need to be much more pronounced in terms of changes in bid-ask spreads.

Harmonised circuit breakers

Theoretical background

Harmonisation across venues

The activation of a circuit breaker results in a constraint on the ability to trade.

If a circuit breaker is activated on one trading venue but not others, it is likely that trading will be constrained to some degree on these other venues. The extent to which trading is constrained on other venues suggests the importance of harmonised circuit breakers (or lack thereof).

In general, intermediation of time is constrained as price uncertainty implies additional market risk associated with carrying out market-making or liquidity provision. Intermediation of form is constrained as traders are limited to a subset of pricing parameters on which to base trading strategies. And, intermediation of place (the provision of a given price for an asset across trading venues excluding transit costs) is constrained, *inter alia*, if a circuit breaker is activated on the price-setting venue. Traders may, as a consequence, cease to quote or price-take on other venues.

Despite trade being constrained, some trade will take place in the absence of harmonised circuit breakers. The character of this activity, in turn, determines its impact on market outcomes.

On price discovery, trades being carried would reflect any price distortions prior to, or resulting from, the active circuit breaker. Therefore, there may be price uncertainty. Given this uncertainty, at any given price there would be less liquidity; and, as a consequence of this, there would be greater volatility. Greater volatility may also lead to a larger chance of margin calls for levered institutions which, has an implication for insolvency risk. These conditions may also lead to a lack of market clearing (or, an exchange "outage").

Alternatively, trades being carried out would reflect fundamental information and market observers may be able to discern this. Therefore, price discovery, liquidity and volatility will improve.

Ex-ante therefore, the relevance of harmonised circuit breakers is ambiguous. Theoretical considerations, however, suggest that the extent to which traders withdraw from markets or not while a circuit breaker is active is an important consideration to market outcomes, as is the character of trades still taking place.

Harmonisation across securities

Two studies consider whether circuit breakers should be harmonised across securities. Focusing only on the futures markets, Brennan (1986) shows that trading halts due to price limits may be helpful in reducing default risk, lowering the margin requirement and decreasing the total cost of participation. This is because, conceptually they obscure the exact amount of losses incurred by the trader.

Taking Brennan (1986) as a starting point, Chou, Lin and Yu (2003) investigate whether imposing spot price limits improves the performance of future price limits and make the following findings.

Imposing futures price limits only - the margin requirement and contract cost are lowered, implying that it is worthwhile for policymakers to use price limits. This supports Brennan's work. Moreover, future price limits help reduce the probability of defaulting. However their effectiveness decreases when precise information from the spot market becomes available (since this allows the derivation of the equilibrium futures price).

Imposing futures and spot price limits – the optimal margin requirement and contract cost decrease further (in comparison to imposing futures price limits only). Default probability is also reduced. However, there is a liquidity cost due to trading interruption. Moreover, the higher the correlation between the spot and futures markets, the lower the default probability (since it constrains the information available to the losing party), efficient contract cost and margin requirements. This also indicates that the spot limit can be used as a partial substitute for the futures limit.

Imposing identical price limits – the margin requirement and contract cost decrease further than when futures price limits are imposed only but this may not be optimal.

It may be optimal for the policymaker to expand futures limits and raise the marginal requirement when there is an increase in price volatility. Alternatively, the imposition of spot price limits can serve as a partial substitute to both futures limits and margin requirements.

These results suggest that futures and spot price limits are beneficial. However, full harmonisation may not have a clear advantage over disharmonised limits.

Results of empirical studies

No relevant literature was found.

Qualitative assessment

Circuit breakers are motivated *inter alia* by a desire to dampen the deleterious impacts of trading at times of market stress. In a computer trading environment, there is a particular concern over erratic price movements leading to a withdrawal of liquidity and knock-on consequences. This motivates circuit breakers in general.

Harmonising the activation of circuit breakers across trading venues and securities is motivated by the view that failing to do so may render circuit breakers ineffective.

This impact assessment is concerned with the impacts of harmonising circuit breakers on trading costs.

Harmonisation of activation of circuit breakers across trading venues and securities. This implies that if a circuit breaker is activated on a spot market for a security, it is also activated across all trading venues and across related markets such as futures, forwards and synthetic markets for that security.

Benefits

If a circuit breaker is activated on one venue and not others and this imposes relatively more losses on liquidity providers (than if circuit breakers were harmonised across venues) this will be reflected in wider bid-ask spreads, with consequences for the cost of capital and the wider economy. This suggests that a circuit breaker should be harmonised across trading venues.

If circuit breakers are harmonised across securities, this is beneficial because it reduces default risk, lowers margin requirement and decreasing the total cost of market participation (as described above). The resultant increase in the number of market participant implies narrower bid-ask spreads, with consequences for the cost of capital and the wider economy.

Costs

Greater trade interruptions resulting through harmonised circuit breakers may impose greater risks on liquidity providers, which are reflected in wider bid-ask spreads.

Key assumptions/sensitivities/risks

In order to support harmonised circuit breakers, the key assumption is that liquidity provision is less risky as a result. In the context of the impact assessment framework, this would lead to narrower bid-ask spreads and lower trading costs, and in turn, wider economic benefits.

For this assumption to hold, the following conditions are required:

- Risks of trade interruption to liquidity providers is relatively low compared risks of trading at times when a circuit breaker is active on one venue/for one security
- Harmonisation implies greater market participation
- Harmonisation can be implemented effectively (i.e., on the basis of an objective measure)
- Activation of circuit breakers is simultaneous

Affirmative obligation for market makers

Theoretical background

The most common affirmative obligation is a rule on the maximum spread width (Charitou and Panayides, 2009).

In a perfectly competitive market without a maximum spread width (MSW) rule, zero profits accrue to market participants, including market makers. If the MSW rule were to be implemented successfully in this setting, market makers would need to be provided side payments to continue in their market making role/to compensate for the negative profits they would otherwise earn.

The rationale behind the MSW rule is that while (ex-ante) each market participant is individually as well-off as absent the MSW rule, narrower spreads resulting from the MSW rule result in a welfare gain (ex-post) due to a greater number of trades bringing about improved market outcomes, including price discovery (Bessembinder, Hao and Lemmon, 2006). Overall, quoted bid-ask spreads narrow directly as a result of the MSW rule and through second-order effects of inter alia improved price discovery.

Results of empirical studies

Empirically, there is evidence supporting the use of a MSW rule with side payments. Cao, Choe and Hatheway (1997) find that market makers use profits from liquid stocks to subsidise trading of less liquid stocks. Given externalities associated with trade (e.g., in price discovery), it may be that cross-subsidising market making activities over different stocks may be suboptimal justifying a role for side payments.

Skjeltopr and Ødegaard (2011) find that it is beneficial for firms to enter contracts with market makers in which market makers agree a MSW. In the context of the framework of the present impact assessment, two channels through which firms benefit from these arrangements are of particular interest. Firstly, quoted bid-ask spreads decrease as a result of contracts between firms and market makers. They are approximately one-third lower and this effect is sustained at least up to a year after a MSW is introduced. Interestingly, the quoted bid-ask spread is significantly lower than the MSW. Secondly, the authors show that liquidity risk decreases substantially, by 2.5% on average after the introduction of a MSW, lowering the cost of capital.

Nimalendran and Petrella (2003) also find evidence of affirmative obligations yielding narrower spreads and increased depth. On average, the quoted bid-ask spread is 0.66% lower for firms switching to a hybrid order driven market with designated market maker against a relevant control group. The effect is driven largely by thinly traded firms making this switch.

In practice, one may believe that high frequency traders would have a greater propensity to fulfil affirmative obligations than other traders; for instance, by offering a MSW to uninformed investors on the main exchange and more easily carrying out compensating trades with other investors on other trading venues. That is, affirmative obligations may facilitate greater trade due to high frequency traders' ability to trade multiple stocks simultaneously that traditional market makers are unable to do (Gerig and Michayluk, 2010).

Hengelbrock (2008) additionally argues a MSW rule with side payments for many market makers is beneficial insofar as it lowers spreads further than if fewer market makers are provided this incentive structure.

Overall, these results suggest that a MSW rule is beneficial; however, there are limitations to using them to infer the success of a MSW rule in the present context. Firstly, the abovementioned studies provide evidence of partial effects, insofar as a MSW rule is implemented for a limited number of stocks. If a MSW rule was implemented more widely, it is unclear what the full effects would be. For instance, a MSW rule may be effective for a single stock if liquidity providers are cross-subsidising it through profits earned on other stocks but if all stocks are subject to a MSW rule, this strategy may no longer be feasible.

Secondly, the results focus, to a large extent, on thinly-traded stocks. Implementing a MSW rule for other stocks may not yield significant benefits.

And thirdly, the settings considered may not reflect trading conditions today. Aside from the NYSE, the main price-setting venues are not considered. And, the timings of the studies do not coincide with recent years in which high frequency trading has reached its peak.

Qualitative assessment

The policy involves the introduction of a MSW rule for high frequency trading firms engaged in liquidity provision.

A MSW rule would see greater liquidity provision, thereby lowering trading costs.

A MSW rule would be particularly beneficial in times of market stress when liquidity would otherwise be absent.

Costs

- Implementation costs prohibitively high.

Benefits

- Given implementation costs, potential benefits would not be realised.

Key assumptions/sensitivities/risks

There are a number of challenges in terms of implementing a MSW rule. In general, in an evolving marketplace, structural and stochastic pricing relationships are continually being discovered, implying that the need to provide market makers with additional incentives to market make within the prevailing spread may be limited.

Moreover, a MSW rule has its largest welfare impact during times of market stress. When other market makers are withdrawing, those with affirmative obligations stay, in theory. In practice, however, it is unlikely that side payments associated with a MSW rule would be sufficient to compensate for potential losses incurred through market risk during market stress. One would therefore expect to see market makers with an affirmative obligation to withdraw as well.

Indeed, under these circumstances there is a substantial chance that market makers would be subject to predatory strategies from other market participants – Arnuk and Saluzzi (2009) find that 10% of US trading is so-called 'predatory'.

Enforcement of affirmative obligations could be used to stop this occurrence. However, it may be possible to subvert any rules in place. For instance, if a rule such as "be available to market make 90% of the time" is in place, market makers can fulfil this obligation and withdraw in times of market stress, limiting the welfare impact of a MSW rule. If a rule such as "be available to market make in times of market stress" is in place, even if a definition of market stress could be agreed upon, market makers can only provide quotes for small sizes (thereby limiting the market risk they take on to levels that they tolerate).

Additionally, if monitoring is ineffective, enforcement of affirmative obligations may not even be feasible. If firms do not wish to market make in certain circumstances they may engage in illegal practices such as quote stuffing that might exacerbate market stress by causing an exchange "outage". Market makers could also provide a given spread that sees them making a loss due to their affirmative obligation, but compensate for this through layering.

Finally, the above challenges notwithstanding, determining the size of side payments is problematic. In a market environment where high frequency traders are continually discovering new opportunities to market make/trade, it is likely that the profitability of these trades falls (i.e., as other adopt the same hedging strategies). Given this, a side payment set at a point in time is likely to be too high at a future date. At the future date, it is also difficult to know what a new side payment level should be because the counterfactual spread width is unknown. And finally, the side payment could slow down the innovation process, whereby hedging strategies that could have narrowed the spread further than suggested by the MSW are discovered relatively slowly due to the side payments reducing the incentive to invest in new hedging strategies.

Order cancellation penalties

Theoretical background

The ratio of cancelled order to executed orders has risen very significantly in recent years and is often said to stretch the physical capacity of the trading venues 'systems.

For example, Battalio et al. (2011) report that in the US in 2010, NASD reported that 82.2% of orders were cancelled and the corresponding figures for ARCA, AMEX, ISE and BATs were 92.1%, 52.8%, 97% and 40.8% respectively.

In Europe, the AMF (2011) estimates that in July 2011 the ratio of order-to-trade surged to a range from 35 to 40, reflect frequent modification and cancellation by HFT firms

Tuominen (2012) notes that, in the case of the 9 most frequently traded securities in November 2010 on the OMX-Helsinki Stock Exchange, the ratio of cancellations to orders was generally close or above 1 for the most active traders[8]. Similarly .Grillet-Aubert (2010) reports that "*three hedge funds known for implementing HFT strategies on the French market together accounted for 39.6% of orders on CAC 40 stocks in April 2010, and that they cancelled 96.5% of these orders*".

The high ratio of cancellations-to-orders and the high ratio of orders-to-trades have given rise to concerns that the high volume orders followed by very rapid cancellations puts a heavy load on trading systems and has increased the risk to orderly trading (European Commission 2011 p. 38).

In order to assess the impact of any measure aiming to reduce the ratio of cancellations to orders, it is important to understand why orders are being cancelled or revised. As noted by Fong and Liu (2010), the two major reasons for revising or cancelling a limit order are non-execution and adverse selection risk. If traders are concerned about non-execution, the action of revising an order or replacing it by a new order increases the likelihood of execution. In contrast, if the revision or cancellation action occurs because of worries about adverse selection risk, the likelihood of actual execution decreases.

In theory, the introduction of penalty fees for high cancellations to order should change the volume of orders submitted to a trading venue as the expected benefit of any order followed by rapid cancellation will be reduced. However, a priori it is not obvious whether this will have an impact on effective market liquidity and bid-ask spread as it depends on a large part whether these orders were actually contributing liquidity or well outside the trading range with little probability of execution.

[8] A cancellation may occur for only a fraction of the outstanding order amount and the complete cancellation of an order may be effected through several cancellations. Thus, the number of cancellations can exceed the number of orders,

Results of empirical studies

To our knowledge, there exist no empirical studies which examine the impact on bid-ask spreads and market liquidity of introducing penalties for a high level of order cancellation.

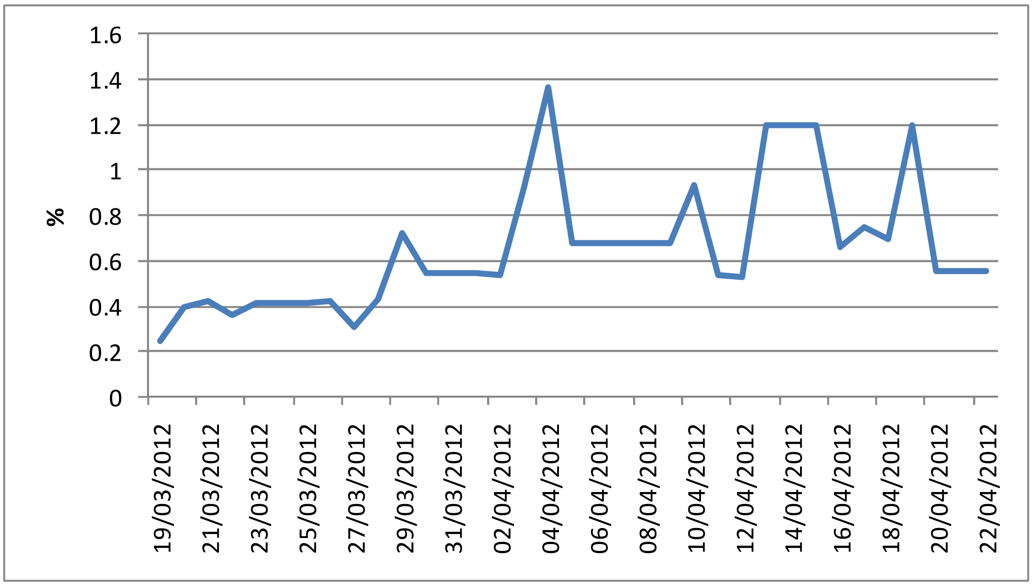
However, some venues have introduced recently such penalties.

For example, the InterContinental Exchange (ICE) instituted in 2011 special fees for the submission of a high volume of orders which are far off the market bid and offer (Osborn, 2012). Following the introduction of such fees, the ratio of orders to trades (by weighted volume) declined by 63% in ICE Futures US markets, 19% in ICE Futures Europe markets and 53% in ICE's OTC markets.

More recently, on 2nd April 2012, the Borsa Italiana introduced special fees for orders entered or modified in excess of a threshold order-to-trade ratio. For the main market of the Borsa Italiana, the MTA, the threshold of the order-to-trade ratio is 100. If a member firm's daily order-to-trade ratio is between 1 and 5 times the threshold, a unit fee of €0.01 is charged. If the actual ratio is between 5 and 10 times the threshold ratio, a unit fee of €0.02 is charged and if the actual ratio is greater than 10 times the threshold ratio, a unit fee of €0.025 is charged. A member's total daily fee is capped at €1,000 per group of instruments (Bolsa Italiana, 2012).

In order to provide an indication of the potential impact of the introduction of such penalty fees for large number of cancellations, the average of the daily effective bid-ask spreads of the 20 largest companies (by capitalisation) during the two weeks preceding the introduction of the penalties and the weeks following the introduction is shown in the figure below.

Figure 5: Weighted average (by market capitalisation) of the effective spreads of the 20 main stocks on Borsa Italiana (March to April 2012)



Source: London Economics based on data from Bloomberg)

The average spread jumped from slightly less than 60 basis points just prior to the introduction of special fees on 2nd April 2012 to almost 140 basis point two days after the 2nd April date. However, this sizeable increase was not sustained and, during week 2 following the introduction of the special fees, the average effective spread stood at 71 basis points, 21 basis points higher than during the week preceding the introduction of the fees.

Moreover, a detailed analysis of the changes in effective bid-ask spreads of each of the 20 stocks reveal very different patterns: 9 stocks show increases in the effective bid-ask spread of more than 50 basis points, 1 stock shows an increase of between 25 and 50 basis points, 5 stocks show increases of less than 25 basis points and 5 stocks show decreases in the effective bid-ask spread.

In light of the significantly different magnitude of change in effective bid-ask spreads and in the absence of detailed information on the change in the ratio of cancellations to orders for each of these 20 stocks, it would be imprudent to draw any firm conclusions, one way or another, on the impact of the introduction of penalties for high levels of cancellation relative to orders.

Table 4: Comparison of effective bid-ask spreads 1 and 2 weeks before and after the introduction of special fees on 2nd April 2012 for high levels of cancellations to orders on Borsa Italiana

	Average spread				Difference	
Name of company	**Week 2 before**	**Week 1 before**	**Week 1 after**	**Week 2 after**	**Week 1 after – minus week 1 before**	**Week 2 after – minus week 2 before**
ENI SPA	0.17	0.38	1.12	0.69	0.74	0.51
ENEL SPA	0.22	0.36	0.25	0.38	-0.11	0.16
INTESA SANPAOLO	0.31	0.49	0.72	0.97	0.24	0.66
GENERALI ASSIC	0.36	0.55	0.51	0.37	-0.04	0.02
TENARIS SA	0.53	1.07	2.41	0.60	1.35	0.07
UNICREDIT SPA	0.67	0.18	1.37	0.53	1.19	-0.14
SAIPEM SPA	0.47	0.85	0.34	0.58	-0.51	0.11
TELECOM ITALIA S	0.29	0.09	0.32	0.40	0.22	0.11
LUXOTTICA GROUP	0.65	0.48	0.30	0.54	-0.18	-0.10
SNAM SPA	0.41	0.49	0.87	1.11	0.39	0.69
ATLANTIA SPA	0.50	0.47	1.33	1.50	0.86	0.99
EDISON SPA	0.53	0.32	0.22	0.33	-0.09	-0.19
FIAT SPA	0.33	0.66	0.28	1.56	-0.38	1.23
STMICROELECTRONI	0.73	1.18	2.36	1.18	1.17	0.45
MEDIOBANCA	0.59	1.03	0.49	2.44	-0.54	1.85
BANCA MONTE DEI	0.90	0.84	0.50	1.65	-0.34	0.75
UBI BANCA SCPA	1.02	1.44	1.31	0.45	-0.12	-0.57
FINMECCANICA SPA	0.63	0.61	0.72	1.35	0.11	0.72
BANCO POPOLARE S	0.95	1.39	1.63	0.79	0.25	-0.16
MEDIASET SPA	0.99	0.53	1.33	1.66	0.80	0.67
Weighted average (by market capitalisation)	**0.38**	**0.50**	**0.90**	**0.71**	**0.39**	**0.33**

Source: London Economics based on Bloomberg data

Qualitative assessment

In the absence of solid empirical evidence on the impact of order cancellation penalties and robust theoretical analysis, it is impossible to predict with any certainty the direction of change, if any, in bid-ask spreads.

Thus, it is not possible to determine what the ultimate impacts will be on users of funds raised in capital markets and savers.

Strengthening real-time surveillance

Theoretical background

There exists a large body of literature showing that maintaining market integrity is critical to ensuring high quality markets. For example, reducing insider trading and market abuse as well as enhancing transparency contributes to reduce information asymmetries between investors and hence increase market liquidity (Diamond and Verrecchia, 1991; Verrecchia, 2001). Increased transparency also contributes to reduce non-diversifiable risk, which in turn lowers the cost of capital (e.g., Coles et al., 1995; Lambert et al., 2007).

All stakeholders stressed, during the consultations undertaken for the present study, the need for robust and vigorous market abuse surveillance and enforcement. Trading venues already undertake such real-time surveillance of trading activities on their platforms. But, because they do not have a complete picture of trades in securities trading on multiple platforms, they cannot perform the function of a market police.

Stakeholders noted also that it was not necessary for regulators to undertake comprehensive real time surveillance for improving market integrity and quality. According to these stakeholders, it was sufficient for regulators to be able to undertake ex-post monitoring of the full market. This would involve combining trading information from various trading venues and combing this information regularly for suspicious trading activities and enforcing robustly existing anti-market abuse legislation and regulation.

According to these stakeholders, the deterrent effect would likely be sufficient to significantly improve market integrity and stamp out a number of undesirable practices.

Very different views were expressed about the surveillance cost that regulators would have to bear to undertake the required market surveillance and monitoring activities, with cost estimates ranging from a relatively low figure of less than several £100,000s to more than several £1,000,000s.

In the absence of a more detailed analysis and assessment of such costs to the regulators, a detailed cost-benefit assessment of stronger surveillance and enforcement is not undertaken in the analysis below.

However, as any significant reduction in bid-ask spreads brought about by such improved surveillance and enforcement will result in significant gains in terms of GDP and business investment, it is highly unlikely that the net benefit would be negative.

Results of empirical studies

Two empirical studies are of particular relevance in the present case.

Christensen et al. (2011) analyse the impact of the implementation of the Market Abuse Directive (MAD) and the Transparency Directive (TPD) in 2004 and 2007, respectively. The stated goals of the two capital-market directives were to increase market confidence and more specifically, to lower trading costs and firms' cost of capital (e.g., Lamfalussy, 2000; Enriques and Gatti, 2008; CRA, 2009). The authors of the study find, among others, that the MAD reduced bid-ask spread by about 13% and the TPD by about 20%, and that the two results are robust to various model specifications and estimation techniques.

The second study by Cumming et al. (2011) examines the impact of market integrity rules on the performance of equity marketplaces in the world and focuses in particular on the impact of the implementation in 2007 of the Markets in Financial Instruments Directive (MiFID).

The authors' estimation results show that detailed trading rules are positively associated with velocity and negatively associated with volatility and bid-ask spreads. In particular, strong insider trading rules are statistically negatively related to the bid-ask spread, reducing this spread by 3 to 5 basis points.

More generally, the authors also show that MiFID decreased bid-ask spreads in Europe by a significant 6 to 20 basis points, depending on the model specification.

At issue is the extent to which real-time surveillance will further improve the integrity and quality of the market.

A number of stakeholders expressed the view during the consultations that some market abuses, such as front-running across different venues, is still occurring, and that this was facilitated by the lack of synchronised clocks for time-stamping trades.

In addition, a 2006 study by Dubow and Monteiro focuses on the market cleanliness around regulatory announcement which issuers have to make to the market. Market cleanliness is the proportion of significant announcements preceded by an "informed price movement" (IPM). The latter is an abnormal stock return before an announcement and that return is positive in the case of a good news announcement or negative in the case of a bad news announcement.

The authors note that IPMs can indicate insider trading while recognising that most insider trading does not give rise to IPMs nor that IPMs arise only as a result of insider trading. The authors' key finding is that there was no change in the UK after 2001 in the level of market cleanliness in relation to the announcements made by FTSE350 issuers even if the prosecuting of the relevant forms of market abuse was made easier in 2001 and greater penalties were introduced.

Moreover, in an analysis performed using announcements of takeovers, the authors find even some evidence of a deterioration in market cleanliness.

Overall, there appears to be further significant scope to improve market quality through stronger market surveillance.

Qualitative assessment

Better and more robust market surveillance would be beneficial for all market participants, would encourage more trading, and would also benefit end users of funds and savers.

Regulators, however, would have to incur some costs. Moreover, because the benefits would accrue not only to market participants, but also to a much wider range of stakeholders (users of funds, savers, and the population at large), it may not be appropriate to charge market participants for the full additional cost incurred by the regulators.

Quantitative assessment

In order to undertake a quantitative assessment of the policy, it is necessary to first assume a potential impact of a policy aimed at more robust surveillance and enforcement. We use an estimate of 5 basis points, based on the estimated impact found by Christensen for strong insider trading rules. In our view, this is a conservative estimate in light of the estimated impacts of MiFID, MAD and TPD.

Under this assumption, the level of EU27 GDP (at constant prices) would be raised by ¼ of a percentage point in the long run and the NPV of the additional GDP over the next ten years is €25 billion, much more than any likely cost incurred by regulators.

EU27 business investment (in constant prices) would be 0.8% higher in the long run.

European limit order book

Theoretical background

At the present time, in the EU, best execution, as required and defined by MiFID, is a multi-faceted concept and does not require routing each and every order to the venue offering the best price at the time the order is given. In this regard, the concept of best execution differs significantly from that in the USA where, under Regulation NMS, an order routed to any of the US trading venues has to be executed, with a few exceptions, on the venue offering the best price.

As a result, the volume of trade-throughs, i.e. trades executed at a price worse than the best price, is likely to be higher in Europe than in the US.

If this was to be systematically the case, savers would suffer a detriment as they would not achieve the best possible outcome when trading directly or indirectly their portfolio. As a result, to compensate for achieving less than the optimal price, they would require an offsetting higher return which, in turn, raises the cost of funds to businesses and other entities raising funds in capital markets.

A single European limit order book would also help overcome some of the information barriers arising from the current fragmentation of liquidity across multiple trading venues.

While larger market participants can easily absorb the cost of collecting pre-trade and trade information from multiple venues and put in place smart routing systems, it is often argued by smaller market participants that the fixed costs of implementing the required systems is high and uneconomical in light of their overall trading volume and revenues.

Results of empirical studies

While there exist a number of studies focusing on the impact of Regulation NMS, they are of little use for the present exercise as the best execution requirements in the USA are so different from the best execution requirements in the EU.

With regards to the EU, a study by Foucault and Menkveld (2008) examines the impact of the entry of the London Stock Exchange into the Dutch equity market with the launch of EuroSets in 2004. Their analysis shows that aggregate liquidity across the two venues became deeper following the entry by the LSE and bid-ask spreads narrowed. They also found that a higher rate of trade-through trading in the entrant market coincides with less liquidity supply in this market.

Unfortunately, as this study covered the early ages of liquidity fragmentation and competition between trading venues in Europe, at a time when the use of smart routing systems in the EU was still in its infancy, its conclusions may no longer apply in the present context of strong competition between venues for a number of years by now.

Qualitative assessment

To the extent that larger and active traders have already implemented the necessary system changes to a) gather pre-trade and trade information from the multiple trading venues in Europe and b) route trades to the different venues in a fast and efficient manner, it is not obvious that a significant amount of liquidity remains persistently sticky to a particular trading venue because of information issues.

However, the consolidation of the various order limit books into a single limit order book will largely eliminate trade-through as all orders (market and limit) will go through a single book and automatically achieve best price.

As there exist no public information on the volume of straight-through trades and the price penalty (in terms of worse price relative to the best price) paid by these straight-through trades, it is not possible to determine whether this is a material issue or not. Thus, it is not possible at the present time to assess the potential benefits of a European limit order book for savers and fund raisers.

Slowing down the market

Theoretical background

The measures considered under this heading include a) establishing a minimum resting time or b) the replacement of order book trading with a randomised stop auction.

Under the latter system, orders received within a given time period would be put into a single bucket and the bucket would be cleared through an auction. The precise length of the period during which orders would accumulate in the bucket would vary randomly so as to prevent market participants from gaming the system.

The idea underlying these measures is that by slowing down the pace of trading it would help establish a level playing field between computer trading and other traders.

We are not aware of any literature which discusses the need to slow down the market or aims to determine the optimal speed of trading.

Results of empirical studies

No studies addressing this point were identified.

Qualitative assessment

All stakeholders consulted as part of this project indicated that any of the two policies above would increase their risk of adverse selection and adverse gaming, and, in the case of the randomised stop auction, create considerable uncertainty as to what trades will actually execute at what time and price.

All stakeholders indicated that, as a result, bid-ask spreads were bound to increase if such policies were to be implemented. This view is entirely consistent with the economic literature on the factors determining the bid-ask spreads.

Wider bid-ask spreads would result in lower trading, raise the cost of capital for firms and hence have a negative impact on business investment and GDP, and reduce returns to savers.

Priority rules

Theoretical background

The measure considered under this heading is a randomised ranking of orders received within a given timeframe with minimum resting times and/or order cancellation penalties. It is very similar to the measures discussed above except that, in the present case, it is aimed explicitly at establishing a level playing field between market participants rather than slowing the speed of trading.

Moreover, it is sometimes said that a minimum resting time would reduce volatility in liquidity provision because liquidity would become sticky during the minimum resting period.

Results of empirical studies

While the concept of minimum resting time has attracted considerable policy attention, we are not aware of any in-depth analysis of the benefits and costs of such a policy or of an economic analysis arguing in its favour.

Qualitative assessment

The policy would increase adverse selection risk and uncertainty for liquidity providers.

This point was noted by all stakeholders (including buy-side stakeholders) consulted as part of this project. They all indicated that bid-ask spreads would increase if such policy were to be implemented. The size of the increase would be directly related to the length of the minimum resting period.

This view is entirely consistent with the economic literature on the factors determining the bid-ask spreads.

Wider bid-ask spreads would result in lower trading, raise the cost of capital for firms and hence have a negative impact on business investment and GDP, and reduce returns to savers.

Make-take fees

In limit order markets, makers are traders that 'make' liquidity by submitting passive limit orders that offer to trade a specific quantity at a specific price, and takers are traders that 'take' liquidity by submitting market orders that hit posted limit orders. Make and take fees are transaction fees charged by trading venues to makers and takers, respectively, every time a trade is carried out.

It is usual for take fees to be larger than make fees. Trading venues require liquidity in order to attract trading. However, unlike traditional intermediated markets, limit order books rely entirely on the voluntary provision of liquidity and therefore it is usual for trading venues to subsidise passive trading volume through fee rebates for makers.

However, maker rebates are a contentious practice, as it is unclear what their effects on market outcomes and other stakeholders actually are. A class of high frequency trading strategies is claimed to focus on capturing maker rebates without adding to liquidity, for instance (Economist, 2009). High frequency traders may quickly outbid other traders for securities before immediately selling them to said traders at a slightly higher purchase price, collecting a rebate on both transactions. While maker rebates may be thought to be adding to liquidity, in this case they simply constitute a transfer to high frequency traders from trading venues offering rebates and traders that were 'pipped' by high frequency traders in making the initial security purchase.

Anecdotally therefore, it is unclear whether maker rebates are beneficial so the aim of this impact assessment is to investigate the costs and benefits of the practice. The following sections present the theoretical background on make-take fees, results of empirical studies and qualitative and quantitative assessments.

Theoretical background

Theoretically, three aspects of make-take fees are of interest to market and stakeholder outcomes, the impact of: (i) total fees increases; (ii) make fee increases (or, a decrease in maker rebates); and (iii) take fee increases.

Each of these is investigated below because of uncertainty as regards the implementation of a proposal to reduce maker rebates. Trading venues may be mandated to increase make fees only. Or, they may increase make fees and at the same time reduce take fees that may have been cross-subsidising maker rebates previously. Therefore, make and take fees could vary individually as a result of a policy on maker rebates as could total fees.

There is a particular focus on trading costs, given the impact assessment framework of this study.

Impact of make fees on bid-ask spreads

The quoted bid-ask spread increases as the make fee increases, but less than one-for-one (Colliard and Foucault, 2011).[9]

If the make fee increases, traders will be less willing to post limit orders and, as a consequence, market orders will be executed with lower probability or with higher latency. Traders submitting market orders therefore respond to the make fee increase by increasing the highest ask price at which buyers are willing to trade and decreasing the lowest bid price at which sellers are willing to trade. The resultant widening of the quoted bid-ask spread increases the willingness of traders to post limit orders, partially offsetting the withdrawal of liquidity associated with the make fee increase. In other words, the quoted bid-ask spread increases as the make fee increases, but less than one-for-one.

In a computer trading environment, the quoted bid-ask spread also increases as the make fee increases (Foucault, Kadan and Kandel, 2011).

An increase in the make fee reduces the incentive of traders and especially HFT firms to invest in strategies involving the provision of limit orders at low latency. This increases the relative rate at which liquidity is consumed to the rate at which liquidity is supplied. As a result, the quoted bid-ask spread widens.

Impact of take fees on bid-ask spreads

The quoted bid-ask spread decreases as the take fee increases but less than one-for-one (Colliard and Foucault, 2011).[10]

The intuition behind this result is similar to that described above. If the take fee increases, traders will be less willing to submit market orders. In the case of a buyer, the highest ask price at which he is willing to trade declines by an amount equal to the take fee increase. Traders submitting limit orders to sell will respond to this by posting more attractive bid prices, thereby narrowing the quoted bid-ask spread one-for-one.

However, there is also a countervailing effect on the quoted bid-ask spread. The narrowing of the quoted bid-ask spread reduces the willingness of traders to post limit orders, reducing the probability of execution of market orders. Traders submitting market orders respond by increasing the concession they are willing to pay to trade. In the case of a buyer, the highest ask price at which he is willing to trade increases. This feedback effect partially offsets the prior change in the quoted bid-ask spread and the net effect of the take fee increase is to reduce the bid-ask spread but by less than the take fee increase.

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9 Given model parameters that describe an 'unspecialised' or 'specialised with high fill rate' equilibrium, as described in Colliard and Foucault (2011)

10 Ibid.

In a computer trading environment, the quoted bid-ask spread also decreases as the take fee increases (Foucault, Kadan and Kandel, 2011).

An increase in the take fee reduces the incentive of traders and especially HFT firms to invest in strategies involving the provision of market orders. This increases the relative rate at which liquidity is supplied to the rate at which it is consumed. As a result, the quoted bid-ask spread narrows.

Impact of total fees on cum-fee bid-ask spreads

An increase in the total fee leads to a widening of the cum fee bid-ask spread (Colliard and Foucault, 2011).[11]

This finding is an implication of the results above. If the make fee increases, the quoted bid-ask spread widens and therefore the cum fee bid-ask spread widens. If the take fee increases, while the bid-ask spread narrows, overall the cum fee bid-ask spread widens. Therefore, a change in the total fee leads to a widening of the cum fee bid-ask spread.

Impact of the distribution of fees on trading volume

A relative increase (decrease) in make-to-take fees leads to an increase (decrease) in trading volume if there is relatively more (less) demand for limit orders than supply (Foucault, Kadan and Kandel, 2011).

The distribution of make-take fees influences the relative profitability of limit-to-market order strategies. If there is a change in make-take fees therefore, it influences the relative supply of limit-to-market orders. And, given liquidity imbalances (too many or too few limit orders), it influences trading volume. For instance, if there are too few limit orders, a decrease in make fees will increase their number, alleviating liquidity imbalances and increasing volume.

Summary

Table 5 provides a summary of the impact of make-take fee changes on trading costs and shows that, in general, any increase in make-take fees brings about an increase in trading costs.

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[11] Ibid.

Table 5: Impact of make-take fee changes on trading costs

	Impacts	
	Bid-ask spread	Cum-fee bid-ask spread
Make fee increase	↑	↑
Take fee increase	↓	↑
Total fee increase	↑	↑

The theory outlined above provides interesting predictions regarding the impact of different make/take fee arrangements on trading costs. However, in the context of the current study, the models do not take into account characteristics of real-world financial markets such as fragmentation of trading and trader choice over acting as maker and taker. These extensions could influence the results presented above.

The theory also does not describe the precise magnitude of impacts. This is an empirical matter and is addressed to through the evidence base below.

Results of empirical studies

The main study providing evidence of the impact of maker rebates is Malinova and Park (2011), which we describe in depth below.

Nature of change to make-take fees

On 1 October 2005, the Toronto Stock Exchange (TSX) switched from a value-based trading fee system, in which market orders were subject to a \$.0002 fee per \$1 traded and limit orders were subject to no fee; to a volume based trading fee system, in which market orders were subject to a \$.004 fee per share and limit orders were provided with a \$.00275 rebate.

Fees were capped under the value-based system at \$50 and under the volume-based system at \$100 and the rebate at \$50.

This change affected a subset of companies trading on the TSX that were interlisted with NASDAQ and AMEX.

Given the median closing share price at the end of July 2005 of the sample of interlisted companies of \$6.08, under the old regime the take fee was 1.8bps (and there was no maker rebate) and under the new regime the take fee is 6.58bps and the maker rebate is 4.52bps. Overall, the total fee and take fee increased while the make fee decreased.

Table 6: Trading costs changes on TSX due to change in make/take fee structure

	Old value-based system	New volume-based system	Change
Trading venue	1.8	2.06	+.26
Make fee	0	-4.52	+4.52
Take fee	1.8	6.58	-4.78

Note: Reported changes are for the median closing share price at the end of July 2005 of the sample of interlisted companies of $6.08

Results on cum-fee bid-ask spreads

Figure 6 plots an empirical measure for the cum fee bid-ask spreads (trading costs/benefits) for market (or active) and limit (or passive) orders shown in the top and bottom panels, respectively.

The left panels break out two sets of equities. The blue lines show the sample of TSX equities that were interlisted on the NASDAQ and AMEX and subject to value-based fees prior to October 2005 and volume-based fees post October 2005. The red lines show the sample of matched TSX equities that were subject to value-based fees throughout the period.

Based on a difference-in-differences methodology, these figures allow for the impact of the fee regime change to be isolated.

The main findings are summarised in the right panels, which capture the difference between matched stocks subject to the old fee regime and the new fee regime prior to and since the implementation of the new fee regime. These show that limit orders benefited under the new fee regime through lower cum fee bid-ask spreads and market orders were affected by similar or slightly higher cum fee bid-ask spreads under the new fee regime.

Figure 6: Cum fee bid-ask spreads (trading costs/benefits) for market (active) orders and limit (passive) orders

Note: The left panel plots the trade-weighted exchange fee adjusted effective bid-ask spread for the group of NASDAQ/AMEX interlisted securities and their matches (labelled as "TSX"). The bottom left panel plots the trade-weighted 5-minute rebate adjusted realized spread. The top and bottom right panels plot the differences of, respectively, adjusted effective bid-ask spread and realized spreads for interlisted securities vs. their non-interlisted matches. All plots are 5-day moving averages. Spreads are measured in basis points of the midpoint.

Malinova and Park (2011) explore and expand upon the above results econometrically and make the following findings.

Overall, the cum fee bid-ask spread increased as a result of the fee regime change, albeit weakly statistically significantly (at the 10% level). This is consistent with the theory, as the fee regime change constituted a total fee increase, which is associated with an increase in the cum fee bid-ask spread.

Limit orders benefited as a result of the fee regime change to a highly statistically significant degree. This implies that any pass through associated with maker rebates is more than compensated for by the value of the maker rebates themselves. This result is consistent with the theory that the benefits of a decrease in the make fee are shared with takers, but also suggests that makers reap the lion's share of benefits.

The results also show that equities with particular attributes are especially impacted upon by the fee regime change, namely stocks: (i) with a lower price per share, (ii) for which there is less competition and (iii) whose trading volumes are less than the median of the TSX.

Results on volume

The results of Malinova and Park (2011) also show that volumes, measured by volume of shares traded and dollar volume, increased as a result of the change in make-take fees, in the order of 20%.

Considering this finding from a theoretical perspective suggests that despite make-take fee changes both making it relatively attractive to submit limit orders, trading volumes fell into greater balance as a result of the changes thereby implying that prior to the change there was relatively more demand for than supply of liquidity (for details, see Foucault, Kadan and Kandel, 2011).

Qualitative assessment

The impact assessment evaluates switching from a fee schedule which sees the taker face a larger fee burden than the maker (i.e., in which maker rebates are offered) to a schedule that sees the maker face the same fee burden as the taker, holding the take fee constant.

The motivation for evaluating this proposal is to assess the significant monetary transfers maker rebates constitute from trading venues to traders submitting limit orders. For example, Foucault, Kadan and Kandel (2011) suggest that on an annual basis, maker rebates constitute a $1bn wealth transfer among traders in the case of NYSE-ARCA alone.

Benefits

The evidence base suggests no benefits resulting from switching from a fee schedule which sees the taker face a larger fee burden than the maker to a schedule that sees the maker face the same fee burden as the taker, holding the take fee constant.

However, there are a number of costs.

Costs

- **Traders/savers/users of funds submitting market orders**: An increase in make fee results in wider quoted bid-ask spread (to attract liquidity in the face of a higher make fee) despite a constant take fee for an overall wider cum fee bid-ask spread, as predicted by theory. Savers require a higher rate of return therefore. Users of funds face a higher cost of capital. And, traders face higher trading costs.

- **Traders submitting limit orders**: Make fee increase will be partially offset by wider quoted bid-ask spread, as predicted by theory and as observed empirically in the context of make fee decreases. However, overall, profitability of liquidity provision will fall.

- **Trading venues**: Make fee increases in an environment in which liquidity is scarce implies that trading volume declines and trading venue revenues fall, as implied by theory and empirical evidence.

Key assumptions/sensitivities/risks:

- No material offsetting second-order (or, general equilibrium) effects, i.e., if all trading venues implement changes simultaneously.

- Limited empirical evidence and empirical evidence only on a total fee increase constituted through a make fee decrease and a take fee increase rather than isolating particular changes to make-take fee structure.

- The theoretical models do not account for characteristics of real-world financial markets such as fragmentation of trading and traders choice over acting as maker and taker. These extensions could influence the results presented above.

Internalisation

Theoretical background

Internalisation is the direction of order flow by a broker-dealer to affiliated market makers or the execution of order flow against a broker-dealer's own account.

The benefits of internalisation from the broker-dealer perspective are potentially threefold. Broker-dealers can earn the spread by executing order flow against their own inventory. In an internalisation dark pool, broker-dealers can direct order flow to a dark pool they have established and earn an access fee from other traders wishing to interact with this order flow. And, through internalisation, broker-dealers can save on clearing fees.

With specific regard to the bid-ask spread, Glosten and Harris (1988) describe its constituents as: processing costs, inventory costs and adverse selection costs. The first two costs are transferred to traders whether order flow is internalised or not. The latter cost is more likely to be passed through to traders if relatively uninformed order flow is internalised.

Traders may also benefit from having order flow internalised through lower trading costs, and additionally: (i) avoiding price impacts; (ii) preventing signalling of strategy; and (iii) facing lower clearing fees.

Despite these benefits, internalisation is associated with higher trading costs on public trading venues. Given an increase in internalisation, liquidity providers only post limit orders at wider bid-ask spreads to compensate for adverse selection arising from being matched to relatively informed order flow with greater likelihood (Chordia and Subrahmanyam, 1995; and Easley, Keifer and O' Hara, 1996).

In addition to this first-order effect, bid-ask spreads are also likely to be wider as a result of second-order effects of internalisation such as through a lack of price informativeness of trades (Chakravarty and Sarkar, 2002).

In the context of the impact assessment framework, theoretical considerations are unable to clarify whether the benefits, in the form of lower trading costs, accruing through internalised order flow outweigh the costs, in the form of higher trading costs, incident on order flow directed to public trading venues.

Results of empirical studies

Kluger and Wyatt (2002) in Weaver (2011) find that internalisation brings about wider bid-ask spreads on-exchange in an experimental setting.

Anand (2011) makes similar findings in a real-world context. With reference to a number of US exchanges, Anand (2011) finds that trades executed off-exchange involved traders paying wider quoted and effective bid-ask spreads than others.

Overall, the difference between exchange and off-exchange dollar effective bid-ask spreads is \$0.005 / percentage effective bid-ask spreads is 4bps.These effects are statistically significant at the 1% level. Similar findings are made in regard to the realised spread.

Chung, Chuwonganant, and McCormick (2004) also find that bid-ask spreads are wider the greater the level of internalisation on NASDAQ. An increase in the degree of internalization from 10% to 40% is associated with a corresponding increase of 0.0207% in the quoted spread and 0.0249% in the effective bid-ask spread on exchange.

Grammig and Theissen (2005) in Weaver (2011) investigate internalisation on Deutsche Börse. They find that internalised order flow is relatively less informed and, as a result, trades on-exchange are relative more informed. As predicted by theory, liquidity providers on-exchange compensate for adverse selection resulting from facing relatively informed order flow through wider bid-ask spread.

Hansch, Naik, and Viswanathan (1999) consider the impact of internalisation on bid-ask spreads on the London Stock Exchange, In contrast to the other studies, they do not find evidence of differences in bid-ask spreads in relation to whether order flow is executed on- or off-exchange. Weaver (2011) suggests that the difference between this result and the results of the abovementioned studies may be due to the fact that this result is based on a sample of relatively liquid equities.

The results of the empirical studies show that internalisation is detrimental to on-exchange bid-ask spreads. However, a gap in this evidence is that the benefits accrued by traders off-exchange (described under Theoretical background) are not properly accounted for.

Qualitative assessment

In times of market stress, it is contended that otherwise internalised order flow may help to reduce liquidity constraints, helping to restore normal market conditions.

Costs

Trading costs (potentially, substantially) higher for orders that benefit from internalisation in terms of avoiding price impacts; preventing signalling of strategy; and (iii) facing lower clearing fees.

Benefits

Narrower bid-ask spreads on main exchanges and attendant benefits.

Key assumptions/sensitivities/risks

- Strong assumption that benefits identified through results of empirical studies carry over in times of market stress
- Otherwise internalised order flow directed to main exchanges does not exacerbate market stress. For instance, if order book of main exchange consists of liquidity imbalances in the

form of too many orders to sell and otherwise internalised flow consist of further sell orders, liquidity constraints will be exacerbated

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Annex: make-take fees in practice

London Stock Exchange[12]

The LSE abandoned maker rebates in September 2009 after carrying out a year-long experiment. This is because of complaints from its biggest broker clients, who felt they were subsidising high frequency firms' trading strategies through payment of aggressive fees.

The LSE institutes the same pricing schedule (Standard Value Traded Scheme) for both sides of the trade. It charges customers 0.45 basis points per trade for the first £2.5 billion of value traded each month. The fee drops to 0.40 bps for the next £2.5 billion, 0.30 bps for the next £5 billion, and 0.20 bps for trades once the firm has traded £10 billion in value.

Passive executions qualifying under the Liquidity Provider Scheme are free-of-charge, whilst aggressive executions qualifying under the High Volume Liquidity Taker Scheme are charged at 0.15bps or 0.28bps, depending on the package that is selected.

In order to qualify for the Liquidity Provider Scheme, in any month passive continuous trading execution by value must exceed 75% of all continuous execution by value in FTSE 350 securities sent through a trader group or group of UserIDs (as appropriate).

In order to qualify for the High Volume Liquidity Taker Scheme, in any particular month a member firm must execute more than £3 billion in qualifying securities within the last two months.

Euronext[13]

Fees depend on the trading mechanism (auction, continuous, trading-at-last) and the level of liquidity (blue chips, mid and small caps). Blue chips are classed as those securities that belong to the AEX-Index, AMX-Index, BEL20, CAC40, PSI20, and SBF120 indices.

Within the fee scheme, there are three tiers depending on the non-Liquidity Provider order book monthly activity.

For blue chips traded during the continuous trading session, the fees are:

- Tier 1: €0.60 + monthly cap at 0.55bps, if monthly activity is 1.75% of the monthly MSCI Euro Index transaction value rounded to the nearest €million

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[12] http://www.londonstockexchange.com/products-and-services/trading-services/pricespolicies/trading-services-price-list-1-january-2012.pdf

[13] http://europeanequities.nyx.com/sites/europeanequities.nyx.com/files/nyse_euronext_cash_market_trading_fee_guide_22_feb_2012.pdf

- Tier 2: €1.00 + monthly cap at 0.65bps, if monthly activity is greater than €200 million
- Tier 3: €1.25 + monthly cap at 1.20bps, if monthly activity is less than €200 million

NASDAQ OMX[14]

Copenhagen – There are three price lists to choose from:

- Maker and Taker are charged DKK 4.00 and DKK 5.96 per executed order respectively, with a minimum monthly fee for equity trading of DKK 6,750
- Maker and Taker are charged DKK 3.00 and DKK 4.47 per executed order respectively, with a fixed monthly fee for equity trading of DKK 82,000
- Maker and Taker are charged DKK 2.00 and DKK 2.98 per executed order respectively, with a fixed monthly fee for equity trading of DKK 188,000

In addition to this, there are a number of discounts available, e.g. a liquidity discount of 20% available for the three price lists under different conditions.

Helsinki – There are also three price lists to choose from:

- Maker and Taker are charged EUR 0.54 and EUR 0.80 per executed order respectively, with a minimum monthly fee for equity trading of EUR 900
- Maker and Taker are charged EUR 0.40 and EUR 0.60 per executed order respectively, with a fixed monthly fee for equity trading of EUR 17,500
- Maker and Taker are charged EUR 0.27 and EUR 0.41 per executed order respectively, with a fixed monthly fee for equity trading of EUR 40,000
- In addition to this, there are a number of discounts available, e.g. a liquidity discount of 20% available for the three price lists under different conditions.

Iceland – Maker and Taker are charged ISK 60 and ISK 80 per executed order respectively.

Stockholm – There are three price lists to choose from:

- Maker and Taker are charged SEK 4.97 and SEK 7.44 per executed order respectively, with a minimum monthly fee for equity trading of SEK 8,333

[14] http://nordic.nasdaqomxtrader.com/digitalAssets/77/77396_nasdaqomxnordic-cashmarketpricelistfromjanuary012012.pdf

- Maker and Taker are charged SEK 3.73 and SEK 5.58 per executed order respectively, with a fixed monthly fee for equity trading of SEK 330,000.
- Maker and Taker are charged SEK 2.49 and SEK 3.72 per executed order respectively, with a fixed monthly fee for equity trading of SEK 800,000.

BATS/Chi-X[15]

BATS Europe employs a maker-taker pricing model, charging 0.28 basis points for taking liquidity and paying a 0.18 bps rebate for posting liquidity.

Turquoise[16]

Investors pay 0.28bps for an aggressive order on Turquoise and receive a rebate of 0.20 to 0.24bps for an executed passive order depending on their trading volume during the previous month.

[15] http://www.batstrading.co.uk/resources/participant_resources/BATSEuro_Pricing.pdf

[16] http://www.tradeturquoise.com/market_notices/Tariff_Schedule.pdf

Annex: circuit breakers rules

London Stock Exchange[17]

Suspension periods of automatic execution occur during continuous trading and are based on dynamic and static price references.

- The dynamic reference price is the last order book execution price (or previous closing price if most recent) before the incoming order is submitted.

- The static reference price is the most recent auction price from the current day. If this auction did not generate an execution, then the first automated trade following the previous auction period should be considered.

If the price of a potential execution is above or below a certain percentage of the reference price(s), then executions do not take place at this price and automatic executions are suspended. This is followed by a five-minute intra-day auction, which allows the price of the security to recover and then return to continuous trading.

Fill or Kill orders are rejected if their execution violates the price threshold and no suspension period will take place.

Price thresholds for the securities are firstly managed by its index or trading sector and then by the relative size and historical volatility of the stock. In general, more (less) liquid securities have lower (higher) thresholds.

A price monitoring extension to the auction call is triggered, if the indicative auction price is greater than a tolerance threshold away from the dynamic reference price at the end of the opening and closing auction call periods.

A market order extension is triggered, if the indicative auction match price results in market orders remaining unexecuted on the order book. This allows participants to re-consider the prices of orders that have been entered, and if appropriate, make amendments.

Borsa Italiana[18]

Borsa Italiana adopts circuit breakers in the following forms:

- Prolonged duration/delay of one or more phases of trading

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[17] http://www.londonstockexchange.com/about-the-exchange/regulatory/lsegresponsetoesmaconsultationonsystemsandcontrols.pdf (p.155)

[18] http://www.borsaitaliana.it/borsaitaliana/regolamenti/regolamenti/rules03102011no.en_pdf.htm (p.38)

- Interruption of continuous trading by reactivating an auction
- Modifying the price variation limits (static or dynamic)
- Suspending/reactivating trading

These measures are adopted if:

- Price variation limits are exceeded
- Anomalous trading conditions are observed in terms of price of volume
- There is a need to gain more information about a particular market situation
- There are technical reasons, etc that do not allow the normal operation of markets
- There have been detailed complaints by approved intermediaries that look into damages caused by irregular behaviour

Euronext

Trading halts may be of two kinds:

- Suspensions which are decided by Euronext and are subject of an official notice. This must indicate the initiator of the suspension, the reason for the suspension and the date and conditions for when trading will resume.
- Trading reservations which are halts applied by Euronext when it is temporarily impossible to match buy and sell orders within the allowed price range.

These halts take place when a potential buy or sell order, if executed, would result in a trade at a price beyond a certain threshold (percentage of a reference price).

There are two types of thresholds: static and dynamic.

Static thresholds are applicable to all securities and are set at 10% above and below the reference price.

Dynamic thresholds only apply in the course of continuous trading and are designed to cap volatility within the range set by the static thresholds. Each traded price becomes the dynamic reference price used to set upper and lower limits on the next traded price. These dynamic thresholds are set at 2% above or below the dynamic reference price.

During reservation, the securities concerned are subject to pre-opening procedures and trading resumes with a call auction as at opening.

Deutsche Börse[19]

All trade halts and suspensions are decided by the DBAG. Circuit breakers are activated when the maximum price range deviation is violated. The static price is the maximum percentage deviation of a reference price, generally the last held auction price. The reference price for the dynamic price range is the last exchange price of the same trading day, generally determined in Continuous Trading with Intra-Day Auctions or in the Auction.

Tourquoise[20][21]

For equities, trading halts for the relevant security is enforced by the Turquoise Market Operations. Existing orders remain in the order book; new orders will be rejected with an appropriate error message and no matching occurs. Members are able to cancel their orders, but amendments are not allowed.

For derivatives, circuit breakers will activate and trigger a 60 second suspension of trading when a trade occurs at a price level deemed to be an unacceptably large percentage margin away from static or dynamic reference prices defined by Turquoise.

Turquoise can set separate circuit breakers against the static control price with respect to both orders and trades.

NASDAQ OMX[22]

Circuit breakers for individual stocks are triggered when there is a single order impact of 3%, 5% or 10% or if there is an accumulated intraday movement of 15%, 20% or 50% (where the percentages apply to different groups of securities).

The reference price for the dynamic circuit breakers (order impact) is the last paid price, whilst for the static circuit breakers (accumulated impact) it is the last auction price.

For each threshold, the trading suspension lasts for three minutes and in some cases, it can be prolonged to seven minutes. It only affects the individual order book.

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19 http://deutsche-boerse.com/dbg/dispatch/en/binary/dbg_nav/metanavigation/30_Regulations?object_id=84XHGZ360NSGDEN (p.35)

20 http://www.tradeturquoise.com/doclibrary/TQ_EQUITIES_TRADING_SERVICE_DESCRIPTION.pdf (p.21)

21 http://www.tradeturquoise.com/doclibrary/TQ_DERIVATIVES_TRADING_SERVICE_DESCRIPTION.pdf (p.23)

22 http://www.nasdaqomx.com/digitalAssets/77/77598_nasdaq_omx_nordic_market_model_2.7.pdf (p.91)

Annex: Empirical details of 2002 London Economics study

Estimation of trading costs and trading turnover

This section considers the basic model and estimation, data and measurement problems arising in the estimation of trading costs and turnover. For details, see London Economics (2002) from page 20.

Empirical model

Drawing on literature reviewed, our empirical formulation is based on a two-equation system, with one equation modelling trading costs and the other modelling trading turnover. This specification has essentially two main advantages. On the one hand, it makes explicit the essential interactions among our variables of interest and the channels through which market depth affects trading costs. On the other hand, by treating both trading costs and trading turnover as endogenous, our approach should avoid any possible bias in parameter estimates caused by possible correlation of turnover with the residual term.

Denoting stocks by i=1,…,N, and time by t=1,…,T, our framework is based on the following two equations:

$$tc_{it} = \alpha_0 + \lambda_1 tc_{it-1} + \lambda_2 tc_{it-2} + \lambda_3 tc_{it-3} + \alpha_1 tt_{it} + \alpha_2 tt_{it-1} + \alpha_3 tt_{it-2} + \alpha_4 \sigma^2_{it} + \alpha_5 \sigma^2_{it-1} + \alpha_6 \sigma^2_{it-2} + \alpha_7 mdep_{it} + \alpha_8 tick_i + \alpha_9 LARGE + \sum_j \alpha^j_{10} d_j + \sum_k \alpha^k_{11} d_k + f_i + \eta_t + \gamma_{it}$$

$$tt_{it} = \beta_0 + \delta_1 tt_{it-1} + \delta_2 tt_{it-2} + \delta_3 tt_{it-3} + \beta_1 tc_{it} + \beta_2 tc_{it-1} + \beta_3 tc_{it-2} + \beta_4 \sigma^2_{it} + \beta_5 \sigma^2_{it-1} + \beta_6 \sigma^2_{it-2} + \beta_7 mdep_{it} + \sum_j \beta^j_8 d_j + \sum_k \beta^k_9 d_k + \mu_i + \phi_t + \psi_{it}$$

where *tc* is the trading cost, *tt* is (the logarithm of) trading turnover, σ^2 is the volatility of returns from shares, *mdep* is (the logarithm of) total stock market capitalisation - a proxy for the liquidity and depth of the market, *tick* is the relative tick size expressed as a percentage of the midpoint of that security, *LARGE* is a dummy variable proxying for the size of the issuer company, d_j denotes a full set of sector dummies, d_k denotes a full set of country/exchange dummies, *f* and *μ* are share-specific fixed effects, *η* and *φ* are time effects, and *α, β, λ, δ*, denote vectors of parameters of interest.

The full sets of sectoral and country dummies identified above cover all unobserved sectoral and country-specific factors, and institutional characteristics influencing the level of trading costs (turnover) across sectors and markets. Examples of country-specific institutional characteristics include the presence of market makers, limit order books, market fragmentation, transparency of order flow, automatic execution of trades, developed markets, ownership of exchange by mutual cooperative of brokers, the existence and effectiveness of shareholder protection laws and rights as in La Porta et al. (1996) and Bhattacharya and Daouk (2002), etc.

The f (/μ) terms cover all unobserved security-specific factors influencing the level of transaction cost (turnover), while the η (/ϕ) terms capture shocks common to all securities.

Finally, γ (/ψ) captures all other shocks to share trading costs (turnover) and it is assumed to be serially uncorrelated. Absence of serial correlation is assured by the inclusion of dynamics in the form of lagged dependent and core independent variables (autoregressive model).

Once the above system of equations has been estimated, it will be possible to compute the effects of European financial integration on trading costs and trading turnover, as was the aim of London Economics (2002). In particular, the proposed system will allow us to estimate 1) what the average trading cost in a fully integrated European financial market would be; and 2) what would be the gain for each country of further financial market integration. However, the results of this estimation are also useful for quantification of the proposals under consideration in the present study.

In the next sub-section we will present our estimation strategy for the system comprising the equations above.

Estimation issues

Estimating the equations above present several econometric challenges, including dealing with unobserved heterogeneity in the trading costs and turnover variables, endogeneity of some of the right-hand-side variables and obtaining a reduced form for the trading cost equation. We deal with each of these issues below.

As long as the fixed effects are uncorrelated with the included variables, consistent estimates of the parameters of interest can still be identified. This is unlikely to be the case however. As the seminal literature on panel data estimation has clarified (see, for example, Hoch 1962, Mundlack 1961, Nerlove 1965) omitting controls for unobserved factors such as, for example, the systematic risk of the stock or for other variables that are difficult to measure or obtain will lead to biased and inconsistent estimates.

There are various approaches in the literature used to deal with unobserved heterogeneity. A simple way to eliminate the stock fixed effect is to apply first differences equations to obtain:

$$\Delta tc_{it} = \lambda_1 \Delta tc_{it-1} + \lambda_2 \Delta tc_{it-2} + \lambda_3 \Delta tc_{it-3} + \alpha_1 \Delta tt_{it} + \alpha_2 \Delta tt_{it-1} + \alpha_3 \Delta tt_{it-2} + \alpha_4 \Delta \sigma^2_{it} + \alpha_5 \Delta \sigma^2_{it-1} + \alpha_6 \Delta \sigma^2_{it-2} + \alpha_7 \Delta mdep_{it} + \Delta \eta_t + \Delta \gamma_{it}$$

$$\Delta tt_{it} = \delta_1 \Delta tt_{it-1} + \delta_2 \Delta tt_{it-2} + \delta_3 \Delta tt_{it-3} + \beta_1 \Delta tc_{it} + \beta_2 \Delta tc_{it-1} + \beta_3 \Delta tc_{it-2} + \beta_4 \Delta \sigma^2_{it} + \beta_5 \Delta \sigma^2_{it-1} + \beta_6 \Delta \sigma^2_{it-2} + \beta_7 \Delta mdep_{it} + \Delta \phi_t + \Delta \psi_{it}$$

Note that differencing eliminates all the variables that are time-invariant and that *tc* is correlated with the equations error. The technique to estimate such dynamic panel data model is due, among others, to Arellano and Bond (1991). This method essentially uses further lags of the level or the difference of the dependent variable to 'instrument' the lagged dependent variables included in the model after the elimination of the fixed effects through first differencing. The validity of this technique depends on the absence of serial correlation in the error term, which can be investigated using serial correlation tests developed by Arellano and Bond (1991).

Once the implications of unobserved heterogeneity in the dependent variables are dealt with, the above system of equations still violates one of the assumptions of least squares estimation.

Specifically, the disturbances of the trading cost equation are correlated with one of the regressors (trading turnover), thus creating a problem of endogeneity.

For example, a technology shock to the trading system may induce a decrease in trading cost and a possible rise in turnover. Therefore, in order to avoid possible biases in the parameter estimates, two stages least square (2SLS) estimation is instead used. In particular, when the equation is over-identified, 2SLS provides the most efficient combination of instruments. Again, providing that the error term is serially uncorrelated, all lags beyond t-2 are valid instruments and can be incorporated in the Arellano Bond methodology.

Finally, once consistent estimates of the parameters of interest have been obtained, the reduced form for the trading cost equation can be obtained by 1) imposing long-run equilibrium conditions (steady state) on both the equations, 2) calculating long-run coefficients for both the equations and 3) substituting the long-run trading turnover equation for the trading turnover variable in the long-run trading cost equation. This yields a trading cost equation that can then be used to estimate the average trading cost in a fully integrated market.

In the next paragraphs we will describe our data sources and discuss some measurement issues with respect to our variables of interest

Data definitions and measurement issues

The data used for our analysis is sourced from Bloomberg Professional 2002, a service that provides information on bid, ask, transaction price, market capitalisation and trading volume on a country and sectoral basis. Data on relative tick sizes are from Jain (2001) while historical information on exchange rates has been obtained on the Internet at www.Oanda.com. More general information on the operation and the characteristics of various stock exchanges has been obtained by The Compaq Handbook of World Stock, Derivative & Commodity Exchanges 2001.

The regression sample consists of the population of ordinary shares that are actively traded on the major OECD stock markets (21 stock exchanges in 20 countries) and for which data on the bid-ask spreads are available over the period 2000-2001. In terms of market capitalisation, the stock exchanges in our sample represent over 90% of the world stock market capitalisation.

The frequency of our data is monthly. The observations on trading costs were constructed from raw daily data on closing bid, ask and transaction price that are available from Bloomberg, as follows. First, we constructed daily measures of trading costs for all the stocks in our sample. Then, for each stock in our sample, we averaged these (daily) trading costs over a month period to obtain a single data point per month. This procedure yields a (monthly) time series of trading costs (up to 24 months) for each stock in our sample. This methodology, used, for example, also by Stoll (2000) and Jain (2001), has two main advantages. On the one hand, it provides a more accurate measurement of trading costs than simply taking one observation per month. On the other, it reduces substantially the measurement error due to random day-to-day fluctuations in market spreads. Data on market capitalisation and trading volume were obtained directly on a monthly basis. Our final sample consisted of 187,340 observations (or data points).

In the following paragraphs, we present the precise definition of each of our variables of interest.

Trading costs: there are several alternative measures of trading costs, each of them with different characteristics. The quoted and effective spreads are static measures observable at the moment of the trade. The quoted percentage spread is defined as:

$$QPS = (A-B)/P,$$

where A denotes the ask price, B the bid price and P the effective transaction price.

As many transactions take place inside the quoted spread, this measure may overstate trading costs. An alternative measure of the trading cost is the effective percentage spread, which can be defined as:

$$EPS = 2*|P-M|/P,$$

where M is the quote mid-point, i.e. (A+B)/2. This measure potentially captures the fact that large trades, that exceed the volume of securities the market is willing to trade at the quoted bid and ask prices, may move prices in the direction of the trade, i.e. the market impact effect. Therefore, the effective percentage spread is preferred as a measure of trading costs because it incorporates both the impacts of market spreads and market impact on trading costs, even if it does not disentangle the two effects.

Stock volatility: the volatility of returns is computed for each stock as the standard deviation of the stock's return in terms of capital appreciation over a period of a month.

Trading turnover: for each stock, trading turnover is defined as the ratio between trading volume and market capitalisation.

Market capitalisation: this variable is computed as the sum of market capitalisation of all firms listed on that trading venue.

Relative tick size: this variable is computed as the ratio between the absolute tick size applicable to price range and the (closing) trade price

LARGE: a dummy variable taking value 1 if the company shows an average capitalisation above the median value of the venue where it is traded and 0 otherwise.

Fixed characteristics (i.e., the fixed effects) of the security/exchange, institutional variables and/or macroeconomic shocks: will be modelled by including dummies for each exchange/country and time dummies.

Estimation results

Model estimation

The trading cost equation has been estimated on a sample of 12,873 stocks from 21 stock exchanges, on a total number of 132,719 observations. The trading turnover equation has been estimated on a sample of 12,841 stocks from the same exchanges, on a total number of 132,430 observations. As noted before, we have used the Arellano-Bond Dynamic Panel Data Estimator for both the equations.

The main results are displayed below.

Table 7: Estimates of Trading Costs and Trading Turnover Equations

Trading cost			Trading turnover		
Independent variable			Independent variable		
tc_{it-1}	0.1365	(5.88)	tt_{it-1}	0.218	(21.21)
tc_{it-2}	0.0051	(0.37)	tt_{it-2}	0.0308	(4.73)
tc_{it-3}	-0.0229	(-1.89)	tt_{it-3}	0.0141	(2.66)
tt_{it}	-0.0356	(-7.22)	tc_{it}	-3.554	(-7.00)
tt_{it-1}	0.0035	(3.13)	tc_{it-1}	-0.1296	(-0.61)
tt_{it-2}	-0.0003	(-0.53)	tc_{it-2}	0.0256	(0.21)
σ^2_{it}	0.7608	(13.99)	σ^2_{it}	11.576	(36.93)
σ^2_{it-1}	0.0075	(0.36)	σ^2_{it-1}	-0.2872	(-1.34)
σ^2_{it-2}	-0.002	(-0.12)	σ^2_{it-2}	0.2099	(1.16)
$mdep_{it}$	-0.004	(-3.14)	$mdep_{it}$	0.1093	(6.50)
Number of obs[15].	132,719		Number of obs.	132,430	
Number of stocks	12,873		Number of stocks	12,841	
Joint significance	1798.76		Joint significance	5221.88	
Serial correlation (p-value)	0.2362		Serial correlation (p-value)	0.6151	

NOTE: All equations include monthly dummies; t-statistics are reported in brackets; instruments for trading turnover in the trading costs equation are given by their lags (t-2, t-3, t-4); instruments for trading costs in the trading turnover equation are given by their lags (t-2, t-3, t-4), LARGE and Tick Size; the joint significance statistic is distributed as chi-squared test; serial correlation statistic is distributed as N(0,1) under the null of absence of serial correlation, see Arellano and Bond (1991).

We first discuss the regression results for the trading cost equation. All the variables included in the regression are statistically significant and show a pattern of signs that is consistent with the literature discussed earlier. More specifically, trading costs are low when the stock is frequently traded or traded in a deeper market, and increase with the volatility of returns. The size of the estimated coefficients is plausible as well.

We now turn to the trading turnover equation. The regression results indicate that lower trading costs substantially increase trading activity. Volatility has a positive and statistically significant effect on turnover, thus suggesting that a more volatile environment is beneficial to trading. This suggests that the trade-generating effect of higher dispersion in traders' viewpoints is stronger than the trade-reducing effect of high market volatility, i.e. risk-adverse agents leaving the market. Lastly, as expected, trading turnover tends to be higher in more highly capitalised markets.

Finally, our regressions also have sound statistical properties. We have assessed the general specification of our models by using a chi-squared test of the null hypothesis that all the coefficients except the constant and time dummies are zero, as reported in Arellano and Bond (1991). The value of the Wald χ^2 test statistic is 648.62 for the trading cost equation and 2997.69 for the trading turnover equation, thus soundly rejecting the null in both cases. In addition, the fact that the error term is serially uncorrelated for both the equations suggests that our dynamic specification is also appropriate. This provides a considerable degree of confidence in our estimates.

Steady state analysis

In the above model, trading costs and turnover are jointly determined. Therefore, to identify the effects of market liquidity/depth on trading costs one cannot simply look at the coefficients as they appear in the estimated equations, but one has to consider the “equilibrium values” of the system. In the analysis that follows we consider only the “equilibrium” effects on trading costs by deriving the steady state version of the two-equation system and treating all the variables other than the two dependent variables as exogenous.

Solving the estimated equations reported above for their long run formulation, the steady-state equations can be expressed as follows:

$$\Delta tc = -0.0362\Delta tt - 0.0045\Delta mdep + 0.8583\Delta\sigma^2$$

$$\Delta tt = -4.8225\Delta tc + 0.1483\Delta mdep + 15.7095\Delta\sigma^2$$

Substituting the former in the latter and expressing that equation in levels, the steady-state, reduced form, trading cost equation is given by the following expression:

$$tc = const - 0.0120 mdep + 0.3506\sigma^2$$

The equation above still shows that trading costs are negatively related to total market size and depth and positively to the volatility of returns. However, before using this equation to generate an estimate of the average trading cost in a fully integrated market, we still need to obtain an estimate of the unknown constant in the equation.

This issue can be resolved by calibrating the estimated reduced form steady-state model given by the equation above on the first moments of the data from the European stock exchanges included in the sample. Applying this methodology yields a value for the intercept of the equation above of 0.1893. Our preferred equation to predict the trading costs of the integrated market can then be expressed as:

$$tc = 0.1893 - 0.0120 mdep_{EU} + 0.3506\sigma^2_{EU}$$

Estimation of impact on cost of capital

Empirical formulation

Model specification

Our approach updates and expands the Domowitz and Steil (2001) study by re-estimating the relationship between trading costs and the cost of equity capital at the company level.

Microeconomic data offers several important advantages for the study of this relationship. First, it allows us to eliminate the impact of aggregation over firms or plants. Second, in a given country, there may be cross-sectional variations in explanatory variables that help to identify parameters of interest. Finally, and perhaps more importantly, the availability of micro data allows us to investigate heterogeneity in behaviour between different types of firms or plants that would simply not be possible with more aggregated data.

Our model is set-up is described in the equation below.

$$k_{it} = \alpha_0 + \lambda_1 k_{it-1} + \lambda_2 k_{it-2} + \alpha_1 tc_{it} + \alpha_2 v_{it} + \alpha_3 RISK_i + \alpha_4 SIZE_{it} + \sum_j \alpha_5^j d_j$$
$$+ \sum_k \alpha_6^k d_k + f_i + \eta_t + v_{it}$$

where *k* is the cost of equity capital for company i, at time t, *tc* is log trading costs, a concave function of trading cost, RISK measures the riskiness of the company, SIZE is an indicator of the size of the company, *v* denotes the full set of sectoral and country dummies cover all unobserved sector and country-specific factors, and institutional characteristics influencing the level of the cost of equity capital, such as the credit rating of the country and the degree of financial development. The *f* terms cover all unobserved company-specific factors influencing the level of the cost of capital, while λ captures shocks common to firms in all markets, such as for example a generalised financial crisis. Finally, *v* captures all other shocks to the cost of capital and is assumed to be serially uncorrelated. The issue of potential serial correlation is addressed by the inclusion of dynamics in the form of lagged dependent variables and the equation will be estimated in first-differences using the Arellano-Bond Dynamic Panel Data Estimator, along the lines discussed in the previous sub-sections.

Using the estimation results of the impact of financial market integration on trading costs from the previous sub-sections, the equation above can then be used to generate predictions of the reduction in costs of equity capital that would occur as a result of lower trading costs. This exercise will provide us with an estimate of the impact of trading costs on the cost of equity capital at the firm level.

First, however, we describe the data sources used to estimate the equation above, explain data definitions and address some measurement issues and then report the estimation results.

Data definitions and measurement issues

Data sources

The data used in our analysis were sourced from Bloomberg Professional 2002, which, in addition to the data described earlier, contains information on key components of the cost of capital. The sample consists of the population of companies whose ordinary stocks are actively traded on the major EU stock exchanges and for which dividend data are available.

The sample period runs from January 2000 to December 2001 and the data frequency is monthly. Table 3.5 shows the distribution of stocks and observations across countries/exchanges, after cleaning the data set and deleting missing observations.

Data definitions and measurement

Cost of equity capital: Our measure of this variable is given by the gross dividend yield, which is the first term of the cost of capital in the dividend discount model (DDM). We do not have information on the long-term expected growth rate in dividends (the second term of the DDM cost of capital), but, given that we estimate our cost of capital equation in first differences, this is not a significant problem as long as the expected long-term growth rate does not change much from month to month.

Trading cost: Trading costs are defined as the effective percentage spread, as described earlier in this section.

Trading volume: The trading volume is the sum of daily trading volumes over a period of one month.

SIZE: Size is measured as the total market capitalisation.

Fixed characteristics of the security/exchange, institutional variables and/or macroeconomic shocks: are modelled by means of fixed and time effects.

Estimation results

The model described earlier has been estimated on a sample of monthly data from 2,556 companies listed in 14 EU stock exchanges by using the Arellano Bond technique. The estimated equation can be expressed as follows:

$$\Delta k_{it} = \underset{(20.73)}{0.8271}\Delta k_{it-1} + \underset{(1.06)}{0.0120}\Delta k_{it-2} + \underset{(5.75)}{0.0922}\Delta tc_{it} + \underset{(0.88)}{0.0001}\Delta v_{it} - \underset{(-5.05)}{0.0387}\Delta SIZE_{it}$$

No. of observations: 31,193[25]

Serial correlation statistic (p-value): 0.44

Joint-significance: 889.08

The regression shows good statistical properties and a pattern of signs that is consistent with both the theoretical and empirical literature surveyed earlier. Our results confirm that illiquidity costs are a key determinant of the cost of equity capital. In addition to statistical significance, the magnitude of the estimated parameter is also quantitatively important. We also find evidence of the so-called “small-firm anomaly”, i.e. a negative relation between stocks’ return and their market value, see for example (Amihud and Meldeson (1986), Banz (1981), or Reinganum (1981a, b). The value of the Wald X^2 test statistic is 673.59, thus soundly rejecting the null that all the coefficients except the constant and time dummies are zero. Finally, the serial correlation statistics suggests that our dynamic specification is also appropriate.

Finally, we quantify the average change in the cost of equity capital for each EU country as a result of the lower trading cost environment. This is carried out using the following formula obtained from the estimation of the cost of capital equation.

$$\Delta k_E = 0.5734 \frac{\Delta tc}{tc},$$

where *(Δtc/tc)* is the percentage fall in the trading costs and 0.5734 is the long run value of the trading costs parameter in the cost of capital equation.

Simulation results

The following table provides an extract of the simulation results from the 2002 London Economics study. The purpose of the simulation was to estimate the equilibrium or long-run impact of the changes in the user cost of capital brought about by the deepening of European financial market integration.

The simulation is run over 10 years and the 10th year should be viewed as the year in which the new equilibrium is reached.

Not much emphasis should be put either on the precise length of the period required to reach the new equilibrium as for technical reasons we decided to implement the changes in the user cost of capital over three years. An alternative approach would have been to implement the whole change in one single period. Although the magnitude of the short-run dynamics would have been somewhat different, the long run equilibrium would have been the same.

For further details please refer to London Economics (2002).

Table 8: Simulation results for 20bps decrease in the user cost of capital (%age changes from base, unless otherwise specified

	Total investment	GDP
Year 1	0.0	0.0
Year 2	0.1	0.0
Year 3	0.3	0.1
Year 4	0.6	0.1
Year 5	1.0	0.2
Year 6	1.2	0.3
Year 7	1.4	0.4
Year 8	1.5	0.4
Year 9	1.6	0.5
Year 10	1.7	0.5
Year 11	1.8	0.5

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