Chief Economist workshop: key macro drivers of change and scenarios for the next ten years

In association with

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The Future of Computer Trading in Financial Markets

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Foresight Project on The Future of Computer Trading in Financial Markets.
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Executive Summary

0.1. Introduction

Foresight has undertaken a two-year project to investigate how computer based trading (CBT) in financial markets might evolve over the course of the next decade. As part of this project, and in order to place the project in a macroeconomic context, the Foresight project team organised a workshop in London with chief economists from a number of leading financial institutions.

Participants at the workshops were asked to identify the most significant factors shaping the world today and the most important drivers of change over the next decade. They were then asked to use these to create short scenarios and to analyse their implications for six key indicators of market performance: liquidity, stability, volatility, price efficiency and discovery, transaction costs and potential for market abuse. Finally, the group discussed some overarching issues associated with computer-based trading.

An overview of the drivers and scenarios is provided below. Chapter 1 describes the workshop objectives and agenda as presented to the participants. Chapter 2 discusses 16 clusters of drivers identified by the participants, and – in slightly more detail – the 5 most important clusters selected by the plenary session. Chapter 3 describes the structure of the scenario space, gives an overview of each of the four scenarios and compares their implications for the six market performance indicators. Chapter 4 summarises the overarching issues considered by the final plenary discussion. Chapter 5 concludes with some brief preliminary conclusions. Names of Participants and workshop slides are provided in annexes.

0.2. Drivers

The participants were divided into five groups, each of which identified a wide range of drivers. These were then combined in a plenary session, which clustered them into 16 aggregates, listed in Table 1 and described in more detail in Chapter 2.

Table 1: 16 Macro drivers

Global economic cycles	Institutional vs. retail trading
Potential loss of risk-free assets	Market vulnerability to manipulation
Demographic shifts	Latent instability
Changes in market structure, intermediation and disintermediation	Geopolitical power shifts
Regulation	Economic productivity and trade shifts
New asset classes	Resource constraints
Increase in globalised asset classes	Cyber-crime and cyber-terrorism
Alternatives to rational profit-maximisation	New wars

The shaded entries were identified by participants as being most likely to influence the future macroeconomic context within which financial markets must operate. These are briefly characterised below.

0.2.1. Global economic cycles (restored/changed)

The world's growth cycles appear to have been perturbed by the recession and its sequellae. The dynamics of growth, employment, savings trade, leverage, etc. may return to cyclical behaviour or some other pattern (prolonged recession, chaotic behaviour). Likewise, global imbalances may persist or resolve. This will affect the demands placed on financial markets in terms of volumes, assert classes and acceptable combinations of risk and return). Global macroeconomic dynamics may also reflect and affect the progress (or regress) of globalisation and the relative economic significance of financial and 'real' markets.

0.2.2. Loss/change of riskless (reference) asset

The current global asset 'ecosystem' uses the return to riskless assets as a reference point in the pricing of risky assets. With the advent of (belief in) riskiness of sovereign debt, this single point of reference may have disappeared. The critical uncertainty concerned the performance and behaviour of financial markets without a commonly-recognised riskless asset and whether a new riskless or other reference point would emerge. A specific aspect of this driver concerned the linkage between sovereign debt and national currencies; in particular the apparent (and possibly temporary) disappearance of the dollar as a global reserve currency.

0.2.3. Impact of demographics (age distribution)

Changing demographics – particularly in the age distribution – are likely to affect demand for management of assets. The group agreed that over the next decade population ageing trends are likely to continue (though as with the UK patterns of immigration may also affect national age distributions). One immediate consequence is an increase in the proportion of (potential) investors over the age of 65. What was potentially uncertain was the impact this would have on the demand for different classes of assets, and the demand for institutional vs. retail investment services. The group noted that populations in different countries were ageing at different rates, and that was likely to interact with different macroeconomic trajectories.

0.2.4. Changes in (dis)intermediation

Both technological and financial market changes were altering the size and functions of intermediaries. This led the group to anticipate a variety of future outcomes in terms of whether such entities could operate across borders, the depth of funding they could influence and more generally whether specific assets or investors would experience further changes in intermediation, disintermediation and other aspects of market structure. There is a link to CBT/HFT via the arbitrage role of intermediaries, the continuum from algorithmic trading to HFT, and the degree to which implications are different for price trading and asset management (see discussion in 0).

0.2.5. Regulation (more/less: national/global)

The group all saw regulation as an important and uncertain influence on financial markets. Regulation was seen as both a driver and a consequence of financial market changes. As a driver, key aspects included the extent to which existing regulation, or new regulation undertaken in response to the crisis, might change the allocation of investment across assets and exchanges and across institutions and investment models or strategies. In terms of modality, future regulation could be more or less coercive, more or less informed by big data analytics or sophisticated models and 'structural' information, heavy- or light-touch, etc. At the international level, there could be costly fragmentation (possibly in conjunction with resurgent protectionism), differentiated or federated regulation reflecting 'comparative advantage' or progress towards a globally-coordinated or harmonised regime.

0.3. Scenarios

The scenarios (see below and Chapter 3) present four alternative macroeconomic future contexts for computer-enhanced financial markets, laid out along two axes related to the drivers of change. The vertical axis indicates the pace, breadth and sustainability of economic growth, while the horizontal axis indicates the degree to which markets are open (and lightly regulated). The defining characteristics of the scenarios are indicated in Figure 1; the scenarios themselves are described in more detail in Section 3.2. The participants identified Scenario B as the most likely one given current circumstances.
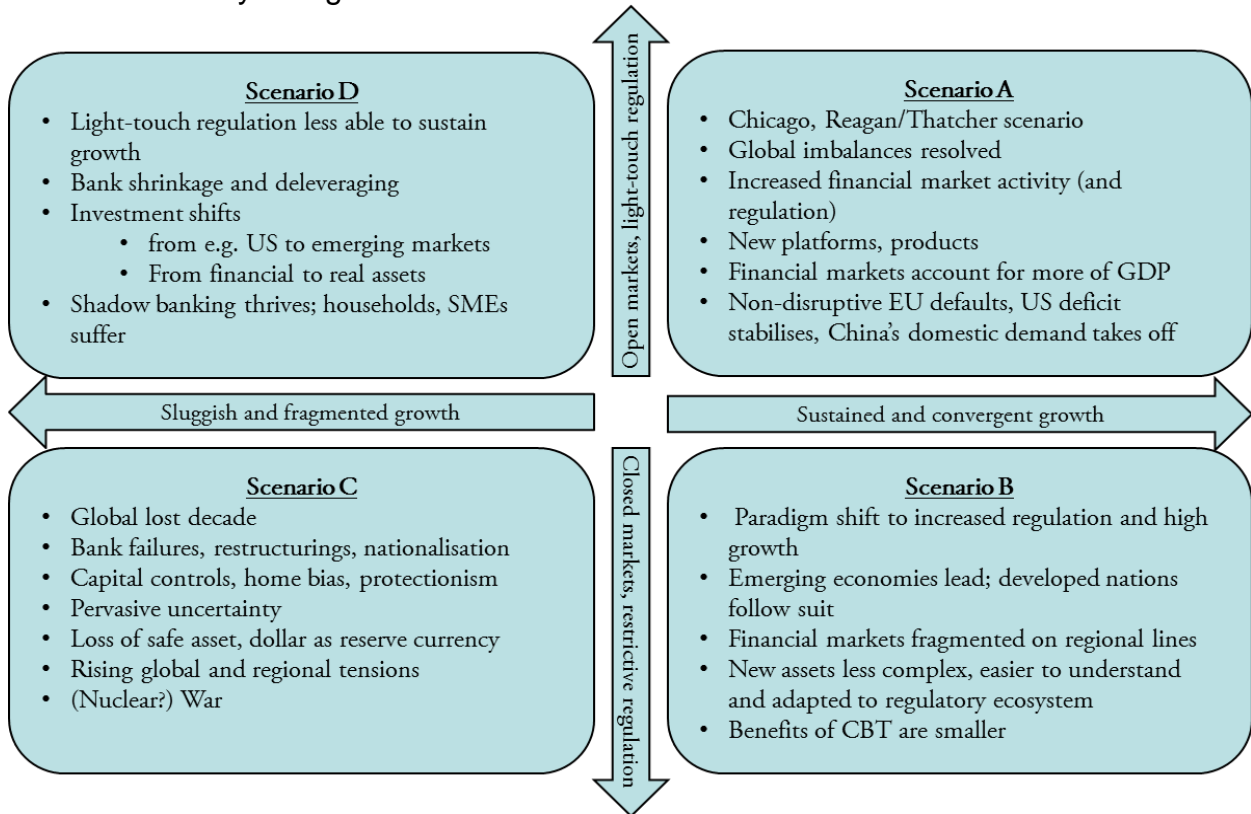
Scenario D
- Light-touch regulation less able to sustain growth
- Bank shrinkage and deleveraging
- Investment shifts
  - from e.g. US to emerging markets
  - From financial to real assets
- Shadow banking thrives; households, SMEs suffer

Scenario A
- Chicago, Reagan/Thatcher scenario
- Global imbalances resolved
- Increased financial market activity (and regulation)
- New platforms, products
- Financial markets account for more of GDP
- Non-disruptive EU defaults, US deficit stabilises, China's domestic demand takes off

Open markets, light-touch regulation

Sluggish and fragmented growth

Sustained and convergent growth

Closed markets, restrictive regulation

Scenario C
- Global lost decade
- Bank failures, restructurings, nationalisation
- Capital controls, home bias, protectionism
- Pervasive uncertainty
- Loss of safe asset, dollar as reserve currency
- Rising global and regional tensions
- (Nuclear?) War

Scenario B
- Paradigm shift to increased regulation and high growth
- Emerging economies lead; developed nations follow suit
- Financial markets fragmented on regional lines
- New assets less complex, easier to understand and adapted to regulatory ecosystem
- Benefits of CBT are smaller

Figure 1: Four macro scenarios

The implications of these scenarios for the six indicators of market performance are summarised in Table 2 and discussed in Section 3.3. Positive effects are shaded in green and negative ones in red; unshaded cells indicate ambiguous or mixed implications.

Table 2: Thematic implications of the scenarios

	Scenario A	Scenario B	Scenario C	Scenario D
Growth	High	High	Low/none	Low/none
Markets	Open	Closed	Closed	Open
Liquidity	High	Low	Low	Low
Financial stability	Up	Up	Up (no riskless asset)	Down (bubbles)
Volatility	Low	Low (high real return volatility)	Low, eventually	High (or low: capital shifting)
Price efficiency, price discovery	Very good (strong form)	Falling (risk not properly priced)	Falling	
Transaction costs	Low	High (market barriers)	High (market barriers)	
Market integrity	High	Low (insiders and bypassers do well)	Low (corruption)	Very low

Chapter 1. **Background**

1.1. **Objectives of the workshop**

The workshop had the following specific objectives:

- To place the project's analysis of the implications of computer based trading in a macroeconomic perspective;

- To capture a long-term perspective on (very) short-term developments;

- To understand the macroeconomic factors likely to affect the evolution and performance of (partially) automated financial markets; and

- To develop a structured and holistic view of the context within which these markets will operate in 10 years' time.

1.2. **Agenda**

The overall workshop agenda was as follows:

- Opening Remarks from FST Minister

- Introduction

  o Objectives

  o Overview of challenges and issues

    ▪ What is CBT/HFT and why do we care about it?

    ▪ What do we know?

  o Workshop expectations and activities

- Phase 1 - Likely evolution: critical factors and uncertainties affecting financial markets, leading to identification of drivers

- Phase 2 - Contexts for financial markets in 10 years' time leading to scenarios

- Final plenary – discussion of cross-cutting and related issues

Chapter 2. **Macroeconomic drivers of future financial market context**

The groups at each table first identified a range of macroeconomic (and other) drivers likely to influence the environment in which financial markets would operate in 10 years' time. These were reported back to the group and clustered according to overall theme. This section summarises these clusters. At this level of generality the clusters overlap substantially. The group then narrowed this down to identify the most relevant drivers

2.1.1. Global economic cycles

All groups noted the importance of global economic developments. These discussions varied in emphasising the cyclical or recurrent nature of some aspects, systematic or continuing trends and current or foreseen global economic developments, which may represent one-off events.

The global business cycle was taken as axiomatic, and not specifically highlighted. However, the groups identified a range of factors that would continue to influence the volume, geographic distribution and structure of demand for assets and financial market services, including

- The global 'leverage cycle' – the world economy is currently experiencing a major deleveraging phase.

- A variety of factors are likely to affect global savings rates. These include demographics, economic uncertainty and increasing levels of disposable income (especially in the emerging economies). This will produce an increased demand for the services of financial intermediaries and a consequent increase in the number such entities and the assets at their disposal.

- The combination of accumulated public debt and falling tax revenues (and other aspects of the current crisis) are likely to lead to increased Government defaults.

- Global imbalances remain at unsustainable levels. This hampers overall growth and development and reinforces protectionism.

- Recovery from the current recession will likewise reinforce risk aversion, especially among the developed nations (who have already become concerned about the rise of emerging economies. This may well reduce cross-border financial flows away from Western nations (but not emerging nations)

Other aspects of the global economic developments driver were more specifically concerned with the role and function of financial markets:

- Whether equities markets are becoming less important;

- Potential changes in the functioning of financial markets and in the ownership of the majority of the high-value and fundamental (as opposed to derivative) assets.

- How long the current spirit of inaction dominating investment trends will last, and whether it will be succeeded by general expansion, general contraction, a mixture of both tendencies or new cycles of investment.

- Currently, many major economies are pursuing some form of quantitative easing, accompanied by near-zero interest rates. At some point, the injection of liquidity into the financial system must slow or stop, and interest rates return to normal levels (aligned with productivity growth). These changes will affect financial markets, both in aggregate and in terms of the order and pace at which the current extraordinary arrangements are unwound.

2.1.2. Potential disappearance of risk-free assets

A second cluster specifically concerned the potential disappearance of safe assets. Government sovereign debt (gilts) has provided a safe asset used to balance risk in investment portfolios; in addition, the riskless rate of return provides a point of calibration for risk-adjusted rates. Previous episodes of sovereign debt default have played a role in global financial crises; they tended, however, to be confined to single countries and of relatively brief duration. Participants saw a real possibility of an extended period (up to a decade) of multiple government defaults. While not all participants thought that all riskless assets would disappear, most foresaw a potentially profound shift in what would generally be regarded as global risk-free assets. In line with this, participants noted that national currencies associated with riskless sovereign debt (e.g. the US Dollar) might lose their reserve currency status. On the other hand, new currencies may assume this role – especially an internationalised RMB.

2.1.3. Demographic shifts

Each of the groups agreed that demography would be a major driver of both macroeconomic scenarios and of the demand for financial services. This was not regarded as in any way uncertain; population ageing – and in particular the increasing proportion of investors over the age of 65 – was regarded as inevitable. The geographic age distribution is less certain; economic migration tends to make destination areas younger and origin areas older. The economic status of the population may also change, as retirement ages and age-related unemployment rates respond to the recession and recovery measures. Overall, however, both developed and emerging economies have ageing workforces. This may well be associated with an increased demand for safe assets and institutional trading and with financial market deepening, as the income-earning and asset-owning portions of the population increasingly look to markets for safe and steady returns. This tendency may be reinforced by the potential insolvency of public pension schemes and reduced public funding for services for the elderly. On the other hand, ageing populations who are underemployed relative to their skills may participate in active trading, increasing demand for retail investment services and (possibly) accepting more risk in return for higher rewards to active portfolio strategies.

The international dimensions of this demographic shift include the differences between developed and emerging economies. Overall, ageing is more advanced in the developed economies. However, neither should be considered as a homogeneous group. Differences among the developed countries (e.g. among European countries or between Europe and the US) are well-known. As far as emerging economies are concerned, in India the economically active (working age) proportion of the population is increasing, while Brazil's demography is likely to be stable over the next decade, with changes mostly related to social mobility, access to financial services, and income distribution. On the other hand, China's population is ageing – while the proportion over 60 is growing at the same pace as the US and Europe (from a lower base), its average age is growing faster, and the proportion of the population with less than 15 years' remaining life expectancy (who can be expected to draw down their savings) is growing

much faster than the US or (Western) Europe). Some participants expected China to begin drawing down its savings from about 2020.
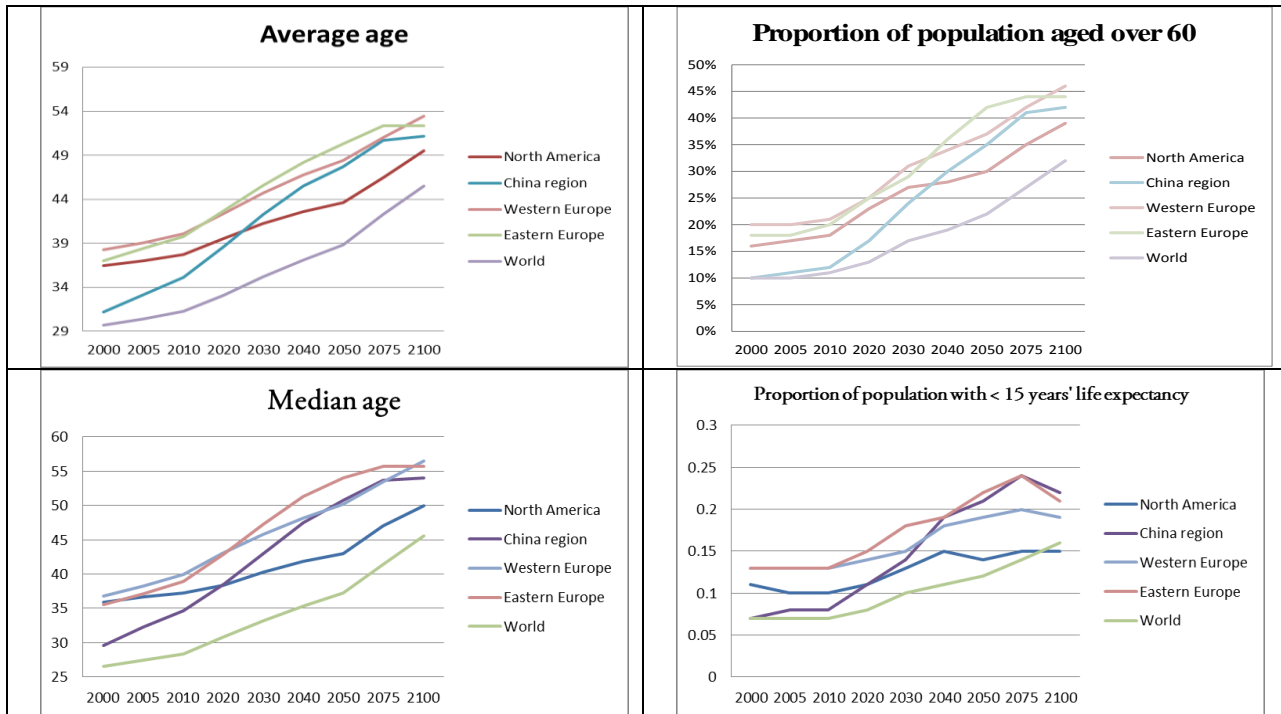
The data in Figure 2 put these findings into perspective[1]:

Figure 2: National differences in population ageing

This general trend towards an ageing investor population will not be sustained in all economies; in addition to the impact of economic migration (as reflected in recent ONS figures for the UK), ageing populations may well become much younger very quickly as the older cohorts die (or lose wealth); such changes will provide a further driver of financial market change (albeit not in the short run).

The general consensus of opinion was that the implications of demography for financial markets would depend on both the participation and the behaviour (as investors) of people of different ages. Demographic differences in different regions would therefore affect global financial flows.

2.1.4. Changes in market structure, intermediation and disintermediation

Cross-border flows of finance are likely to increase in volume and complexity. This may lead to greater connectivity among exchanges: linkages, integration and even globalisation. By the same token, the group expressed concern that CBT and financial innovation would increase the extent and density of the shadow banking network[2]. Participants in this network include

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[1] Lutz, W., Sanderson, W., Scherbov, S. (2008) "The coming acceleration of global population ageing" *Nature* **451** (7179), pp. 716-719.

[2] Shadow banks are financial intermediaries that conduct maturity, credit, and liquidity transformation without access to central bank liquidity or public sector credit guarantees. Examples include finance companies, asset-backed commercial paper (ABCP) conduits, limited-purpose finance companies, structured investment vehicles, credit hedge funds, money market mutual funds, securities lenders and government-sponsored enterprises. They are linked into a shadow banking network by extended chains of vertically integrated credit intermediation involving securitisation and secured funding techniques such as ABCP, asset-backed securities, collateralised debt obligations and repo. In the run-up to the crisis, this system provided inexpensive credit by

mutual funds, hedge funds and exchange-traded funds (ETFs); the group noted a possible positive feedback between the growth of ETFs (esp. synthetic ETFs) and computer-based trading. This feedback relationship between CBT and financial market complexity is enhanced by the non-transparency of shadow banking, which can lead to price inefficiencies that CBT can profitably exploit (but may not arbitrage away).

Accompanying these structural changes is a likely continuation of disintermediation away from traditional depository institutions. In consequence, many participants will not have easy access to lender-of-last-resort or resolution facilities.

Other changes in the structure of financial activity will include:

- deleveraging (debt reduction and/or broad shifts in demand from debt to equity);

- increased demand for retail (as opposed to institutional) investment, and

- possibly increased market depth as a result of expansion of assets and participation.

Taken together, these trends will change investment strategies and the governance landscape; if this leads to major international shifts in capital availability, there will be political pressures for restrictions on cross-border intermediaries.

2.1.5. Regulation

Financial crises are nothing new; neither are regulatory responses. The crisis cannot be blamed on computer-based trading, and recent proposed and implemented changes in regulation are not centred on problems arising from new technology. Technology has changed markets before, but this time much of the most troublesome market behaviour lies outside regulatory oversight and traction; these areas are highly profitable and growing very rapidly.

Public pressure to regulate is increasing in response to both adverse events and growing inequality. Some participants suggested that it might be desirable to explicitly consider how best to reconcile top-down, functional or technocratic regulation (cyclical performance) with transparency, accountability and responsiveness to public preferences to ensure credibility and market efficiency in the long run.

One example of regulation that has attracted both popular and academic attention is some variety of transaction tax (or "Tobin tax"). This could serve several purposes: slowing the rate and reducing the volume of financial transactions (in the process reducing the attractiveness of high-frequency trades that generate a multitude of small gains); changing the informational efficiency of markets (by slowing transactions enough to allow information to 'catch up'; and generating revenues for governments at a time when conventional fiscal instruments seem to be less effective. The group did note that the revenue raising and enhancing efficiency aspects might come into conflict, and that the political debate about the tax was also affected by redistributional concerns. It was also noted that implementation details matter (one variant proposed being a tax rate inversely related to the length of time the asset had been held) and that new forms of capital gains tax might also be implemented over the coming years.

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converting opaque, risky, long-term assets into money-like and seemingly riskless short-term liabilities, which contributed to bubble formation. See Pozsar, Z., Adrian, T., Ashcraft, A. and H. Boesky(2010) "Shadow Banking" NY Federal Reserve Bank Staff Report 458 (July 15, 2010). Available at SSRN: http://ssrn.com/abstract=1640545.

Other regulatory measures that might change the context in which financial markets operate include supply-side measures and capital controls, though the impact of these will depend on the whether current slow (real) productivity growth and national imbalances (leading to regional and eventually European policy shifts) will continue. Certainly, the continuation of present trends could see an era of forced private sector lending to governments. Other measures could be placed on institutions to account for the increased complexity of controlling risk exposures arising from financial innovation and CBT e.g. to require banks to issue low-interest bonds, whose value would depend on the market's trust in the risk management capabilities of the issuing institution[3], providing a disincentive to continual development of new management technologies that reduce capital adequacy requirements.

At the same time, the group noted that financial institutions are more likely to be regulated than financial products. In consequence, regulation might lead to market segmentation, resulting in a reduction in liquidity. Indeed, even the question of who will regulate and how regulators will coordinate their activities remains open; regulatory responses are evolving, but continue to differ among countries, while markets and financial flows are much more connected.

The constraints arising from regulatory changes may even reduce the ability of financial institutions to manage or withstand risk. However, regulatory measures and financial institution behaviour are linked; regulation is thus both a driver and a consequence of financial market change. Therefore, governance roles (in terms of responsibilities, powers of action and information) may be shared between authorities and industry. Self- and co-regulation have played positive and negative parts in the development of the financial sector; this is expected to continue. Private parties are expected to act out of self-interest, but market stability may be in their long-run interest. By the same token, governments increasingly need to balance market stabilisation and revenue generation objectives. A useful point of departure might be the OED definition of 'regulated' – "adjusted in response to, or in order to conform to, a principle, standard, set of circumstances, etc." which does not imply either a formal regulator or a legal regulation.

2.1.6. New asset classes

Financial innovation is expected to accelerate. While there is substantial uncertainty as to what kinds of asset classes will emerge and who will own them, it is likely that they will be increasingly controlled by emerging entities, in a centralised manner.

Financial innovation is linked to technological and business innovation; assets are proliferating so fast that they may need some degree of standardisation if investors and markets are to evaluate them and make appropriate trades. Innovation is also driven to some degree by deleveraging; the need to unwind existing positions and to efficiently manage the resulting liabilities and capital adequacy requirements.

The new derivatives are increasingly likely to affect the underlying assets, but the nature and extent of these effects are unknown. Over and above the asset risk, trading diversity, complexity and speed make these new assets prone to operational risk. It was generally agreed that the growth in innovative products would probably be associated with new investment strategies, forms of intermediation and linkages in the global financial network.

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[3] Nightingale et al (2003) "Capacity utilization revisited: software, control and the growth of large technical systems" *Industrial and Corporate Change* **12** (3): 506.

In particular, the next decade is likely to see an increase in the number and range of synthetic derivatives (especially those based on African assets and exchanges). These synthetic assets may lead to increased arbitrage. More generally, emerging markets are likely to drive the creation of a wide range of additional assets. It is an open question as to how trade in these assets will affect the availability of capital for 'real' investment in these economies.

2.1.7. Increase in globalised asset classes
This was initially proposed as a separate driver, but in discussion was subsumed into "new asset classes."

2.1.8. Alternatives to rational profit-maximisation
A variety of factors were seen as contributing to a greater variety of behavioural paradigms, compared to a model in which all financial market participants acted as Bayesian maximisers of expected (trading) profit. On its face, this is nothing new; stakeholders have always had a great variety of alternative objectives ranging from e.g. market stabilisation to profits made elsewhere (in the case of FX hedging). Therefore, some participants noted that the 'driver' might simply be a matter of correcting the distortions arising from overuse of rational profit-maximisation models.

Nonetheless, there was a general sense that the distribution and influence of trades made from different perspectives might change. Departures from rational profit-maximising behaviour might be particularly strong in specific markets (such as FX). The increasing accessibility of financial markets to a wider selection of the population was seen as potentially disruptive, if wider direct participation led to negative externalities (e.g. herding). From this perspective, increased market transparency might lead to more democratic and/or less sophisticated governance.

Potential consequences include:

- A possible shift of (parts of) the global financial system from risk-reducing diversification and arbitration towards speculation and gambling; this might be particularly pronounced in emerging economies such as China, due to a combination of cultural attitudes and rapid and profound increases in disposable income;

- An overall reduction in price-elasticity (especially on the demand side); and

- Pressures for greater controls.

2.1.9. Institutional vs. retail trading
The group noted that both the overall behaviour of markets and the willingness to embrace and undertake financial innovation and CBT/HFT differed between institutional and retail investment. The demographic shift (Section 2.1.3) is not the only factor driving a shift from the former to the latter. Access to models and information and the reduction in transactions costs also play a part. This shift forms part of a feedback loop with CBT/HFT; the group noted that e.g. Japanese retail investors might be one of the first groups fully to embrace HFT.

2.1.10. Market vulnerability to manipulation
As noted in relation to e.g. cyber-crime (Section 2.1.9), changes in markets, assets and investors may create new opportunities for manipulation. For instance, the widespread availability of semantic analysis programmes linked to trading programmes lets the market

handle information on a much faster and more widespread basis – whether or not the information is correct. In particular, if the use of common technologies and common information causes everyone to mimic the most successful strategies and positions, there is a risk of excess volatility arising simply from the fact that everyone will become a seller or a buyer at the same time. Moreover, the ability of large (or rapid) traders to dominate the information network and meet market needs can lead to (temporary) monopolisation. Some of this is a natural consequence of networked information search, some is a result of the economics of networked technology and some is the result of large and sophisticated risk control[4] systems encouraging concentration in the sector.

There is already some evidence that the general increase in liquidity has been accompanied by episodes in which liquidity 'dries up;' these could be the result of manipulation. Certainly such episodes can lead to relatively large transfers of wealth (as with 'flash crashes' or 'flash booms'); it may be difficult to detect them or distinguish between events triggered for strategic purposes and those associated with the 'normal' operation of the system.

2.1.11. Latent instability

The group noted the findings of the science reviews showing that the system continued to function well under normal circumstances, but noted the potential for gradual 'occult' changes pointing to major instabilities under adverse circumstances in the future. In this regard, they thought that other issues might be more important than flash crashes, e.g. excessive synchronisation or alignment of programmed responses or changes in the structure of financial networks. The group considered whether there was evidence of such shifts, and whether this would be equally obvious (or of concern) to all stakeholders.

2.1.12. Geopolitical power shifts

The group noted large-scale, long-term changes in the balance of power that would shape the alignment of countries and the patterns of economic activities in the period leading up to 2022. While the United States once stabilised the global financial system, it appears now to be preoccupied with its domestic crises (including the domestic manifestations of the global financial crisis). The future may see a return of the US as an engaged global power, the emergence of another nation to replace it or a prolonged period with no overall leadership (for better or worse).

Other global trends include: transition in China, the Arab Spring, and the emergence of a more democratic global economy. At a more parochial level, the position of the UK may also change, especially in relation to the EU. One group thought it possible that the UK might opt out of the EU (in some sense) and that the Eurozone might collapse or realign. This would change the transactions costs for cross-border financial and other economic activity and redefine 'natural trading areas.' In particular, the city of London might become more important as a global financial hub (and as a centre for both the practice and the policy response to CBT/HFT) if either of these events (UK opt-out, Euro collapse) occurs.

Beyond the borders of Europe, new affinities among nations might lead to the emergence of new regional trading hubs and 'trading corridors' (e.g. connecting countries of the global South). These would be given particular dynamism by the on-going liberalisation of capital markets in the emerging world.

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[4] Beniger, J. (1986) The control revolution: Technological and economic origins of the information society Cambridge, Mass: Harvard University Press.

Ultimately, we may see a major shift in policy-making power. For example, the new G20 may come of age as a primary basis for policy coordination and the management of collective or even global problems.

2.1.13. Economic productivity and trade shifts

Not all the large-scale changes are political in nature. The group noted that equity and FX markets, in particular, are increasingly international. In parallel with US withdrawal from the world stage (Section 2.1.2), the group noted the waning influence of the dollar as a global 'reference' currency. It does not appear at the moment that there are many capital markets of sufficient depth to take up the slack if the dollar no longer provides global access to US-based capital pools; the € is too fragmented and unstable, the Yen is too 'domestic' and the RMB is not yet open enough.

Beyond the existence of a global financial 'commons' the group considered national nodes within the network. They noted that emerging markets (in particular) trade in different assets and that market structures differ according to how these assets are managed. Another important development shaping the financial market future was whether and how these markets might converge in terms of the kinds of assets traded and the way they were managed and regulated.

In relation to finance and other sectors of the world economy, the current political opposition to globalisation may produce policies that lead to fragmentation or to a unifying crisis. However, the group did not identify a credible alternative model.

2.1.14. Resource constraints

Despite the attention paid to the financial crisis and other troubling events, the world's resource and environmental problems have not resolved themselves. Therefore, any view of the medium-term outlook needs seriously to consider other global issues such as food security, climate change, access to water, access to critical non-renewable resources (e.g. rare earths) and energy availability, cost and environmental burden. This may reshape the financial market context in both direct and indirect ways. On one side, energy regulation and trading in energy sources will affect demand for specific assets (including e.g. weather derivatives). On the other, the data centres used to support both the regular and the computer-based operation of major financial exchanges already threaten to overwhelm energy supplies. One group noted that energy policy could shape energy technology innovation, which in turn would shape the financial market context, by cutting the costs of some energy sources and strengthening the positions of countries and companies in control of the technology and/or specialised in the consumption of those resources. Some participants cited the dramatic gas price reductions produced by US adoption of fracking technology as an example of the convergence of technological innovation with policy dialogue regarding safety and renewable alternatives to produce a substantial effect on financial markets and the US economy. It was even suggested that this lowering of energy costs was the single most important factor behind the recent recovery in US growth.

2.1.15. Cyber-crime and cyber-terrorism

Low-touch trading, the global scope of trading, the spread of cybercrime skills, increasing market volumes, limited transparency, data overload and increasing critical dependence on financial markets make them attractive targets for malicious attack. Such attacks could range from outright asset fraud, manufacture of false identities and price manipulation and technical exploits (e.g. Distributed Denial of Service (DDOS) or targeted latency). They could be financially motivated or used to attack financial networks as critical (inter)national

infrastructures. They may originate with criminals and terrorists, or with other sovereign nations.

Increased prevalence or perceived risk and severity of such attacks could cancel out the efficiency and other benefits of CBT and HFT, by reducing trust. They may even threaten political and economic sustainability.

Cybercrime and cyber-terrorism could increase gradually in a statistical sense; but the future could equally be shaped by a sufficiently severe or disturbing incident or by the demonstration of a serious vulnerability (a la Stuxnet[5]). However, the occurrence of such incidents is not limited to malicious or opportunistic behaviour; the complexity of the computerised financial system is such that disruptive incidents could result from accidents. These might be due to failures in individual programmes or systems, or more systemic coordination failures. Policies adopted to deal with one sort of threat (e.g. information security policy designed to counter attacks) might be ineffective (or even counterproductive) in the face of the other sort.

2.1.16. New wars

Global and regional tensions may continue to breed armed conflict. The location, severity and duration of regional crises will be dependent to some degree on US engagement, at least in the near term. More directly, another war in the Middle East could affect the availability of oil (and thus energy security), with long-term geopolitical implications.

To the extent that such shocks are exogenous, it is important to consider the resilience of the financial system; will markets continue to function after an exogenous shock? Even the perception of risk may be damaging to global financial connectedness and openness; political instability (particularly cross-border) will lead governments to examine (if not actually implement) new types of capital controls.

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[5] A recent computer virus that specifically targeted industrial technical systems.

Chapter 3. **Scenarios**

3.1. **The scenario space**

The group debated whether the driver clusters in Chapter 2 could be translated into critical uncertainties or dimensions that could be used to map a set of relevant scenarios. Ultimately, they decided to use two:

- High vs. low growth, where 'high' growth was taken to mean sustained and convergent growth in both income and productivity, while 'low' growth indicated sluggish, patchy and uneven growth, or prolonged stagnation of the global economy.

- Closed vs. open markets, where 'closed' markets place limits or high costs on intermarket linkages and international flows and regulation is highly restrictive and nationally fragmented, while 'open' indicates a regime of substantial low-cost and unfettered intermarket and international activity (in finance, but also other sectors) and regulation is light-touch and internationally coordinated (if not harmonised).

The resulting scenarios are shown in Figure 3 (which reproduces Figure 1 above) and described in more detail below.
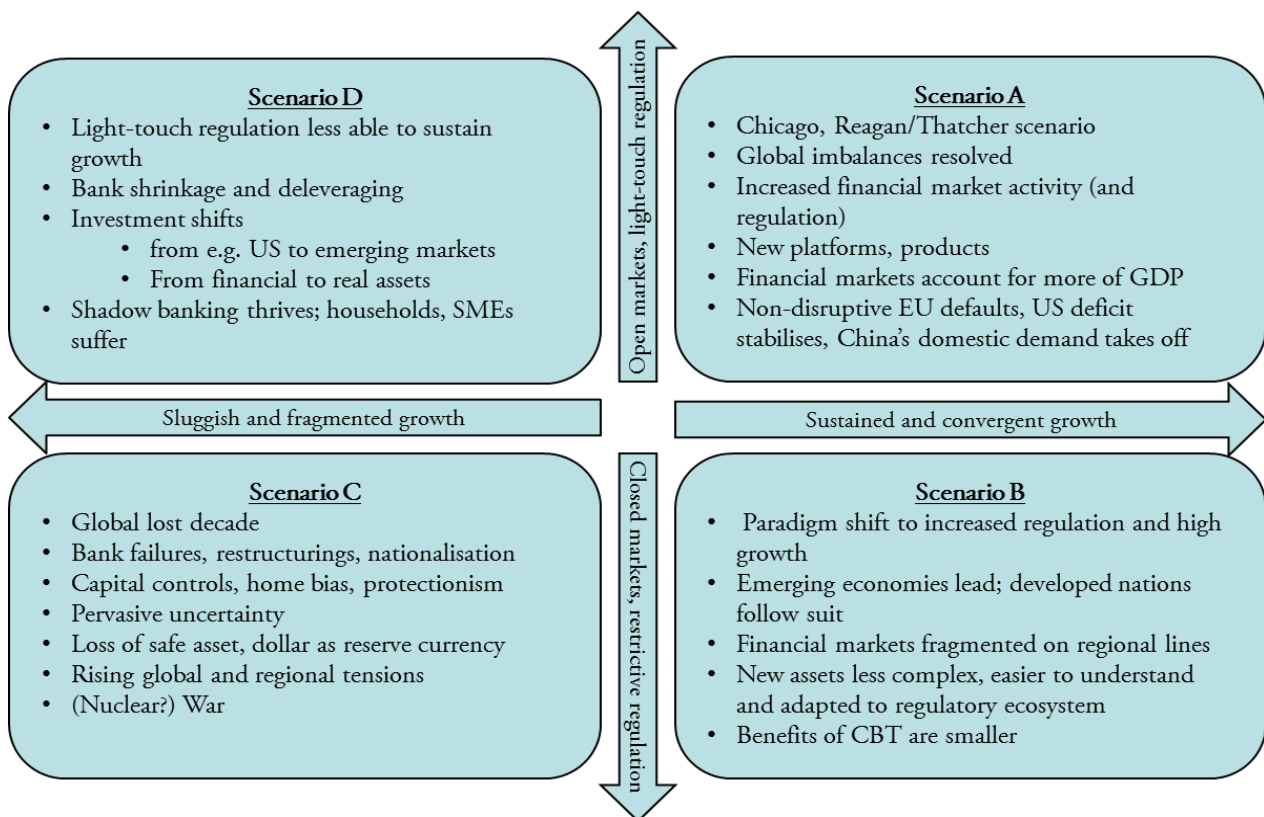
Scenario D
- Light-touch regulation less able to sustain growth
- Bank shrinkage and deleveraging
- Investment shifts
  - from e.g. US to emerging markets
  - From financial to real assets
- Shadow banking thrives; households, SMEs suffer

Scenario A
- Chicago, Reagan/Thatcher scenario
- Global imbalances resolved
- Increased financial market activity (and regulation)
- New platforms, products
- Financial markets account for more of GDP
- Non-disruptive EU defaults, US deficit stabilises, China's domestic demand takes off

Open markets, light-touch regulation

Sluggish and fragmented growth ← → *Sustained and convergent growth*

Closed markets, restrictive regulation

Scenario C
- Global lost decade
- Bank failures, restructurings, nationalisation
- Capital controls, home bias, protectionism
- Pervasive uncertainty
- Loss of safe asset, dollar as reserve currency
- Rising global and regional tensions
- (Nuclear?) War

Scenario B
- Paradigm shift to increased regulation and high growth
- Emerging economies lead; developed nations follow suit
- Financial markets fragmented on regional lines
- New assets less complex, easier to understand and adapted to regulatory ecosystem
- Benefits of CBT are smaller

Figure 3: Four macro scenarios

3.2. Individual scenarios

3.2.1. Growth in an open world (Scenario A)

Participants referred to this as the 'Chicago school' or 'Thatcher/Reagan' scenario. Global imbalances begin to be resolved because of trends associated with continued openness. In particular, savings and investments imbalance between East and West begins to disappear. The Japanese economy develops (modest) surpluses; US deficits stabilise; Europe survives a series of 'corrective' defaults without major disruption; and China's growth is stabilised by the emergence of healthy levels of domestic demand.

However, increased levels of financial market activity displace increasing amounts of investment and trading activity onto alternative platforms such as renascent hedge funds. In general, capital finds its way around any barriers and regulations. In consequence, financial markets account for an ever-expanding proportion of GDP, and generate a steady stream of new platforms and financial products.

Discussion

The group questioned the plausibility of continued financial market expansion, arguing that the 'real' economy will eventually have to come to the fore. Doubts were also expressed as to whether sovereign debt default of major European nations (e.g. Italy) could really be accomplished without disruptive consequences.

3.2.2. Growth in a closed world (Scenario B)

In this scenario, financial markets are subject to increasing regulation. This leads to a paradigm shift; the emerging economies, with their greater regulation and coercion of financial markets, are better able to sustain growth. Eventually, the (formerly) developed economies follow suit, bringing an end to the long-prevailing Washington consensus of relatively unregulated financial markets and capital flows.

The UK sees a return to the post-war macroeconomic consensus that dominated between 1945 and 1970, when much higher levels of financial market regulation coexisted with average annual growth rates of 5% or more in the Western economies.

Financial markets are fragmented along regional lines, with some resurgent protectionism and increasing investment in domestic markets. Federal and regional governments use differentiated regulation to capitalise on local comparative advantages. As a result of these factors, globalisation declines. However, it does not disappear altogether and some regional trading blocs (e.g. the EU) remain effective, if less coherent than before.

Many of the financial products current in 2012 became unappealing to investors – without openness they could only generate small returns. Therefore, the financial world saw a return to less exotic products and services. However, there is still a flow of new products, players, institutions and instruments. On the whole, these products are less complex, easier to understand and adapted to the regulatory ecosystem; there are even signs of a re-emergence of building societies. CBT/HFT has more limited benefits in this world; although the technology is there, it is little used, and there is more risk-sharing than aggressive (financial) gain-seeking.

Governments engage in financial repression. Resources and capital are not allocated as efficiently as in 2012; there is rather more strategic allocation and less short-term profit maximisation – at least, profit maximisation is even less strongly aligned with overall efficiency

than before. Part of this is due to the impediments to price discovery and information flow; risk is not efficiently priced and allocated. Capital flows are difficult to predict; more savings are domestically invested in the (formerly) emerging countries and the West has to work hard to attract investment capital from the East.

In consequence, the WTO has not achieved much success – there were more bilateral than multilateral deals, and the Western developed economies could not be as demanding as they were in the pre-2012 period. Indeed, as their economic performance weakens, so does political support for free trade and open markets; this [sustains the scenario and] leads to a gradual migration of entrepreneurial talent to the more dynamic (formerly) emerging economies.

This scenario, once set in motion, is resilient and self-sustaining. If acceptable levels of growth are achieved in a closed environment there is no incentive to open markets further. Assets are moved to safe havens. Interest rates do not equalise on a global basis. Institutional investment dominates retail investment. Finally, there are more manufacturing jobs and the financial-services industry accounts for a much smaller proportion of GDP than in 2012.

Discussion

The groups found this to be a very plausible scenario, despite the potentially broad definition of 'closedness.' This could mean:

- Financial constraints, e.g. requiring citizens of one country to purchasing that country's bonds. Doubts were expressed as to whether this could be enforced, but the example of France was cited to demonstrate the feasibility of relatively inward-looking markets and the likelihood that such markets would not efficiently or accurately price risks and that resources would not be efficiently allocated;

- Regulatory balkanisation – e.g. some of the responses to the 2012 Euro crisis; and

- A 'closed' mentality leading to specific regulations against CBT – examples from the post-2007/8 era were cited.

However, it was emphasised that this was not an 'extreme' scenario involving isolationist governments and suppression of global trade; rather, all governments are somewhat more protectionist and willing to intervene in the national interest. The general trend thus favours formation of small clusters of trading partners over dispersed global networks and 'level playing fields' and most investment capital is raised in local markets, with the inevitable result that disparities in national economic performance tend to grow over time.

In further support of the feasibility of this scenario, the group developing this scenario cited some current examples:

- India's good levels of liquidity despite market fragmentation and regulation; and

- African markets that are so underdeveloped that they are akin to being closed (although there is at least a latent world demand for opportunities to invest in Africa).

The strong performance of the emerging economies in the period 2012-2022 was linked to the existence of large domestic traders combined with interventionist government policy; this ultimately allowed 'national champion' financial entities to set the rules of the game. Therefore,

even Western nations will experience growth and trade, but with Eastern rather than Western characteristics.

Looking out beyond 2022, it is not clear whether India and China will be able to absorb their productivity growth, or whether a new cycle of openness will begin as they seek to develop overseas markets on their own terms.

Despite the plausibility of this scenario, not all participants were convinced that governments would be capable of controlling all financial markets at the same time; they noted that capital tends to find ways to circumvent restrictions. If stability is enforced – or volatility reduced - in one market, it often simply transfers to another market or class of assets.

Finally, it was noted that fragmentation and asymmetric economic performance makes war more plausible.

3.2.3. No growth in a closed world (Scenario C)

Under this scenario there is a return of capital controls in Europe and home bias in the banking system (i.e. nationalised banks) and a re-emergence of protectionism. This possibly stems from the eventual collapse of the Euro and an associated recession or even depression. Global imbalances persist to such an extent that more and more nation states prefer to close their markets to outside traders, with capital controls and a strong home bias.

These problems are compounded by the US frontloading its austerity measures and, as a result, the loss of the dollar as the world's reserve currency as domestic fiscal policy is tightened. The US also attempts to default to reduce its exchange rate. There is confusion and disagreement about what constitutes the risk-free reference asset. Without a common basis, risk is not properly priced or allocated.   There is no anchor for expectations leading to constant uncertainty.

Globally, there are persistent increases in deficits and a Japanese-style lost decade everywhere. The west reacts to this by blaming others and, therefore, increasing protectionism. There are bank failures, restructurings and nationalisations.

The loss of equilibrating global trades and the resulting restrictions on entry lead to increasing inequality within and among nations. This is extended to intergenerational inequity by the failure of markets properly to price claims in different dates and states.

Populist political parties and politicians come to the fore, riding a wave of discontent. These increase protectionism still further. There are wars and the 'Arab spring' turns out to be the 'Arab winter' as dictatorships are replaced by theocracies. Tensions rise throughout the world, as developed and emerging nations blame others for their growing economic troubles. In particular, tensions arise between India and China, driven by demographics and limited access to the few remaining open global markets. These tensions may lead to regional wars or even global conflict.

3.2.4. No growth in an open world (Scenario D)

This scenario sees a continuation of light-touch regulation, especially in countries such as the UK where it has a long history - but this openness becomes less effective at generating growth. This stance is not universal; as stagnation persists, some nations opt for greater regulation and restrict access to their financial markets.

Under this scenario, European macroeconomic growth remains sluggish and even China sees GDP growth fall to about 4% (CAGR). The US develops a massive underclass because so many people dropped out of the labour market starting in 2012. Their unemployed (or underemployed) children are now causing even slower productivity growth; this skill inequality exacerbates wage inequality both among and within countries. The US is deleveraging, but only because it is reneging on so many of its debts and struggling to recover its capital base. Rising inequality means political parties struggle to represent everyone, and there is increased political fragmentation and extremism.

There are changes in disintermediation and intermediation. Especially in countries that persist with light-touch regulation and open markets, banks and some other financial institutions shrink. This is partially a consequence of lightly-regulated competition and partially a necessary condition if authorities are to resist calls to strengthen regulation; an open world only works if the banks aren't too powerful. This scenario sees a continuation of deleveraging, which contributes further to the shrinkage of banks.

Investors become desperate for any type of yield whatsoever. As a result, capital flows from the US to China Latin America or other emerging markets and from financial assets to real investments; some markets may struggle to handle these shifts and episodes of illiquidity may result. The flight of capital to emerging – and liberalising - markets also acts to prolonging the stagnation of the developed economies. The financial sector fragments along national, asset class and institutional lines. The shadow-banking sector does well, but households and small firms struggle for access to capital. At the same time, hard-pressed national governments fail to invest in skills, leading to generations of unemployment and migration from poorer to richer countries. Less-urgent problems (e.g. the environment) increasingly take a back seat to short-term economic policy. Finally, both domestic and international political tensions are stoked by migration, continued economic malaise and growing differences in economic performance.

Discussion

The plenary discussion questioned the plausibility of this scenario. While there are precedents – e.g. Japan's long stagnation despite having an open economy, it is not obvious that this can be scaled up or maintained in the absence of growth somewhere in the world economy. Increasingly, countries will recognise that the benefits of openness require symmetric trade; why stay open if you're not growing? One possible reason might involve a symbiosis between bankers and government to constitute a *de facto* ruling elite able to preserve openness in their own interest against the collective national interest.

3.3. Comparing the scenarios: thematic implications

This section briefly summarises the implications of the scenarios for six thematic criteria; liquidity, financial stability, volatility, price efficiency and/or discovery, transaction costs and market integrity. These are discussed for each scenario and summarised in Table 3 (which repeats Table 2 in the Summary).

Under scenario A the outcomes for the six are 'obvious' and positive as implied by mainstream economic theory. Liquidity is good, financial stability increases, volatility declines, prices efficiently incorporate all knowledge and risks, transaction costs are low and markets effectively self-regulate against opportunistic or predatory behaviour.

Scenario B entails compartmentalisation, asset simplification and financial restrictions, especially of international flows. This generally reduces liquidity, but increases financial stability and lowers overall volatility. Markets will not price properly for risk, which will harm price efficiency and discovery and increase the volatility of real returns to specific assets. Unit transaction costs will increase. Market integrity will decline but market insiders and those who circumvent the markets will do well.

Scenario C also sees widespread use of capital controls and a strong 'home bias.' In contrast to Scenario B, however, it also has limited or no growth. In consequence, although liquidity is down, increases in financial stability cannot be taken for granted, because low growth threatens the existence of a riskless asset. On the other hand, short of catastrophe, low growth depresses volatility and assets prices alike. Transaction costs are up. The pervasiveness of inefficient barriers to economic activities produces corruption and other threats to market integrity.

Under scenario D, openness without strong global growth exacerbates unstable global financial flows. Liquidity is unreliable, financial stability is threatened by a series of speculative bubbles and crashes, and volatility increases. The group did not specifically discuss price efficiency and price discovery or transactions costs, though it could be argued that unstable flight of capital through a fragmented financial system indicates effective price discovery and low transactions costs. The zero-sum nature of this scenario makes the threats to market integrity even worse than in Scenario C.

Table 3: Thematic implications of the scenarios

	Scenario A	**Scenario B**	**Scenario C**	**Scenario D**
Growth	High	High	Low/none	Low/none
Markets	Open	Closed	Closed	Open
Liquidity	High	Low	Low	Low
Financial stability	Up	Up	Up (no riskless asset)	Down (bubbles)
Volatility	Low	Low (high real return volatility)	Low, eventually	High (or low: capital shifting)
Price efficiency, price discovery	Very good (strong form)	Falling (risk not properly priced)	Falling	
Transaction costs	Low	High (market barriers)	High (market barriers)	
Market integrity	High	Low (insiders and bypassers do well)	Low (corruption)	Very low

Some conclusions from this comparison are briefly presented in Chapter 5.

Chapter 4. **Crosscutting issues**

The final plenary session returned to a number of issues that had arisen in various contexts during the day. These are briefly recapitulated here for the sake of completeness.

4.1. Computers or quants?

From the outset, some participants asked whether the phenomena noted in the scientific reports could be ascribed to computer-based trading, and the extent to which such trading represented (or might eventually represent) an automation of quantitative approaches to market trading, and to asset management more generally. The subsequent discussion considered a number of variations on this theme.

One thread concerned the performance of quantitative investment strategies; these were seen by some as having failed to live up to their initial promise, though there are various possible explanations:

- A 'Prisoner's Dilemma' dynamic whereby 'quant' strategies work well as long as only a few traders adopt them, but become self-defeating when adopted more broadly;

- A 'selective vision' aspect of quant strategies that downplay unquantified (possibly unquantifiable) information – to the extent that such strategies are widely adopted, they become self-fulfilling until a disruptive collapse occurs;

- A 'complexity' phenomenon whereby the active use of quant strategies makes market information progressively harder to interpret and predict, leading to ever-shorter trading horizons and ever-worse medium-term forecasting, and thence to shorter market positions; and

- A 'common knowledge[6]' process, in which quant strategies embodying assumptions of common knowledge of key information and of Bayesian optimisation become increasingly vulnerable to 'irrational' behaviour.

It was noted that computerisation of valuation and automation of information flows and trade execution could affect each of these mechanisms; the key issue was the degree to which the impacts of automation would vary with the ascendency of quant strategies and an emphasis on trading profits over longer-term and 'real economy' returns.

The group noted that this picture could be affected by pending policy changes. For instance, it was argued that the implementation of the Dodd-Frank Wall Street Reform and Consumer Protection Act[7] in the US will increase the costs and decrease the scope of quant strategies.

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[6] This is a technical term with a specific meaning. An event is common knowledge if everyone knows whether or not it has occurred, everyone knows that everyone else knows whether or not it has occurred, everyone knows that everyone knows this, etc. *ad infinitum*.

[7] The full text of the Act can be found at: http://www.sec.gov/about/laws/wallstreetreform-cpa.pdf.

Another thread concerned the progress of computer-based trading – whether it is inevitable that more investing (as opposed to price-making) will be computerised. Some participants thought that the same niche could be filled by e.g. ETFs to some extent.

Following on from the scenario-based discussion of volatility, some participants wondered whether policy makers had presumed that computer-based trading would automatically lead to greater volatility, or to a different kind of volatility. To the extent that recent evidence points to a drop in volatility from the peak levels of 2007/8, the latter may be a more salient question.

Finally, regardless of cause, there seems to be evidence of continuing flash events, albeit on a smaller and more localised scale. The group considered the possibility of reorganising financial markets to prevent such events from getting out of hand, perhaps without the need for automated circuit-breaker rules.

4.2. Information flows and data mining

Automated trading strategies must make use of increasing volumes of information flowing through the markets. The group discussed the implications of technical approaches to filtering this traffic. Semantic analysis programmes are increasingly used to screen for relevant information – information likely to move the market. The group noted the circularity of this screening process - i.e. that information deemed likely to move the market is used by computer-based trading to place orders, and thus to move the market. Other aspects of this topic included the growing use of big data analytics – in particular the extent to which simple correlations, financial economic models and/or network structure-based models might thrive in the future market environment. One table also pointed out that human intelligence had thus far proven far more effective at spotting emerging patterns and identifying important weak signals, though this was probably most effective after automated screening to reduce the flood of information to a manageable volume.

A related issue concerned the common knowledge assumption. Put simply, many models used by traders and by market analysts who study the collective behaviour of traders assume that some aspects of information and the processes used by others to reach decisions are common knowledge. Indeed, prices in an efficient market aggregate information in such a way that all traders behave as though the information revealed about the likelihood and severity of risks was common knowledge. However, the process by which common knowledge is achieved involves successive rounds of trading and inference based on previous prices. If traders behave irrationally, prices may be misinterpreted; if traders do not respond quickly enough, others may mistakenly infer that they see no reason to trade; if traders only pay attention to part of the available information, their behaviour may be misleading; and if markets are not sufficiently transparent, it may not be possible to associate specific price movements or trades with information known (or believed to be known) by specific traders. To the extent that computer-based trading increases the amount of potentially relevant information available and the likelihood that traders will respond out of sequence or on the basis of partial information, common knowledge may become at once harder to attain and less relevant as a modelling benchmark.

Chapter 5. **Preliminary conclusions**

The scenarios are intended as input into the project; only limited conclusions can be drawn directly from them on their own, not least because the participants considered each scenario separately. This is appropriate, because the scenarios depend on a mix of exogenous and endogenous factors lying well outside the scope of the project. However, some tentative conclusions can be formed. As regards the criteria for market performance:

• Liquidity will increase in in the high-growth open scenario, but episodes of localised illiquidity are likely to persist if growth is limited or markets are relatively closed;

• In most scenarios, volatility will continue to abate, at least in overall terms, though localised volatility of prices and real returns may persist);

• Price efficiency and price discovery *processes* become more efficient, but the *outcomes* are only better if information flows are unimpeded. Otherwise, selective or biased information is rapidly reflected in prices;

• Technical innovation may lower transactions costs across the board, but closed markets and regulatory barriers may selectively raise them, especially for cross-border transactions; and

• Limited growth or closed markets are likely to have low market integrity.

More generally:

The pace and global uniformity of macroeconomic recovery will affect household disposable income, public expenditure and business demand for particular forms of investment capital, and thus have a strong impact on the demand for assets and for the services of financial intermediaries. An uneven recovery may lock-in global imbalances and automated trading is likely to facilitate this process. Conversely, CBT can help to ensure that economies recovering together remain 'in touch.'

The potential loss of a riskless asset and/or a strong national lead for the global economy may contribute to a prolonged period of instability; this could lead to major shifts in geopolitical and economic power and further waves of innovation, or to a revived – and strongly regulated – period of stability and stasis. CBT-powered trading can contribute both to the cause (e.g. by facilitating speculative attack on currencies or magnifying short-run default pressures) and the cure.

Demographic factors such as population ageing and migration are likely to affect global savings rates and the demand for more-or-less risky assets. These effects could go either way. Population ageing will increase both the number and proportion of older investors. Those older citizens with money to invest and greater life expectancies than previous generations might demand low-risk, institutionally-invested assets. Alternatively, given their rising levels of education, ICT skills and access to capital markets, they could seek return more aggressively, using retail trading to manage their own portfolios of higher-risk assets. The latter possibility may be particularly likely if they have access to HFT tools and if a sluggish recovery means that returns to safe portfolios – and levels of public expenditure for old-age benefits - are inadequate. Even if the world economy does grow, changes in preferences for high vs. assured

returns are likely to affect demand for high-frequency market trading vs. algorithmic trading and asset management. National differences in the demographic transition are thus likely to induce major shifts of international capital, creating a feedback loop with global recovery.

Finally, CBT may change the framing of regulatory issues by policy makers, but is not a unique cause of current problems. Indeed, the spread of CBT seems to be associated with increased efficiency, at least according to some measures. What is clear, however, is that future regulation – of whatever form – will need to take the specific characteristics of CBT into account.

Annexes

5.1. Invited Participants

Name	Position	Organisation	Country
Invited participants			
Armstrong, Angus	Director of Macroeconomic Research	NIESR	UK
Barbieri, Riccardo	Chief European economist	Mizuho International	UK
Barr, Malcolm	Economist	JPMorgan Chase	UK
Bate, Nick	UK Economist	Bank of America Merrill Lynch	UK
Bootle , Roger	Economist	Capital Economics	UK
Buckley, George	Chief UK Economist	Deutsche Bank	UK
Buiter, Willem	Chief Economist	Citigroup	UK
Carnell, Rob	Chief International Economist	ING	UK
Dixon, Peter	Global Equities Economist	Commerzbank	UK
Foley, Patrick	Chief Economist	Lloyds Banking Group PLC	UK
Gardner, Robert	Chief Economist	Nationwide Building Society	UK
Hatheway, Larry	Chief Economist	UBS	UK
Hilton, Andrew	Director	CSFI	UK
Huang, Haizhou	Chief Strategist	China International Capital Corporation (UK) Limited	China based in UK
Jagirdar, Brinda	General Manager & Head of Economic Research	State Bank of India	India
King, Stephen	Group Chief Economist	HSBC PLC	UK
Loyo, Eduardo	Latin American Chief Economist	BTG Pactual	Brazil
Lyons, Gerard	Chief Economist	Standard Chartered PLC	UK
McLaughlin, Andrew	Chief Economist	The Royal Bank of Scotland Group PLC	UK
Miles, David	Monetary Policy Committee	Bank of England	UK
Naisbitt, Barry	Chief Economist	Santander UK	UK
O'Neill, Jim	chief economist	Goldman Sachs	UK

Name	Position	Organisation	Country
Pryce, Vicky	Senior Managing Director	FTI Consulting	UK
Roberts, Richard	SME Market Analysis Director	Barclays PLC	UK
Supple, Des	Head of Fixed Income Research	Nomura International PLC	UK
Tinsley, David	Chief UK Economist	BNP Paribas	UK
Wang, Yan	Quantitative Analyst	Bank of China (UK) Limited.	China based in UK
Weale , Martin	Monetary Policy Committee	Bank of England	UK
Facilitators and study team			
Cave, Jonathan	Senior Research Fellow	RAND Europe	UK
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Pisani, Mario		GO-Science	UK
Gershlick, Jonathan		GO-Science	UK
Davenport, Piers		GO-Science	UK
Lazaro, Jorge		GO-Science	UK
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Goodhart, Charles	Professor of Finance,	London School of Economics	UK
Zigrand, Jean-Pierre	Reader in Finance	London School of Economics	UK
Houstoun, Kevin	Chairman	Rapid Addition	UK
Linton, Oliver	Chair of Political Economy	Cambridge University	UK
Bond, Philip	Visiting Fellow	Oxford Centre for Industrial and Applied Mathematics	UK

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