BANK OF ENGLAND

Speech

Financial arms races

Remarks by

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Elephant seals have got too big for their beaches. A large specimen might weigh over 8000 lbs (3700 kg).[1] Their size has a simple evolutionary explanation. Large males fight for the right to mate with a whole beach full of females. For elephant seals it is, quite literally, winner-takes-all. And the key to winning is simple – size. No-one is going to argue with a male swinging around his proboscis on the beach. In that way, size has become the dominant gene in the evolutionary trajectory of the elephant seal.

But size is not costless for the elephant seal. It makes them easy prey on land. At times in the past, this has threatened their very existence. In the 18th century, their main land predator - man - hunted elephant seals for their blubber and fur. In the 19th century, their numbers fell rapidly to below 100 and for a time they were believed to be extinct.[2] Just in time, governments intervened to place restrictions on hunting, nationally and internationally. Today, elephant seal numbers have swelled to above 800,000. The hand of government has protected them from man – and from themselves.

The pattern is found throughout the animal world, in features as conspicuous as over-sized antlers and over-elaborate plumage.[3] In many cases, these physiological features have evolved as a response to a competitive sexual race, a Darwinian tournament. Matthew Ridley calls this the *Red Queen Race* from the Alice in Wonderland scene in which "however fast they went, they never seemed to pass anything.[4] As elephant seals, deer and peacocks can attest, it is a race in which, in their quest to win, the species as a whole may end up as loser.

So nature can deliver an evolutionary equilibrium which is sub-optimal for its participants, a market failure. The more intense the competitive race, the greater this market failure or co-ordination problem. Elephant seals would prefer to co-ordinate on a lower-blubber equilibrium, deer on a shorter-antler equilibrium, peacocks on a smaller-tail equilibrium. Competition prevents them from doing so. If there were a benign, enlightened zoological planner, able to compel less-conspicuous features, this would benefit not only each animal but the species as a whole. Unfortunately, there is not.

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These inefficient Darwinian equilibria are as common in social as in natural systems. Garrett Hardin's 1968 classic *Tragedy of the Commons* uses the metaphor of individual herdsmen grazing their cattle on common land. "Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited. Ruin is the destination to which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons".[5] Therein lies the tragedy, the market failure. This situation is made more, not less, tragic by unbridled competition.

[1] Byatt et al (2001).
[2] Science News (1983).
[3] Frank (2011).
[4] Ridley (1993).
[5] Hardin (1968).

The tragedy of the commons is one example of an age-old problem of military arms races. The incentives of individual players, and outcomes for society, are much the same as in commons tragedies. Individual country incentives are to increase military might, to leapfrog opponents to improve national security. But this game of leapfrog is a Red Queen Race. The quest for national safety results in a steady rise in military spending and a steady fall in both societal and national security. The common good is jeopardised.

These arms-race dynamics, and commons tragedies, have a history in economics too. It is not just plumage that is conspicuous. As Thorstein Veblen set out at the end of the 19th century, so too is consumption.[6] Some goods serve as a signal of social standing: they are positional. Not everyone can have the apartment which is closest to the sea. As in other arms races, the equilibrium is a sub-optimal one – a competitive shopping war in which everyone conspicuously over-spends.

And so it is with economic behaviour more generally. Surveys indicate that relative income and wealth are crucial to perceptions of happiness.[7] Economic theories of wages, asset prices, employment and consumption often embed concerns about relative standing.[8] When making many of life's choices, it appears to be important to "keep up with the Jones's", to earn and spend with reference to one's neighbour. This concern with relative standing sows the seeds of arms-race behaviour.

Finance is far from immune to these pressures. Indeed, some structural features of the financial system make it particularly prone to arms-race behaviour. One such structural feature is information asymmetry. Imperfections in information generate risk. Finance provides an information bridge between end-savers and investors, thereby prospectively reducing risk. Success in finance means forming that bridge at least cost and risk to those travelling across it.

But judging how much risk is really being taken, and whether it is being managed well, is rarely easy for either end-savers or end-borrowers. Risk shows its true face perhaps only once in a generation. So as much as investors might wish to risk-adjust their returns, this is a daunting informational task. Facing this problem, many participants in the financial system (investors, managers, trustees, remuneration committees, pay consultants etc.) have resorted to simpler, indirect metrics to gauge skill in navigating risk.

Ranking is one such performance metric. It provides a simple way of ordering the apples, the oranges – and in particular the lemons. Indeed, in the face of acute uncertainty, ranking can be the optimal inference strategy.[9] This explains the ubiquity of league tables across the financial sector when judging everything from investment performance to financial deal-making. But ranking has an unfortunate side-effect. By hard-wiring relative standing, it builds in arms-race behaviour among financial participants.

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6 Veblen (1899).
7 For example, Layard (2005).
8 For example, Dusenberry (1949).
9 Lazear and Rosen (1981).

A second structural feature of finance, which generates similar incentive effects, is maturity transformation. Banking involves borrowing short in a capital-certain instrument to lend long through a capital-uncertain instrument. When doubts creep in about this balance sheet structure, investors run on the bank knowing it is first-come, first-served. They are engaging in a liquidity arms race, penalising those behind them in the queue. These actions are individually rational but collectively self-defeating if the bank goes bust.[10]

A third structural feature is that some markets for financial services are winner-takes-all tournaments, like elephant seals seeking mates on the beach. Whether it is making markets in financial instruments, lead underwriting a debt or equity issue or advising on a merger or takeover, there is typically only one winner. They take all. Tournaments like these lead to arms-race behaviour as firms seek to leapfrog one another in their competitive quest for top-dog status. In finance, this can lead to the winner being "cursed" and to everyone else over-competing by under-pricing risk.

Financial arms races are scarcely a new phenomenon. How different history might have been had Chuck Prince heeded JP Morgan's words from a century earlier: "I made a fortune getting out too soon". Although not new, the liberalisation of financial services over the past 30 years, and the accompanying increase in financial scale, has probably increased arms-race pressures. As banks have piled on the pounds, their fights on the beaches have intensified. The stronger those competitive forces, the quicker an arms race escalates.

In what follows, I discuss three examples of modern-day arms races in the financial sector: races in return, races in speed; and races for safety. These are examples from the past, present and future respectively. In each, a competitive battle for relative dominance results in an evolutionary equilibrium which is sub-optimal, individually and socially. They are latter-day tragedies of the financial commons.

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By any historical metric, the pre-crisis period was an extra-ordinary one for the financial sector. This is no better illustrated than in the returns to financial sector labour and capital. Between 1989 and 2007, the nominal gross value added of UK financial intermediaries rose more than threefold, or by about 8% on average per year. Over the same period, value-added of the non-financial corporate sector rose by about 5½% per year.

More commonly-used performance measures in banking are returns on equity and executive compensation. These rose even more dramatically over the period. Returns on equity for UK banks rose from on average 1% in 1989 to 38% by 2007. This pattern was mirrored among other major global banks where returns rose

[10] Diamond and Dybvig (1983), Brunnermeier and Oehmke (2010).

from 8% to 22% (Chart 1). The only even broadly comparable period in banking history was in the early part of the 20th century when UK banks' return on equity averaged 13% (Chart 2).

Measures of executive compensation rose even more dramatically. UK bank CEO compensation rose by 13% per year on average between 1989 and 2007, from $0.5 million to $4.3 million. US bank CEO compensation rose from $2.8 million to $26 million, also by 13% per year (Chart 3). Over the same period, compensation in the non-financial sector rose by around 4% per year in the United States.

As Thomas Phillipon and Ariell Reschef have shown, that Himalayan rise in bank executive salaries made the financial sector salary boom of even the 1920s look like a foothill.[11] In 1980, a similarly-skilled individual earned about the same in investment banking as in the non-financial sector. By 2005, that same person would be benefitting from a salary four times that of their non-financial sector counterpart.

What explains this extra-ordinary period of high returns in finance? Arithmetically, the answer is simple – leverage. The pre-crisis rise in returns on bank equity can be explained almost fully by higher bank leverage.[12] Equity returns inflated in line with bank balance sheets. So too did bank CEO salaries. The increase in pre-crisis bank CEO salaries can be fully explained, arithmetically, by high and rising returns on bank equity.[13] Javier Gabaix and Augustin Landier have shown that levels of CEO pay generally are well-explained by their market capitalisation – the bigger the market cap, the bigger the bonus.[14]

But what drove those behaviours in the first place? It was a classic financial arms race, a case not so much of "keeping up with the Jones's" as "keeping up with the Goldmans".[15] From the early 1990s onwards, league-leading firms began posting high returns on equity. Those firms with lower relative returns, who languished in the league, found themselves with sand kicked in their face. They felt obliged not just to keep pace but to leapfrog, to shake their tail feathers. The lower their rank, the greater these market pressures.[16]

Facing these competitive pressures, the best-response strategy for languishing banks was simple – gear-up. They added to their waistlines to compete with the dominant male in the pack. Like Hardin's cattle herdsmen, they multiplied their numbers. Leverage delivered an instant leapfrog in returns on equity, a conspicous display of rich plumage.

High equity returns also added fuel to the parallel race in financial sector pay. With equity-based remuneration contracts increasingly dominant, high equity returns added directly to pay packets. And with remuneration committees and pay consultants using relative pay as a reference, an arms race in remuneration took hold. As wages and equity returns ascended, the races in pay and returns joined forces.

[11] Phillipon and Reschef (2009)
[12] Haldane (2011a).
[13] Haldane (2011a).
[14] Gabaix and Landier (2008).
[15] Aikman, Haldane and Nelson (2010) provide a formal, multiple equilibrium model of this phenomenon.
[16] McLean and Nocera (2010).

That spiral defined the pre-crisis arms race in financial returns. It generated an equilibrium of synchronously high returns and pay, as banks unilaterally militarised as defence against their competitors. But as in military arms races, the resulting outcome was a sub-optimally risky one. High equity returns came through risky leverage. And high pay, especially in equity-based forms, further encouraged risk-taking.[17] The resulting high-leverage equilibrium sowed the seeds of the financial crisis.

With hindsight, it was easy to spot this market failure, the co-ordination problem. Banks and the financial system as a whole would have been better off had there been a benign, enlightened regulatory planner, able to co-ordinate banks on a lower return equilibrium. Unfortunately, there was not.

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Over the past decade, trading in financial markets has undergone a technological revolution.[18] The frontier of this revolution is defined by speed. A decade ago, trade execution times were measured in seconds. A few years ago, they were measured in milliseconds. Today, they are measured in microseconds. Tomorrow, it will be nano-seconds or pico-seconds. For technologists, this is a "race to zero" – the promised land of zero latency where execution times converge on the speed of light.[19] For social scientists, this is a financial arms race, a sub-second game of leapfrog.

In their quest for speed, a number of firms are also engaged in a positional race. The shorter the cable to the trading exchange, the faster a trade can be executed. This has encouraged some firms to begin relocating their servers as close as physically possible to the trading exchange – so-called "co-location". This is the financial equivalent of seeking the apartment closest to the sea. It, too, fuels arms-race behaviour: "however fast they went, they never seemed to pass anything".

Accompanying this shift in speed has been a dramatic change in the composition of trading and market-making. During this decade, so-called High Frequency Trading (HFT) has come to dominate. It now accounts for anywhere between a half and three-quarters of trading volume on the world's major equity markets and a rising share of futures and other derivative markets.[20] In some markets, HFT firms have become the de-facto liquidity providers or market-makers.[21] Historically, designated market-makers were often granted privileges in return for agreeing to ensure trade and price continuity. No longer: the sleek have inherited the earth.

[17] Cheng et al (2010), Fahlenbrach and Stulz (2009).
[18] See, for example, Foresight (2011).
[19] "Latency" refers to the time it takes from sending an order to it being executed.
[20] Haldane (2011b), Mackenzie (2011).
[21] Menkveld (2012).

This emerging topology of trading has had some clear benefits. This is manifest in narrower, sometimes dramatically narrower, bid-ask spreads for trading.[22] For equity markets, these have fallen by an order of magnitude since 2004. This is typically taken as evidence of improved market liquidity and price efficiency.

But this dominant role for HFT, in their race to zero, has also had some potentially less benign side-effects. Take order cancellations. All market participants cancel some of the orders they place before they are executed. HFT firms have taken this to new levels, submitting many (many) more order messages than they are willing to execute. A decade ago, ten orders might be cancelled for every one executed. Today, that order cancellation ratio can be closer to 60 (Chart 4).

There are some good reasons for order cancellation, including the arrival of price news after an order has been placed. But there are, too, some potentially jarring side-effects. With HFT firms serving as de-facto market-makers, but with the vast majority of their orders cancelled, many on-screen quotes may not actually be executable. This creates a potentially misleading picture of market resilience, a mirage of liquidity.

Second, because bandwidth is finite, submitting multiple quotes may slow down activity by competitor traders. This practice of clogging competitors' screens is known, accurately if inelegantly, as "quote stuffing".[23] It is a classic congestion externality or commons tragedy.

These externalities are not hypothetical. They have already shown their face in the extra-ordinary dynamics in market prices for an hour on 6 May 2010, the "Flash Crash". Market dynamics during that period are yet to be given a fully-convincing explanation. But some aspects are documented. One is the disappearance of liquidity and market-making by HFT firms for a period during the Flash Crash. The mirage of liquidity proved just that. That evaporation appears to have played a key role in propagating stress during the Flash Crash.[24]

So too did message traffic congestion. One side-effect was to slow-down price discovery across exchanges. Many traders firms found themselves observing stale prices. As a result, identical stocks traded at different prices across exchanges (Chart 5). In principle, this represented an arbitrage opportunity. In practice, arbitrage relies on costless trading and, at that time, trades could not have been executed at any price.

The Flash Crash was short-lived. Some have argued the lessons have been learned. Yet it appears to have been anything but a flash in the pan. In the period since, researchers have identified a large number of "mini-Flash Crashes", with temporary dislocations in prices in markets as varied as Japanese yen and cocoa futures.[25] As with the Flash Crash, there appears to be no convincing explanation for these gyrations.

[22] Angel et al (2010).
[23] Egginton et al (2012).
[24] CFTC-SEC (2010).
[25] Johnson et al (2012).

The uncertainties and externalities associated with the race to zero are one candidate explanation. Liquidity mirages and message traffic congestion are nibbling away at the common good of market stability. The competitive quest for individual speed risks a fragile evolutionary equilibrium. If there were a benign, enlightened regulatory planner, able to co-ordinate the actions of traders on a lower-velocity equilibrium, the Flash Crash might have been forestalled. Unfortunately, there was not.

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The pre-crisis quest for return has, over the past few years, been replaced by a quest for safety. Return on capital is no longer investors' priority. Return *of* capital is. That risk-aversion is manifest in high risk premia on a wide range of risky assets and abnormally low yields on a range of risk-free assets. It is also evident in investors' desire for financial instruments which are secured on high-quality collateral. Investors are taking literally the notion of a security.

That desire for security has had a particularly pronounced impact on banks, which are refinancing large legacy asset portfolios. The cost of refinancing those portfolios has increased dramatically since the crisis, particularly for instruments lower-down the creditor hierarchy. The cost of unsecured borrowing by European banks has increased roughly 27-fold since 2007, while the cost of borrowing against high quality assets has risen "only" 16-fold.

These relative price effects have shaped importantly banks' financing choices. A large and rising fraction of global banks' refinancing has taken place on secured terms. In 2007, the majority of term refinancing of European banks' debt was on an unsecured basis. By 2011, secured and unsecured refinancing were roughly balanced. In 2012, secured financing is likely to take the lead (Chart 6).

For example, euro-area banks have roughly €1.1 trillion to refinance in 2012, 80% of which is unsecured funding coming due. So far during 2012, only 20% has been rolled on unsecured terms, with the lion's share on a secured basis (Chart 7). Central bank financing has played its part in this shift. Of the €600 billion raised on secured terms by euro-area banks so far in 2012, 80% has been associated with the ECB's long-term refinancing operations.

Gauging levels of secured financing by commercial banks is difficult. Technically, the fraction of banks' liabilities that are secured against their assets is often called encumbrance. But data on banks' encumbrance levels are thin on the ground. Where data exist, they are rarely on a consistent basis across banks. Some recent studies have suggested that the encumbrance ratios of banking systems within Europe may lie anywhere between 3% and 40% of their liabilities.[26]

[26] For example, Barclays Capital (2012).

That is the arithmetic. But what explains this behaviour? This, too, appears to have an arms-race element. Consider an unsecured creditor about to refinance. The larger the existing fraction of secured financing, and the greater the uncertainty about this fraction, the greater will be their incentive to seek security. Not to do so runs the risk of other creditors leapfrogging ahead of them in the seniority queue. Creditors' incentives are very similar to those during a bank run, except with investors now seeking security rather than immediacy.[27]

As with a bank run, this dynamic risks becoming self-fulfilling. The greater the level of, and risk around, encumbrance levels, the higher the return unsecured creditors will demand given the risks of subordination. And the higher this cost, the greater banks' incentives to finance instead on secured terms. Both banks and their individual investors have incentives to encumber the balance sheet by progressively – and self-fulfillingly – larger amounts. There is an arms race spiral.

Yet the equilibrium of this seniority game is unlikely to be an optimal one, either for individual investors or for the financial system as a whole. To queue-jump is ultimately futile for creditors; it is another Red Queen Race. Not everyone can be at the front of the seniority queue. Indeed, at high levels of encumbrance, the financial system as a whole may even be riskier, as it is more susceptible to pro-cyclical swings in the underlying value of banks' assets. The quest for individual security generates system-wide instability.

So under an arms race to safety, the like of which may be currently underway, the outcome for the financial system could be both socially and individually inefficient. If there were a benign, enlightened regulatory planner, able collectively to co-ordinate investors and banks on a lower-encumbrance equilibrium, this race for safety could be forestalled. Unfortunately, there is not.

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What public policy lessons might be drawn from these financial arms races? First, because they generate sub-optimal outcomes, policy intervention can be justified. This policy intervention ought to act like a self-denying ordinance for financial firms, a protection against themselves. It ought not to be a tug-of-war between regulator and regulated. Rather, it aims to defuse a competitive tug-of-war among regulated firms.

Second, to be effective this intervention needs to constrain behaviour across the financial system as a whole; it requires multilateral disarmament. Acting to constrain only those at the top of the league (those bearing most risk, trading at greatest speed, seeking greatest safety) will do nothing to defuse competitive pressures lower down the pecking order. Indeed, it might even conceivably intensify the competitive scramble. In the language of financial regulation, policy needs to have a *macro*-prudential, as distinct from *micro*-prudential, perspective.[28]

[27] Gai and Shin (2004) develop a model of a race to the exit, with investors seeking progressively to shorten the maturity of their investment to reduce risk.
[28] Bank of England (2011a).

The need for a system-wide perspective to preserve the public good of the commons was recognised by Garret Hardin almost 50 years ago. It has been increasingly recognised by financial regulators over the past five years. Over that period, we have seen the emergence of explicitly macro-prudential agencies charged with safeguarding systemic risk in a number of countries. In the United States we now have a multi-agency Financial Stability Oversight Council (FSOC), in Europe the multi-country European Systemic Risk Board (ESRB) and in the UK the Financial Policy Committee (FPC).

Third, what tools might such agencies bring to bear in tackling financial arms races in return, speed and safety? With hindsight, it is not difficult to identify instruments which might have slowed the pre-crisis race for excessive returns in banking. The most direct and effective would have been to place tighter constraints on banks' leverage. This would have defused the return on equity race at source. The FPC has prioritised the leverage ratio as a macro-prudential instrument in its recommendations to date.[29]

A complementary approach would have been to require banks to adopt performance metrics which did a better job of adjusting for risk. At the end of last year, the FPC raised concerns about the use of return on equity metrics by banks which generate incentives to shrink equity to hit return targets.[30] Some institutional investors have raised similar concerns – and are showing encouraging signs of acting on those concerns. After all, it is not difficult to devise performance metrics which would do a better job of adjusting for risk, such as return on bank assets.

There is some evidence recently of return on equity targets having become a less important determinant of some banks' portfolio allocation and executive pay decisions. But equity returns remain hardwired into both to some degree. Moreover, many global banks continue to publish return on equity targets. This continuing attachment to counter-productive performance metrics is a puzzle – and a worry. As long as it remains the case, it raises questions about whether the lessons from the crisis have truly been learned.

Races in financial sector pay can also be tackled, albeit indirectly, by placing restrictions on leverage and by avoiding linking remuneration to return on equity targets. Restrictions on cash distributions by banks to shareholders and staff can also help. This has been a favoured recommendation of the FPC over the past six months, as a means of bolstering UK banks' capital defences against risks in the euro-area. In response, there is some evidence of UK banks having modestly reduced cash distributions to staff in 2011.

A more direct approach to tackling pay races would be to set remuneration codes. This can be justified as a regulatory means of leaning against excessive risk-taking incentives – incentives which might be fanned by remunerating in equity.[31] These have already been developed by the Financial Stability Board internationally and by the FSA in the UK. They specify, for example, maximum ratios of cash distribution and minimum

[29] Bank of England (2012).
[30] Bank of England (2011b).
[31] Bebchuk and Fried (2003).

periods of pay deferral. Yet whether these codes go far enough in aligning pay and performance, in equating risk and return, is an open question.

For example, consider the issue of pay horizons. Bonuses are typically set on an annual cycle, with deferral or claw-back for maybe three or four years if guidelines are followed. But this return cycle is materially shorter than the typical risk cycle. The risk cycle might last perhaps 20 years. This duration mismatch means it is more likely than not that risk and reward may get out of kilter in the financial sector. The current environment is evidence of such a mismatch: while bank performance has fallen off a cliff, executive pay remains close to pre-crisis Himalayan heights.

Lengthening deferral or claw-back periods, say to 10 years or more on an internationally co-ordinated basis, would help close this gap in horizons, between risk and return. It would elongate the period of liability bank managers face when they take on risk. This would better align firm-level risk-taking incentives with the societal optimum. Avoiding relative benchmarks in the setting of remuneration would also reduce the risk of an upwards-only pay escalator.

There is scope, too, for a reconsideration of the instruments used for remuneration. The focus to date has been on non-cash distributions, often in equity. But paying in equity appears in some pre-crisis cases to have exacerbated risk-taking incentives, acting as a disincentive to raising new equity and encouraging gambles for resurrection. Remunerating in long-maturity debt, or contingent capital instruments, may do a better job of aligning risk-taking incentives with the public good than either cash or equity.[32]

Speed races in financial markets potentially generate societal sub-optimality, for example due to message traffic congestion. As with road traffic congestion, one way to tackle that would be to place direct restrictions on excessive message traffic – for example, by setting maximum order cancellation ratios. The US Securities and Exchange Commission (SEC) are considering this option. So too are the authorities in Europe under the draft proposals contained in MiFID II. These are welcome moves.

New trading topologies also run the risk of turning the miracle of higher liquidity into a mirage in situations of stress. One potential response would be to strengthen market-making commitments. The past few years have seen a dilution of some of those commitments. For example, in 2008 the New York Stock Exchange relaxed its market-making commitments on maximum bid-ask spreads. One upshot was that, during the Flash Crash, the prices of some stocks hit zero and others $9999.99 – so-called “stub quotes”.

Following the Flash Crash, the SEC moved swiftly to ban stub quotes. This effectively re-introduced a requirement for market-makers to ensure price continuity. It has also been considering enhanced market-making obligations or incentives to improve the resilience of market liquidity in situations of stress. In

[32] Haldane (2011), Mehran and Mollineaux (2012).

Europe, MiFID II is looking at the scope for strengthening market-maker commitments for similar reasons. This would be a welcome turning-back of the trading clock – a clock otherwise at risk of running too fast.

Strengthening circuit-breakers across exchanges can also help to restore market order in situations of stress. They are means of automatically, if temporarily, halting the trading race if it gets out of hand – a multilateral disarmament device. Following the Flash Crash, the US authorities altered circuit-breaking rules so that they applied on an across-exchange basis to prevent stress simply migrating between exchanges. It would be useful if the revised trading proposals in Europe under MiFID II contained similar provisions.

Finally, safety races by bank investors are being explored by financial regulators. Over the past six months, the FPC has paid increasing attention to the systemic risk posed by rising levels of bank encumbrance. The FSA recently undertook a survey of UK banks' level of encumbrance which the FPC will consider later this year.[33] The issue is also being looked at internationally.

There are a variety of policy options to forestall self-fulfilling safety races. One would be greater transparency about levels of encumbrance. Lack of transparency creates an uncertainty premium in unsecured borrowing rates, encourages further secured financing and thereby speeds up the seniority race. Reducing that premium through greater transparency would tend to slow the race, if not stall it. An option for stalling the race would be to place maximum limits on levels of bank asset encumbrance. These would be similar in principle to prudential limits on bank leverage and large exposures.

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Systems, both social and natural, are characterised by a survival of the fittest. But for both, that competitive race can at times generate unhealthy outcomes for the system as a whole. In finance, these tragedies of the commons are, if anything, more likely than in other fields (seas, beaches and forests). The financial crisis attests to that. If there were a benign, enlightened regulatory planner, able to redirect competitive forces, this could potentially avert future tragedies of the financial commons. Fortunately, there is.

[33] Bank of England (2012), Bank of England (2011b).

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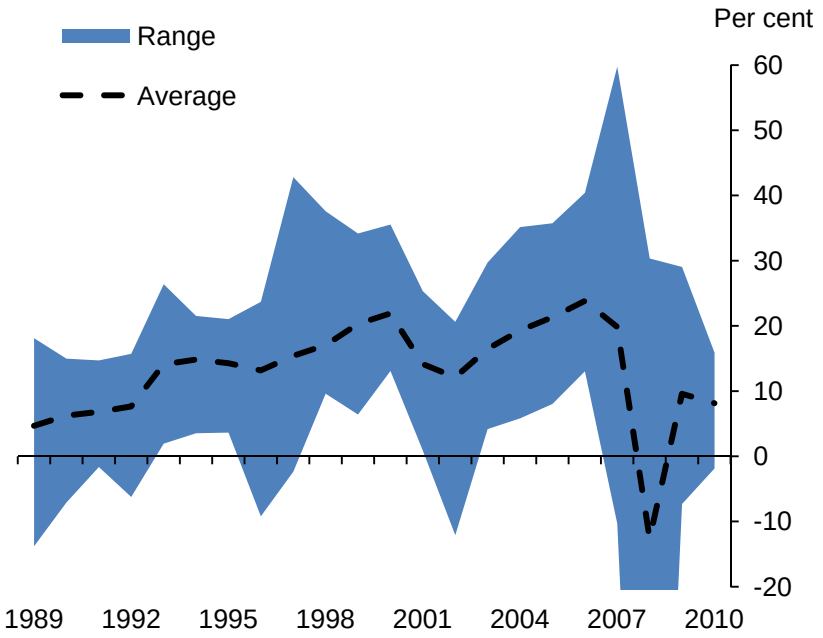
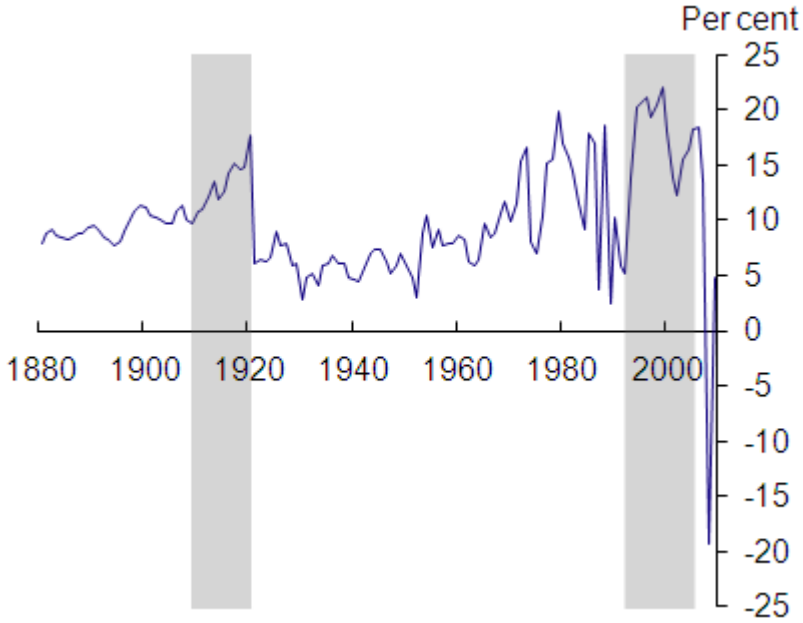
Chart 1: Return on equity for global banks



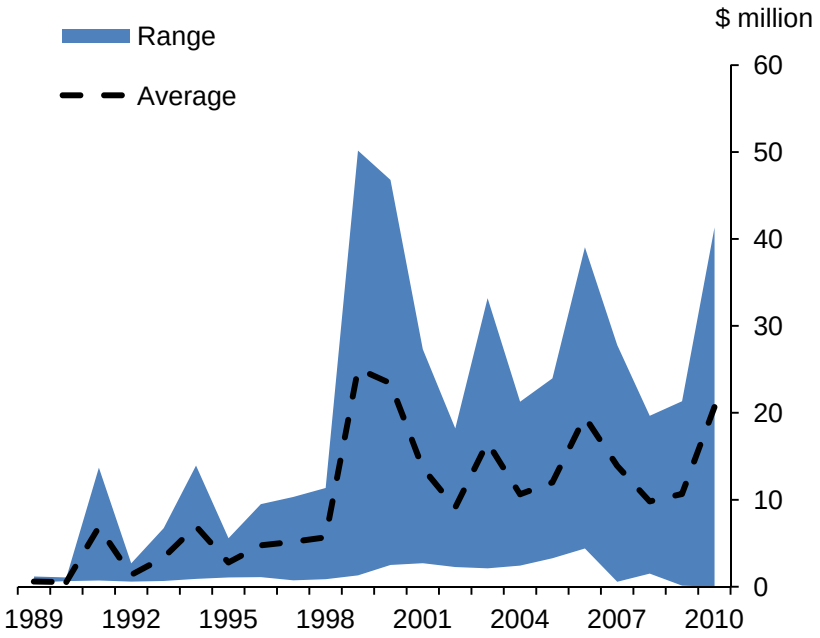
Source: Capital IQ, published accounts and Bank calculations.

Chart 2: Return on equity for UK banks



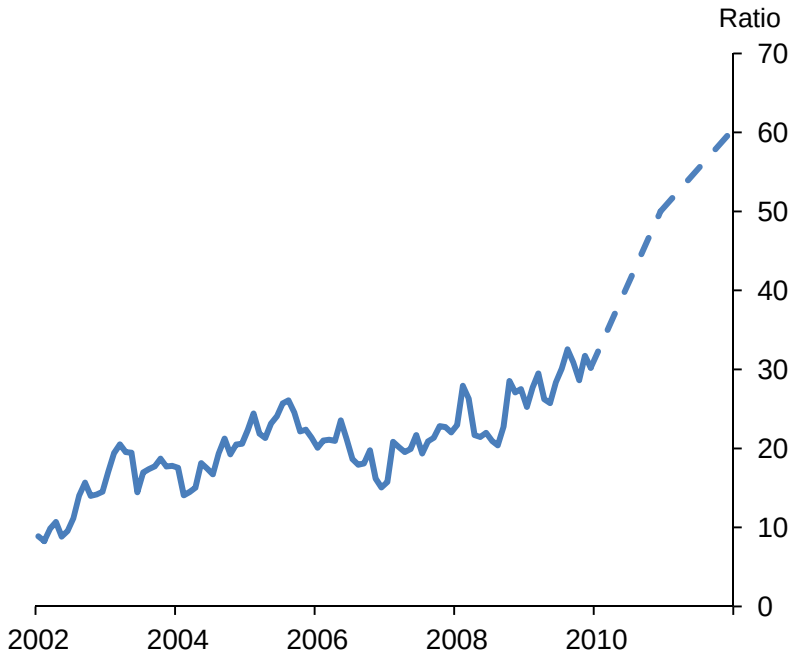
Source: Capie and Webber (1985), Billings and Capie (2011), British Bankers' Association, Megabank and Bank calculations.

Chart 3: Global banks' CEO compensation



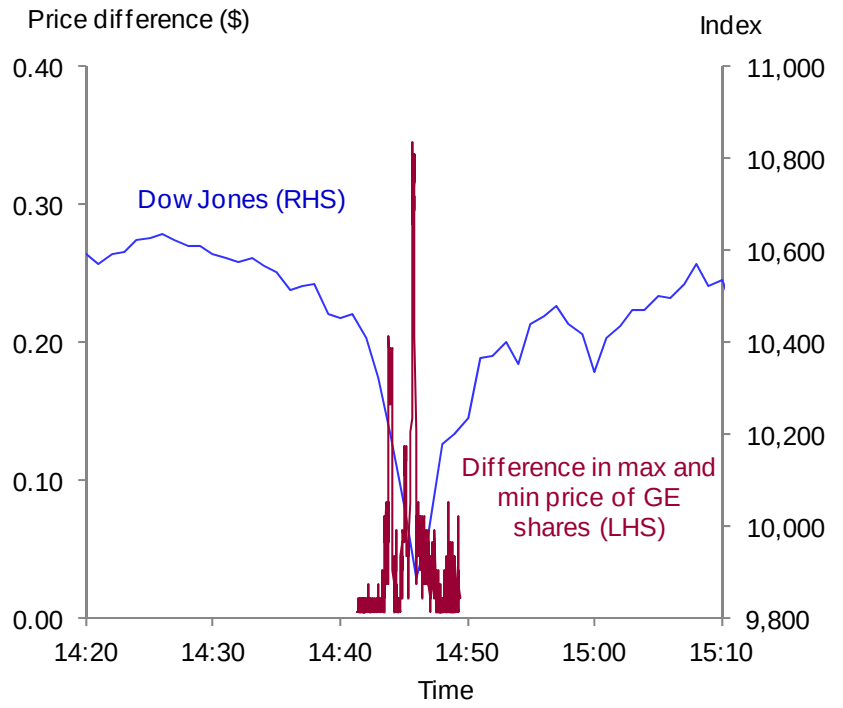
Source: Published accounts and Bank calculations.

Chart 4: Order cancellation ratios



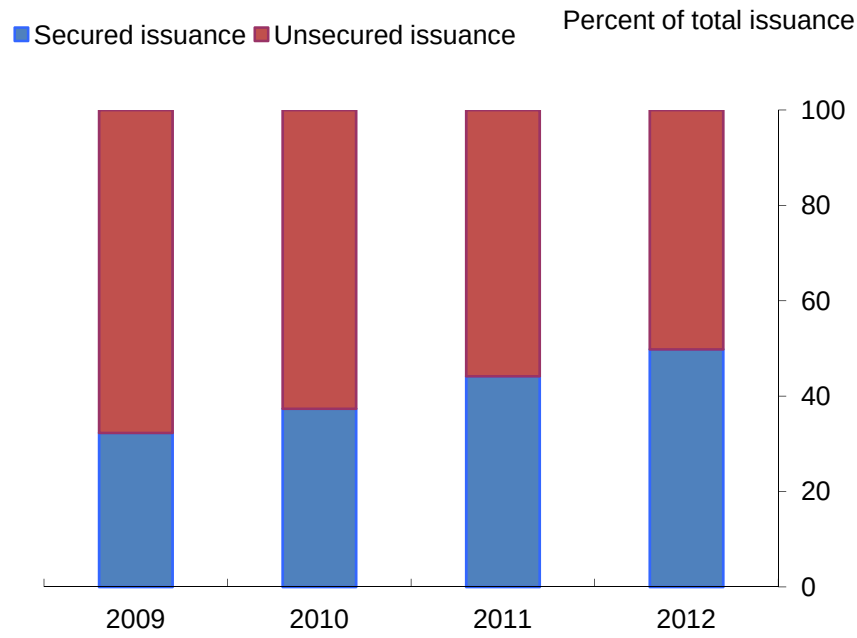
Source: Angel et al (2010), Nanex and Bank calculations.
Notes: Data before 2010 are for the Nasdaq exchange only and refer to the ratio of cancellations to transactions. Data for 2010 onwards refer to all US exchanges and are the ratios of quotes to transactions.

Chart 5: Flash crash dynamics



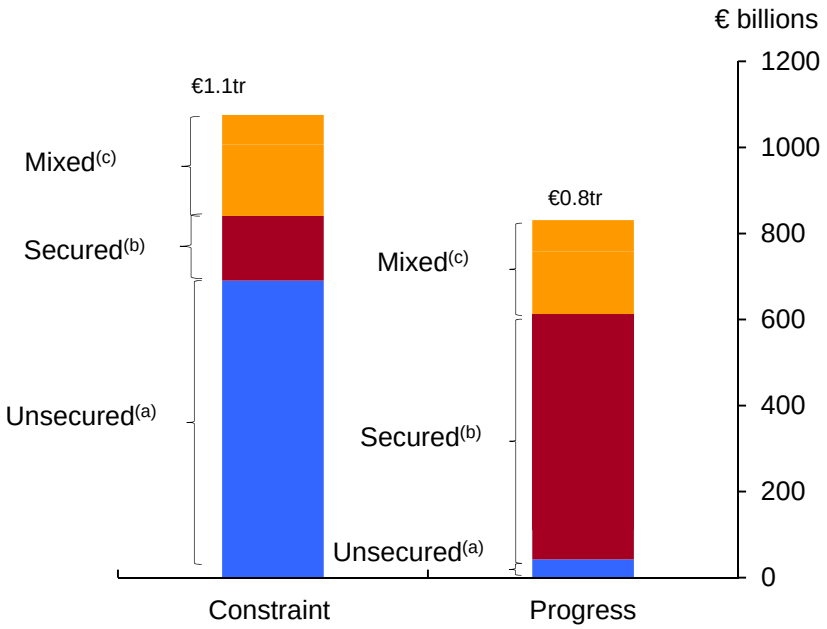
Source: Bloomberg, NANEX and Bank calculations.

Chart 6: Composition of European banks' term debt issuance



Source: Dealogic and Bank calculations.

Chart 7: Euro-area banks' refinancing challenge, 2012



Source: Dealogic, CPWare, Crane, SNL Financial, National Central Banks and Bank calculations.

(a) Senior unsecured funding issued in public markets with a maturity greater than 18 months.
(b) Covered bond issuance and net take up of central bank repo funding as part of the two ECB 3-year LTRO operations.
(c) Commercial paper issuance and exposures to US money market funds.