LONG FINANCE

A Wholesale Insurance Executive's Guide To Smart Contracts

A Long Finance guide prepared by Z/Yen Group
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Introduction

An abundance of new technologies and new technology interactions has created the buzz surrounding 'InsurTech', the emerging combination of insurance and technology. Smart contracts are an increasingly popular point of discussion as people realise that computer code can be embedded in distributed ledger technology. Yet, smart contracts do not need distributed ledgers and could promote straight-through-processing (STP) in the London wholesale insurance Market with current technology.

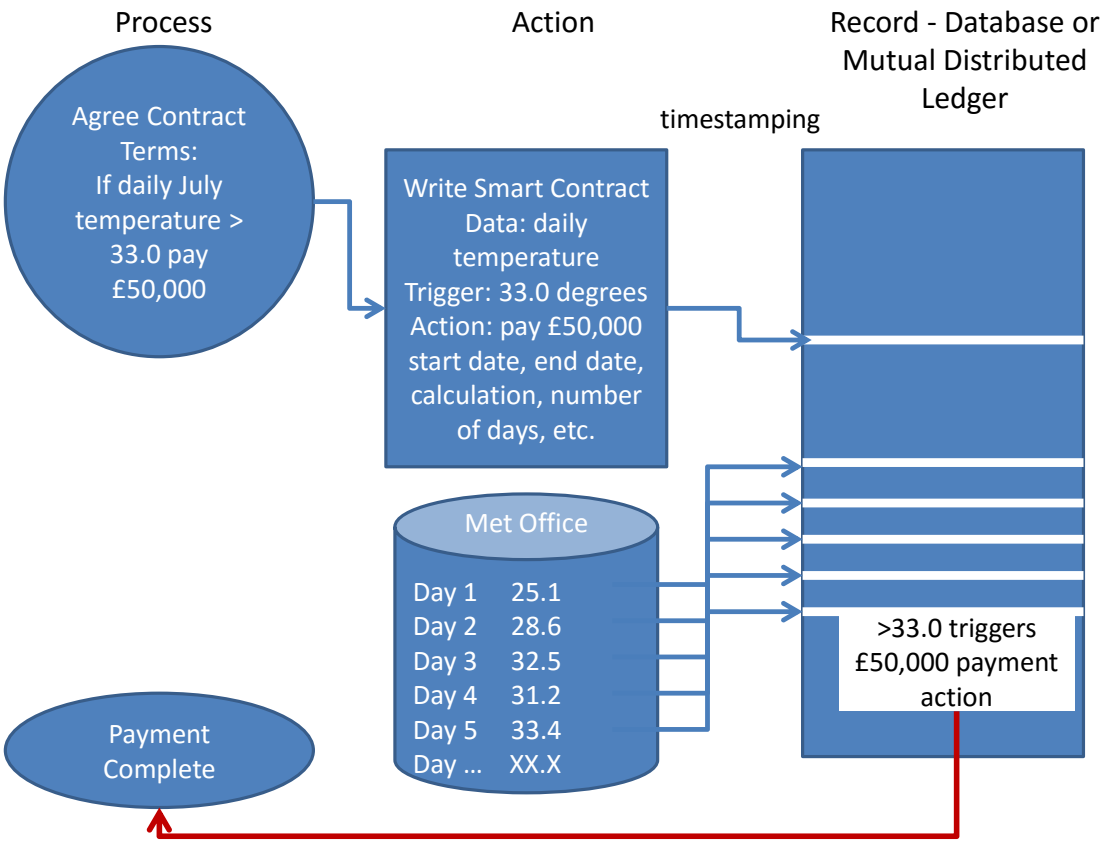
This guide aims to give insurance executives an overview of smart contracts that should aid them in discussions about the technology future of the Market. The guide tries to explain the concept, give a taste of the technology and applications, and look to the longer-term risks and rewards.

1. Why Smart Contracts?

Smart contracts can be an effective way of implementing 'straight-through-processing' (STP) in a complex environment, reducing costs and increasing speed of execution. They can also provide a framework for reducing legal risks. They have the potential to support efficiency and innovation in many areas of wholesale insurance through increased automation and new ways of processing.

2. What Is A Smart Contract?

A smart contract is "the implementation of contract terms as executable computer code". A simple example of a smart contract is a contract which pays $50,000 on every day in July when the temperature recorded by a given field on the Met Office website is above 33 °C.



The smart contract should mirror actual contract terms between the parties and execute specific contract requirements.

A smart contract is neither smart nor a contract. Rather, it is a code element containing two basic components:

- conditions which trigger action(s);
- actions to execute.

The smart contract should mirror actual contract terms between the parties and execute specific contract requirements. A memorable way of explaining this is 'time, test, trigger'. Parties agree on timings, the tests or conditions they will apply, and the action or trigger to be taken.

Smart contracts are not restricted to payments. For example, in the subscription process they could lock the amounts underwritten once the total reaches 100% and other conditions are met, and confirm to all parties. Similarly, over the life of a policy they could adjust the premium as particular events happen and send an update to the insurers, broker and client, with settlement of the cumulative adjustments at the agreed insured period(s).

If you can structure a smart contract in such a way that the contract can be 'encoded' with the appropriate agreement on times, tests, and triggers, then it can be unconfined. How smart can a smart contract be? This depends on what – if any – limitations are put on the executable code. One approach is to make the choice of code very restricted, for example only 'Pay the client recorded for this contract using the payments instruction file on the database for details' but not 'Pay X at account number Y'. Another approach is to allow more general purpose code, but more complexity brings more risk of error, fraud, or cyber attack.

Much of the literature on smart contracts links them to mutual distributed ledgers (aka blockchains), and to cryptocurrencies (such as bitcoin) but in a professional services environment such as wholesale insurance, where there is commercial trust among participants, smart contracts can be implemented on existing conventional processing platforms too and linked to conventional fiat currencies and settlement infrastructures.

3. What Can Smart Contracts Do?

As mentioned above, the concept of STP is a precursor to the use of smart contracts. In STP the parties to a contract validate the underlying data between them and thereafter all processing is automatic, minimising costs and errors and maximising speed. This can be represented as a simplified layer model:

Function	Process
Business rules & operations	approvals & confirmations
Control flow	sequencing & reporting
Data management	sharing & storing
Messaging	synchronising

Smart contracts provide another layer to this process, sitting above the business rules & operations to carry out the actual execution of code and providing a rigorous link to the legal contract itself:

Function	Process
Client	risk management
Insurance policy	risk transfer
Smart contracts	legally compliant actions

Business rules & operations	approvals & confirmations
Control flow	sequencing & reporting
Data management	sharing & storing
Messaging	synchronising

The discipline of linking the legal contract directly to the execution of the automated process via a smart contract creates benefits over and above STP.

4. What Could Smart Contracts Do Today In Insurance?

The London Market for wholesale insurance provides bespoke cover for specialist risks to large clients. At a processing level, this involves data-heavy interactions between multiple participants in a one-to-many value chain, in addition to large-scale processing within individual firms. Brokers, underwriters, and reinsurers compete and cooperate , creating a complex environment for agreeing cross-market structures. Smart contracts could perform many different types of functions, such as:

- control process flow – for example, instigate workflow actions such as initiate a claim agreement process on notification;
- agree subscription or claim – for example, as an agreement party to a subscription contract, when satisfied the claim is valid notify other subscribers of approval to pay;
- set liabilities or commitment - for example, update an adjustable contract premium based on supply of pre agreed data;
- interrogate data - for example, aggregate data, such as indices, without revealing detailed data;
- move money – for example, pay a claim on a contract trigger, such as when a flight is delayed.

There are numerous opportunities where smart contracts might help improve efficiency and reduce risk, including:

A. The 'Internet of Things'

A clichéd example of the Internet of Things, where all electrical things are connected to the internet, is a refrigerator that tracks your groceries and orders new supplies as things run low

However, there is already an internet-of-big-things uploading information to the internet, which could automate insurance processes. For example, aircraft, ships, and, increasingly, logistics vehicles

broadcast their GPS position in real-time. This could be used to identify when they enter high risk areas, such as a ship sailing into an area where there is a risk of piracy or an aircraft flying close to a war zone. A smart contract could adjust the insurance premium in real-time or take mitigating action.

Tracking performance of assets in real-time also creates the possibility that an insurer can move from simply providing cover to offering risk mitigation. For example, when a ship engine broadcasts data indicating a 25% chance that it may fail in the next 30 days, the insurer might calculate that it would be better to pay the owner to divert to a nearby port for repairs, rather than to let the ship continue its voyage and have the possibility of an expensive failure mid ocean.

B. Asset registers

Registries of assets and ownership could be used as source data for the 'time, test, trigger' model of smart contract. Alternatively, the insurer could access the insured's database; for example, in commercial fleet insurance the insurer could see detailed telematics data and information such as usage, cargoes, maintenance, and repairs. This should allow better, dynamic pricing and mitigation of risk. It would also permit registries of insurance status or insurance certificates available as needed to authorised parties.

C. Reducing friction for the client

Smart contracts could automate large parts of client insurance processes, such as renewals, updating information on changing circumstances, and making claims. If the insurance parties (the broker, subscribing insurers and any other third parties) are granted direct access to the underlying data smart contracts, they could populate much of the renewal information themselves and identify new assets needing to be added under a policy. Similarly, the Internet of Things will identify many claim events to which an insurer could respond without waiting for client notification.

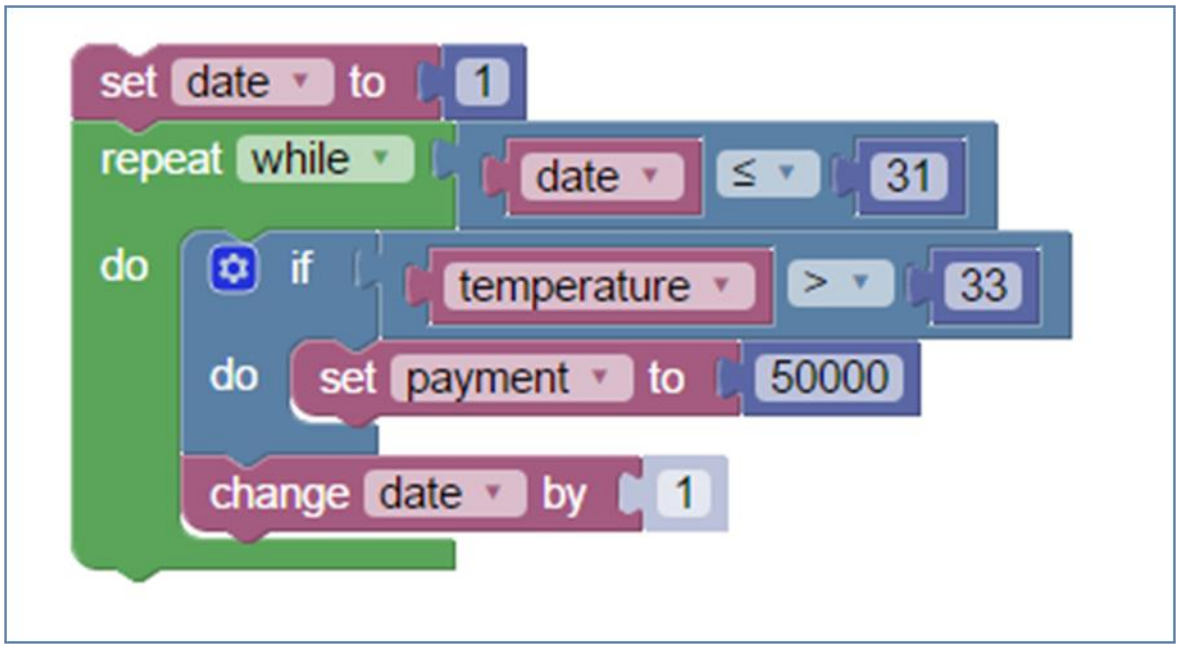
D. STP

The insurance industry is built around the transfer of risk between clients, insurers, and reinsurers. This generates a complex series of contractual arrangements and processes. Wholesale banking, albeit with a more constrained set of variables per transaction, has achieved huge efficiency improvements in many areas by implementing STP, where once data is confirmed between parties all further process steps are automated. In the more diverse world of insurance, smart contracts could be a vital part of

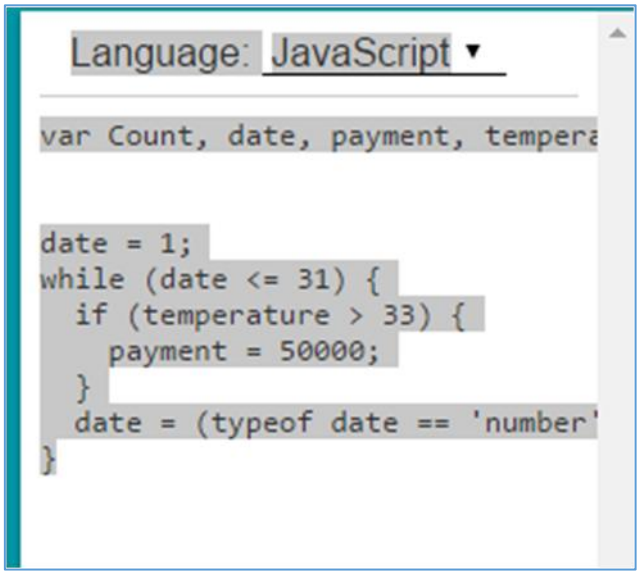
achieving STP as they would provide the machinery for executing complex contract terms.

5. What Does A Smart Contract Look Like?

What a smart contract might look like is shown here in diagrammatic structured English.[1] The example here is for the same weather contract above.



This can then be turned into computer code in various languages, such as JavaScript below.



[1] Created using Blockly - https://developers.google.com/blockly/.

6. How Do Smart Contracts Relate To Contracts?

There are two competing definitions of smart contracts, 'smart legal contracts' and 'smart contract code'. In a 'smart legal contract', some aspects of a conventional legal contract are executed operationally through computer code, whereas in 'smart contract code' the code itself defines the relationship between the parties.

The relationship between legal entities is defined by contracts and by legislation or regulation. If a smart contract produces an outcome which does not conform to contract terms or is contrary to legislation or regulation, then the impacted party can claim redress through the mechanisms defined in the contract or through the courts as appropriate.

Turning this round, specific contract terms could be written in a special format so that they can be implemented unambiguously in computer code. This would reduce the risk of mistakes between negotiation and implementation. There are various suggestions for a 'meta-language' which could be used to define such contracting terms.

There are further advantages of defining contract terms in such a rigorous meta-language. First, it forces the parties to be very clear on what they are agreeing, and to put more thought into what they mean by edge cases such as 'sudden change'. Second, there are mathematical techniques of 'formal verification' which allow computerised review of possible outcomes so that the parties can validate the combined effect of complex terms.

In any process there is always a possibility of error. These may be irreversible once executed by the code. Or, if recoverable in principle, they may be irrecoverable in practice, for example where money is transferred to a party which subsequently defaults. Smart contracts do not change this picture but, as they rely heavily on automatic validation of data in order to avoid errors, it is necessary to ensure that the savings on processing will not be outweighed by the costs of recovery from errors. The experience of wholesale banking, which

has significantly reduced its cost base though implementing STP, suggests that benefits outweigh costs.

7. What Issues Are There With Smart Contract Code?

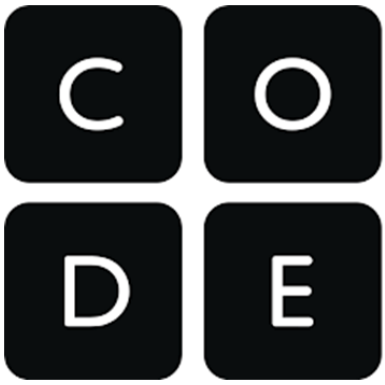
Smart contract code defines the relationship between the parties as being the effect of executable computer code. In both cases the smart contract approach provides an immutable audit trail. Relationships come in two flavours: with a legal contract between the parties, and without a legal contract.

With a legal contract

The idea is that the contract states that certain terms are implemented as defined in specific computer code. This would reduce the risk of divergence between contract and code, but at the cost of making any error in the code binding on the parties. As machines, networks, operating systems, and applications are replaced or updated, it may be become difficult or impossible to prove details of how the smart contracts were originally meant to act in the event of rounding calculations or disputes about the order in which a complex list of items is sorted. Best practice would of course, like traditional contracts, keep the original contract and all amendments together, with all parties agreeing any changes to the underlying clauses (or technologies in this case).

Without a legal contract

A more extreme model is to dispense with the legal contract and rely on the code alone; typically this involves applications using mutual distributed ledgers. There have been well-publicised incidents of fraud and theft from Bitcoin exchanges and wallets, but not on the core blockchain ledger.



Cyber risk

Much of today's early attempts at inter-connectivity come with data security risks as the information processing capacity of the devices falls behind the capabilities of cyber criminals[2]. Smart contracts are potentially neutral in this debate, i.e.

[2] For example, the attack on the domain name service provider Dyn on 21 October 2016 through malware installed by hackers on millions of hardware devices attached to the internet. ('Connected Devices Create Security Weak Spots', *Financial Times,* 24 October 2016, page 16)

architecturally they might decrease systemic risk, but with greater adoption there is clearly more cyber-activity vulnerable to cyber-attack.

A recent high-profile implementation of more general functionality using smart contract code demonstrates some new risks. 'The DAO' was an investment fund project implemented on Ethereum smart contracts in April 2016. The DAO defined all its relationships with investors through embedded code in the Ethereum ledgers. Due to a coding mistake, one party was able to extract funds then worth tens of millions of dollars to their own account. The Ethereum community acted to overturn to mistake, but this implies 'tyranny of the majority' might, in some systems, supersede 'control by the code'.

There are lessons from this incident:

- simplicity in smart contract design is important;
- smart contracts on unpermissioned distributed ledgers are not yet a mature technology;
- governance structures on permissioned ledgers are important - the security weakness was published before the incident, but Ethereum's governance mechanisms did not let it react quickly. In a permissioned ledger with active governance, there is more scope for preventing this sort of problem, and even more on a central database.

8. What New Risks Do Smart Contracts Create?

The underlying goal of implementing smart contracts is to make contract administration and processing swifter, more efficient, and more accurate. However, any error in the underlying data may result in an incorrect contractual outcome from execution of code, for example triggering an incorrect transfer of assets. Although the party transferring the asset in excess of contractual requirements will have redress through the mechanism defined in the contract (a) it has to identify that an error has occurred, (b) by the time it seeks redress the other party may be unable to repay its debts, and (c) if small payments are made to multiple parties it may not be cost effective to recover incorrect payments.

Therefore, for any proposed use of smart contracts there needs to be risk analysis of how the benefit of faster and cheaper processing in the normative case will be offset by the costs of remediation where process controls let through incorrect data. Note that the baseline for the analysis should not be 'zero errors' but the error rate expected from a more manual process. Indeed,

contract lawyers or technicians, or perhaps 'bots', might emerge to review and agree that codes reflect contracts.

A second risk is that data feeds from external sources driving the 'time, test, trigger' process are wrong (accidentally or maliciously). Risk can be mitigated to some extent by a time delay in transferring assets, coupled to manual or automated review.

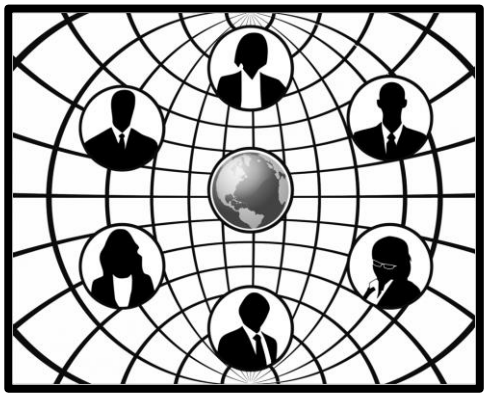
There are different types of risk around claims. Currently, insureds do not claim on all possible loss events. A move to automatic detection of loss events might therefore increase the total amount of claims paid. Also, the claims management process currently requires repeated human judgement learning over time. Excessive process automation could reduce pressures keeping down invalid or inflated claims.

For smart contract code, there is a more technical risk where the code is so complex that the parties cannot fully understand its implications. This may allow for outcomes which the parties did not intend, as happened with The DAO. To some extent this can be mitigated by using tools such as formal, mathematically rigorous code verification.

9. What Are The Longer-Term Prospects For Smart Contracts?

In the coming years we can expect:

- a huge increase in connections to the Internet of Things;[3]
- greater use of digital asset registers;
- developments in cryptography and zero-knowledge proofs permitting the controlled exchange of snippets of data;
- further development of artificial intelligence (AI).



[3] Gartner forecast in 2015 that there will be 21 billion devices connected to the internet-of-things by 2020. http://www.gartner.com/newsroom/id/3165317

Real-time access to digital information validated by AI will greatly increase the scope of smart contracts to provide efficient processing with lower error rates. This will reduce total processing costs (taking into account the costs of rectifying errors) and increase speed and accuracy, even as the volume of processing increases due to the implementation of more sophisticated insurance products.

It is reasonable to expect the future to bring developments such as the following:

A. Smart property insurance

By consolidating information across property registers, property values, the Internet of Things, weather, crime statistics, and other sources, an insurer can obtain a more granular understanding of the underwriting risks and can take mitigating action to reduce risks as appropriate. For example, if there is an increased crime rate in an area, an insurer could demand better security protection for buildings. Smart contracts could be used to optimise processing of such requests and to help manage the agreed changes in premia as circumstances change.

B. Insurance-on-demand

Retail insurance startups now offer 'pay-as-you-go insurance', for example, offering car insurance for a single journey "available through an app in 60 seconds". To make this work requires very cheap distribution and processing. There are similar possibilities in wholesale insurance, for example calculating the premium for insuring hire cars according to the characteristics of each driver and booking. Vessels taking on war risk as they cross zones. Aircraft fleet portfolios dynamically adjusting. The process would have to be fast and transparent enough not to upset the customer, and it would have to be cheap enough not to outweigh the benefit of reduced risk. In the long-term, smart contracts have the appropriate characteristics to support many novel forms of insurance-on-demand.

C. Insurance indices

Insurers and brokers may be reluctant to contribute to indices if they are perceived as disclosing proprietary information or giving market power to clients. Developments in cryptography allow smart contracts to transfer information in such a way that it is anonymised and time delayed, but can still be audited. This should make it practical to construct indices in insurance

markets, which in turn can facilitate alternative techniques of risk transfer and capital raising.

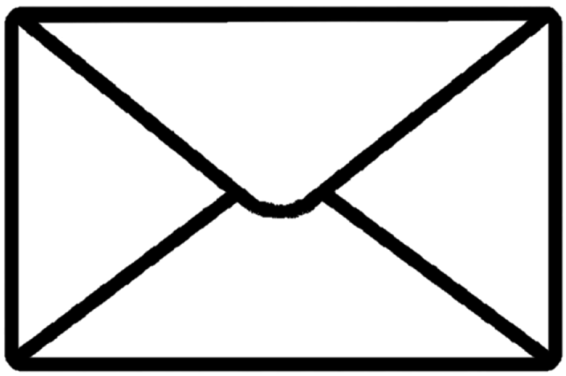
D. Industry Loss Warranties (ILWs)

These are derivative contracts through which one party will purchase protection based on the total loss arising from an event to the entire insurance industry rather than from their own losses. The contracts are written with reference to data amalgamated by a recognised industry source such as the PCS Catastrophe Loss Index for USA hurricanes. Smart contracts would enable the parties to interrogate the detail of the PCS data to calculate pay outs, or to create their own index linked to ILWs in the capital markets.

10. Next Steps?

The large number of use cases in different areas for STP and smart contracts indicates that these are technologies which could have a strong impact on the London Market over the next few years, and they should be part of the strategic debate within firms and at Market level.

The technologies are not just about revolutionary change. There are many promising use cases for simple cost savings and income growth, as well as for increasing speed and accuracy of processes. If the Market is to flourish, firms must take advantage of incremental *and* revolutionary improvement. Smart contracts appear to offer both kinds of opportunity.



The Long Finance initiative grew out of the London Accord, a 2005 agreement among investment researchers to share environmental, social, and governance research with policy-makers and the public. In 2007 Long Finance was established more formally by Z/Yen Group and Gresham College with support from the City of London Corporation with the aim of exploring long-term thinking across a global network of people.

"When would we know our financial system is working?" is the question underlying Long Finance's goal to improve society's understanding and use of finance over the long term. In contrast to the short-termism that characterises today's economic views the Long Finance time-frame is roughly 100 years. Long Finance aims to:

- expand frontiers - developing methodologies to solve financial system problems;
- change systems - provide evidence-based examples of how financing methods work and don't work;
- deliver services - including conferences and training using collaborative tools;
- build communities - through meeting, networking and events.

Long Finance runs programmes exploring four major themes:

- **London Accord** – looking at environmental, social, and governance investment research issues;
- **Financial Centre Futures** – seeking to explore how finance might work in the future;
- **Meta-Commerce** – aiming to identify and structure the critical questions underlying the long-term viability of the financial system;
- **Eternal Coin** – encouraging a global discussion on the nature of money and the concept of value.

www.longfinance.net

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It speaks collectively for market practitioners on growth and modernisation issues, and its aim is to build on London's position and reputation as the global centre of insurance excellence.

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