October 2018

Whitepaper

Smart Derivatives Contracts: From Concept to Construction

CONTENTS

EXECUTIVE SUMMARY

Smart contracts could help revolutionize the derivatives market by creating much-needed efficiencies that would benefit the entire industry. But transforming smart contracts from an exciting concept to practical use will present a number of challenges.

From a legal perspective, a number of issues need to be considered. What contractual terms should be automated? How should these terms be expressed? How can lawyers validate the legal effect of any automated contractual terms that are not expressed in natural language?

This paper considers some of these issues, and proposes a practical framework for constructing smart derivatives contracts (see Figure 1). This includes:

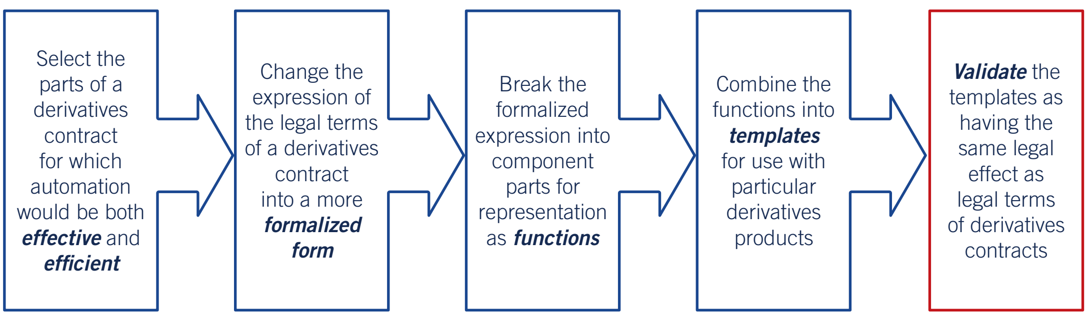
- Selecting parts of a derivatives contract for which automation would be effective and efficient;
- Changing the expression of the legal terms of those parts of the derivatives contract into a more formalized form;
- Breaking the formalized expression into component parts for representation as functions;
- Combining the functions into templates for use with particular derivatives products; and
- Validating the templates as having the same legal effect as the legal terms of a derivatives contract.

In developing this framework, the ISDA Common Domain Model (ISDA CDM™) could play an important role in ensuring that a shared, standardized representation of events and actions that occur through the derivatives lifecycle is applied across the industry.

For smart derivatives contracts to fulfill their potential, it is important they are developed in a way that is compatible and consistent with the technological, commercial, regulatory and legal standards applicable to both derivatives contracts and smart contracts. This will require knowledge and experience from different disciplines and domains. Expertise in the technology used, the commercial context of its use, the regulation that applies to it and the law that supports its effectiveness, are all critical.

These suggestions, and the issues discussed in this paper, are intended to stimulate further collaborative work between ISDA and its members in developing a set of principles that can be used to construct smart contracts for derivatives that are not only technologically efficient, but are legally effective and consistent with ISDA's mission to promote safe and efficient markets.

Figure 1



INTRODUCTION

Smart contracts could create significant efficiencies in derivatives markets, but further industry effort is required to address the legal, technological and operational challenges

Smart contracts could radically improve the efficiency of the derivatives market by automating the performance of certain events and obligations. Significant work has been conducted to explore the use of smart contracts, and to consider the implications from a technological, legal and operations perspective.

As part of this work, ISDA has published a series of papers looking at both legal and technological aspects of smart contracts. These include:

The Future of Derivatives Processing and Market Infrastructure (September 2016)[1]: This paper summarizes the need to develop new and efficient processes for the global derivatives market, and identifies three key contributors to the improvements required: standardization, collaboration and technology. The paper highlights the importance of distributed ledger technology and smart contracts.

Smart Contracts and Distributed Ledger – A Legal Perspective (August 2017)[2]: Jointly prepared by ISDA and Linklaters, this paper sets out a framework for smart contracts in the context of ISDA's documents. It describes what smart contracts are and makes an important distinction between smart contract code and smart legal contracts. It also gives a preliminary and high-level description of the application of smart contracts within the ISDA documentation framework.

ISDA Common Domain Model Version 1.0 Design Definition Document (October 2017)[3]: This publication describes some of the fundamental elements of the ISDA CDM. The ISDA CDM seeks to create a standard blueprint for events and actions that occur throughout the lifecycle of a derivatives trade.

CDM 1.0 (June 2018)[4]: This initial snapshot of a digital version of the CDM provides a human-readable standard digital representation of the model, addressing a limited product scope of simple interest and credit derivatives products and an agreed sample of business events.

This paper contributes to this work by examining, from a legal viewpoint, what is required in order to apply smart legal contracts to ISDA documentary standards, within the context of the ISDA CDM where relevant.

[1] International Swaps and Derivatives Association, Inc. (ISDA), The Future of Derivatives Processing and Market Infrastructure (September 2016), https://www.isda.org/a/UEKDE/infrastructure-white-paper.pdf

[2] ISDA and Linklaters LLP, Smart Contracts and Distributed Ledger – A Legal Perspective (August 2017), https://www.isda.org/a/6EKDE/smart-contracts-and-distributed-ledger-a-legal-perspective.pdf

[3] ISDA, ISDA Common Domain Model Version 1.0 Design Definition Document (October 2017), https://www.isda.org/a/gVKDE/CDM-FINAL.pdf

[4] The ISDA CDM 1.0 (June 2018), https://www.isda.org/2018/06/04/the-isda-cdm-1-0/

CONCEPT: SMART DERIVATIVES CONTRACTS

Smart derivatives contracts include terms within the contract that can be performed automatically

The term 'smart contracts' can be defined in multiple ways, but the following description is commonly used in work on smart contracts with derivatives transactions.

> *"A smart contract is an automatable and enforceable agreement. Automatable by computer, although some parts may require human input and control. Enforceable either by legal enforcement of rights and obligations or via tamper-proof execution of computer code."* [5]

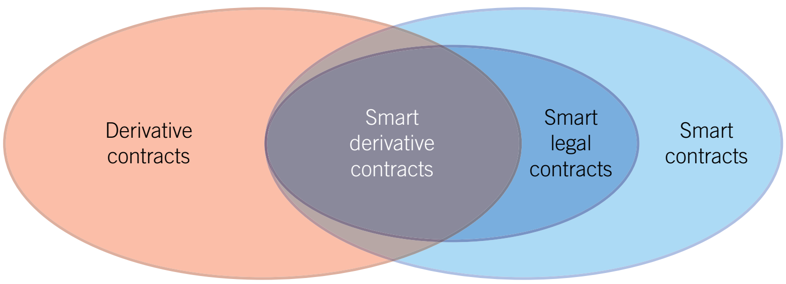
Usefully, this definition combines the elements of both legal and technological effectiveness. However, a smart contract does not have to be a legal contract. There is a distinction between smart contract code (a piece of code designed to execute certain tasks if pre-defined conditions are met) and smart legal contracts (legal contracts, or elements of legal contracts, represented by software)[6].

The ISDA/Linklaters *Smart Contracts and Distributed Ledger – A Legal Perspective* paper also distinguishes between two different models of smart legal contracts: the external model and the internal model. In the external model, the coded provisions remain external to the legal contract, and represent only a mechanism for automatic performance of the contract. In the internal model, the provisions that can be performed automatically are included in the legal contract, but are rewritten in a more formal representation than the current natural language form. A computer could then take this more formal representation and automate performance.

This paper focuses on smart legal contracts using the internal model. This is where the most complexity in legal issues arises, because changes to the legal contract would be necessary[7]. But it also provides the greatest efficiency and risk management benefits, because the same representation could be used both for legal effect and to implement automation. This would minimize the possibility of divergence between the legal meaning and operational performance of the contract.

To avoid repetition and confusion, this paper refers to these smart contracts as ***smart derivatives contracts***. Smart derivatives contracts are smart because they are derivatives contracts with some terms that can be automatically performed. Those terms are expressed in a form that enables their efficient automation. Other terms that are not automatically performed are expressed in natural language. As such, they are derivatives contracts and smart contracts (and smart legal contracts), as shown in Figure 2.

Figure 2



[5] Clack, C., Bakshi, V., and Braine, L., Smart Contract Templates: foundations, design landscape and research directions (August 4, 2016, revised March 15, 2017)

[6] Stark, J., Making sense of blockchain smart contracts (June 4, 2016, updated June 7, 2016), https://www.coindesk.com/making-sense-smart-contracts/

[7] However, issues of legal validation discussed later in this paper can arise whether the internal model or external model is used

COMPATIBILITY WITH STANDARDS

Smart derivatives contracts would need to comply with regulatory, legal, commercial and technological standards

"Standardization takes many forms, covering product definitions, process descriptions, legal documentation, messaging and terminology. ISDA has long been at the forefront of publishing and promoting legal documentation standards, from the ISDA Master Agreement and CSAs to definitional booklets and confirmation templates. … Standards in all forms help to create a platform for technology to evolve within an ecosystem." [8]

There are many different standards applicable in the derivatives markets and for regulating conduct and decision-making. All have a similar overall goal – to enable reliable, consistent and safe outcomes. This should also be the goal in developing smart derivatives contracts and is consistent with ISDA's role in facilitating safe and efficient markets.

At least four different types of standards need to be considered for smart derivatives contracts: regulatory, legal, commercial and technological.

Regulatory Standards

Regulatory standards would include those applicable to derivatives markets and participants, such as requirements on clearing, data reporting, trading, capital and margin[9]. These standards are often conceived at an international level in an effort to provide a consistent cross-border regulatory framework for derivatives market participants[10]. Despite the existence of international standards, a lack of harmonization in the implementation of regulations at a national level can create jurisdictional complexity that should be considered.

In the context of smart derivatives contracts, regulatory standards would also include regulations directly applicable to smart contracts, but these are less well developed.

The Financial Stability Board and Committee on Payments and Market Infrastructures have both highlighted issues related to automated contracting[11], including transparency, appropriateness of the code and data feed concerns[12]. However, there are currently no comprehensive international standards on regulatory policy issues relating to smart contracts. Such standards could emerge in the future, and smart contract work with derivatives will need to be compatible with them.

[8] ISDA, Future of Derivatives Processing and Market Infrastructure, page 15

[9] Derivatives documentation needs to comply with these regulations. For example, ISDA is in the process of drafting of next-generation initial margin (IM) documentation for phases four and five of the IM regulation phase-in, scheduled for September 2019 and September 2020, respectively

[10] For example, through bodies such as the International Organization of Securities Commissions (IOSCO), Financial Stability Board (FSB) and the Committee on Payments and Market Infrastructure (CPMI)

[11] For example, FSB, Financial Stability Implications from FinTech: Supervisory and Regulatory Issues that Merit Authorities' Attention (June 27, 2017), http://www.fsb.org/2017/06/financial-stability-implications-from-fintech/

[12] "Automation of contract terms could improve efficiency by eliminating the need for human intervention in executing a transaction and thus reduce the probability of human error. The addition of automated contract tools, among other value-added features, could significantly simplify back office processes and records management. At the same time, self-executing applications may create new challenges and risks for the financial ecosystem": CPMI, Distributed ledger technology in payment, clearing and settlement - an analytical framework (February 2017), https://www.bis.org/cpmi/publ/d157.htm, pages 13–14

Legal Standards

Legal standards exist to provide certainty that arrangements entered into between parties will be enforceable as a matter of law[13]. The laws on which legal standards are based are developed at a national level. Like regulatory standards, this can create complexity where these arrangements are entered into on a cross-border basis between counterparties that may be subject to different legal systems.

However, international standards do exist for laws in important areas, such as the model laws of the United Nations Commission on International Trade Law (UNCITRAL), the work of the International Institute for the Unification of Private Law (UNIDROIT) and the Hague Conference on Private International Law. This assists the development of cross-border trade by providing for consistency of laws across the different jurisdictions that adopt them.

Nonetheless, the bodies responsible for international legal standards have been mostly silent on legal standards for smart contracts.

An example of where such standards may develop is in relation to the cross-border recognition of smart contracts, including in relation to choices of law. If smart contract legal standards are developed, then the derivatives smart contract work will need to be compatible with them.

Commercial Standards

Commercial standards set out the market practice for how commercial arrangements are reached and performed. They are usually developed by participants in the relevant industry and facilitate cross-border activity by creating consistency across the different markets that adopt them[14].

This gives market participants confidence that their transactions will be conducted on the same basis, regardless of counterparty. This is critical for proper identification and assessment of risk. Ensuring that smart derivatives contracts reflect and are compatible with these commercial standards is important work for ISDA and its members.

Technological Standards

Technology standards set a common framework for development, and provide for consistency between results. A smart contract framework should therefore be built on a technological framework because consistency is critical for adoption.

Various technological standards (such as those applicable to messaging) can be applied to the operational aspects of derivatives contracts. Some international standards bodies, such as the International Organization for Standardization, are also working on technical standards for smart contracts, although the focus is on a wide range of smart contract applications and not derivatives contracts[15].

[13] The legal standards applicable to derivatives contracts are reflected in ISDA's standard legal documentation. For example, ISDA's work in commissioning netting opinions in relation to that documentation provides certainty to derivatives markets participants that they are entering into legally enforceable netting arrangements

[14] The development of commercial standards in the derivatives market has been reflected through the development of ISDA's documentation framework, including its credit support documentation and its transaction-specific definition booklets

[15] ISO Technical Committee, ISO/TC 307 Blockchain and distributed ledger technologies, includes Working Group WG3, Smart Contracts and their applications

Compatibility with Standards

Smart derivatives contracts need to be compatible and consistent with the technological, commercial, regulatory and legal standards applicable to both derivatives and smart contracts. This is necessary in order for them to achieve their potential to improve efficiency in the derivatives market.

For example, if smart derivatives contracts are developed only with technological standards in mind, they may not be legally enforceable, they may conflict with regulatory requirements, and they may be inconsistent with the way that derivatives contracts are actually transacted between parties[16]. This would obstruct their use, even if they represent a significant technological improvement.

Alternatively, if they are developed only with legal standards in mind, they may not be technologically operable. Consequently, it is important that smart derivatives contracts are compatible with the multiple sources of standards described above, and work to develop them is a co-operative effort between lawyers, computer scientists and banking technology practitioners.

Fortunately, ISDA's documentation framework provides an excellent foundation for the development of smart derivatives contracts[17]. These documents reflect and are consistent with legal, regulatory and commercial standards for derivatives. Importantly, use of ISDA documents would allow the technological framework ultimately used to be consistent with the commercial standards for derivatives contracts.

In order to achieve compatibility with the various standards, the sharing of terms and concepts across different knowledge disciplines will be important. The ISDA CDM will play a fundamental role in this regard. The CDM builds a foundation for common data and process standards, providing a platform for the development of a framework that may ultimately be applicable to smart derivatives contracts.

[16] An example of this could be a technological process that automates the close-out amount calculation process. If such a process was constructed without regard to regulatory, legal and commercial standards, it might be unlawful in the insolvency of one of the parties and deprive the other party of the flexibility needed to manage the market risks arising because of the transactions' termination

[17] For example, ISDA recently assisted Axoni in its development of peer-to-peer blockchain infrastructure for equity swaps processing by helping to create a standardised equity swap confirmation and trade template based on a 2011 ISDA Equity Derivatives Definitions framework designed to facilitate electronic processing of equity derivatives

The ISDA CDM provides a standard digital representation of events and actions that occur during the life of a derivatives trade

ISDA COMMON DOMAIN MODEL

> *"The ISDA CDM aims to deliver a standardized model for the post-execution trade lifecycle, focusing on the non-differentiating aspects of that trade lifecycle that are candidates for mutualization by the industry."*[18]

ISDA published the first draft of the ISDA CDM in October 2017. This initial conceptual version of the model served as a basis for discussion with ISDA's membership and the broader industry on its feasibility as the basis for common process and data standards.

ISDA subsequently published ISDA CDM 1.0 in June 2018. This provides a standard digital representation of events and actions that occur during the life of a derivatives trade, expressed in a machine-readable format that is agnostic of any programing language or software technology.

The ISDA CDM framework is more in line with ISDA's work in developing operational standards[19] than its work on legal documentation. It can therefore initially be difficult to understand from a legal perspective. However, understanding the way in which the CDM can connect the different representations of derivatives transactions is important to constructing smart derivatives contracts that operate efficiently in the derivatives market[20].

Events

The ISDA CDM focuses on 'events' that occur during the life of a derivatives transaction. These include 'independent events' that are independent from the economics of a derivatives transaction, such as the creation, termination, amendment and cancellation of a transaction. It also includes 'dependent events' that are contingent on the economics of a derivatives transaction, such as updating the floating rate for a payment, making a payment, valuing a transaction and exercising an option. From a legal perspective, independent events can be thought of as actions that change the contract, while many dependent events are actions that happen under the contract[21].

For smart derivatives contracts, an initial step for lawyers may be to focus on dependent events, as they can represent operations that occur under the terms of a contract. For example, the calculation of a floating rate interest amount starts with an observation of the rate, followed by a function for its calculation, which results in a derived observation of the floating amount. The ISDA CDM has described this 'function' as highly automatable in a smart contract.

The ISDA CDM looks at derivatives products not by reference to the labels given to them, but by reference to the functions performed under them. Derivatives products are expressed as combinations of these functions and the observations they use, rather than being expressed as a prescribed form for a particular type of product into which product specific inputs are made.

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[18] ISDA, Design Definition Document, page 4

[19] For example, ISDA's work in developing FpML® (Financial products Markup Language) has certain similarities to the approach taken to developing the ISDA CDM, as it is open sourced and establishes the industry protocol for sharing information on, and dealing in, financial derivatives and structured products. The standard is developed under the auspices of ISDA, using the ISDA derivatives documentation as the basis. While the ISDA CDM is based on FpML product representations, it goes further by providing a digital representation of all the events during the lifecycle of a derivatives transaction

[20] An analogy that may help is to consider the legal, risk, pricing and collateral perspectives of a derivatives transaction to be different, partial maps of the same landscape. The ISDA CDM is the common system of reference points that can be used to ensure that that each of these maps is of the same landscape so that when they are used together, they cover all aspects of the derivatives transaction

[21] However, some dependent events, such as valuation of a transaction, are not required to take place by the terms of the contract, even though they are based on the contract's economic terms

Functions and Templates

Certain operational clauses within legal contracts are more suitable to automation and self-execution than non-operational clauses

From a legal perspective, this approach is a significant change. The focus on functions applied to observed information changes the role of the operative legal terms of a derivatives contract (many of which are contained in ISDA's product definitions). Rather than being the fundamental rulebook for the transaction's lifecycle, terms can be seen as inputs into the current representation of the state of the transaction.

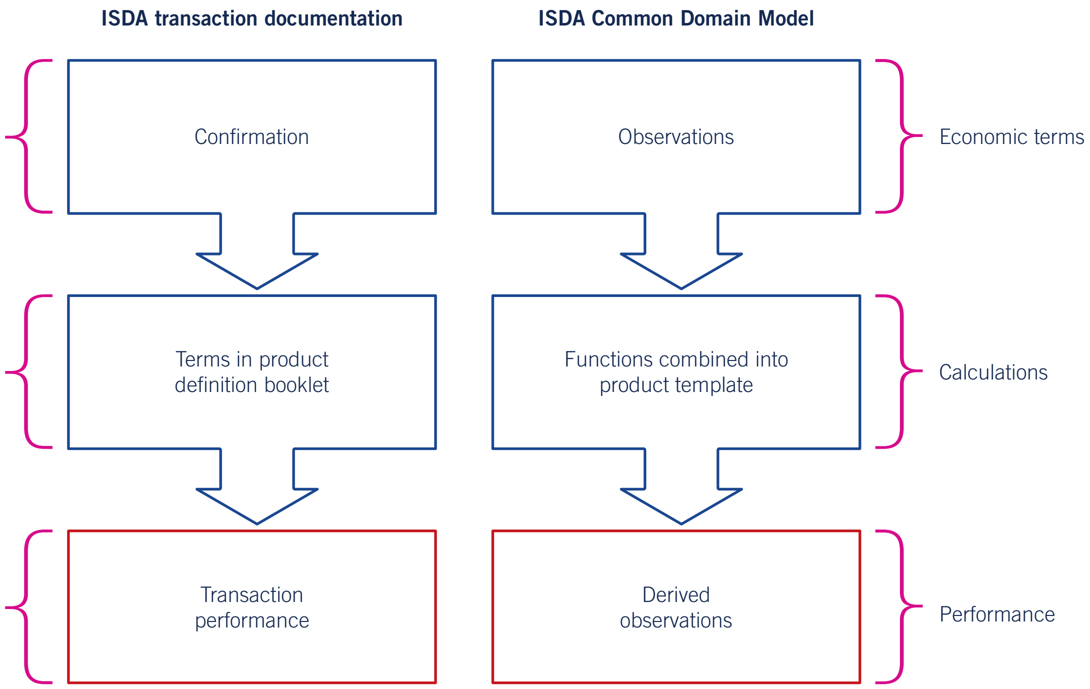
These inputs can be broken down into their simplest representation – for example, an interest rate swap as a combination of two coupon payments. Those simple functions can then be combined into templates that follow the functionality of the ISDA definitions, producing observations when they are run together with the economic terms (the derived observations). This combination of functions into templates is an important aspect of what makes a smart derivatives contract 'smart' and effective for implementation with derivatives transactions.

This means there could be a single 'library' of functions that can be used to build the templates of smart contracts used for different products, rather than having separate definitional booklets for each product.

Figure 3 shows how the features of the economic terms, calculations and performance in the ISDA CDM have analogies in the ISDA transaction-specific documentation.

The ISDA CDM proposes a hierarchical product definition to allow a product to be built from predefined functions, which are in turn built from predefined elements (such as dates and numbers). This produces a template for the product that that can be used repeatedly for transactions. This structure is important in enabling a framework for constructing smart derivatives contracts. However, before applying this framework, it is necessary to consider the legal complexities that need to be managed within it. These are considered in the next two sections of this paper.

Figure 3



COMPLEXITY IN THE CONTRACT

Some parts of a legal contract are complex or involve subjective judgement and will be challenging to automate

"Defining contractual performance in software requires prudence and forethought. Hundreds of years of case law, legal tests such as 'the reasonable person' test, and the chaotic nature of real-world events and human frailties presents an environment that is impossible to entirely emulate in code. This software is not a contract in reality, and ideally should exist wrapped within a legal framework that links the code with a contract." [22]

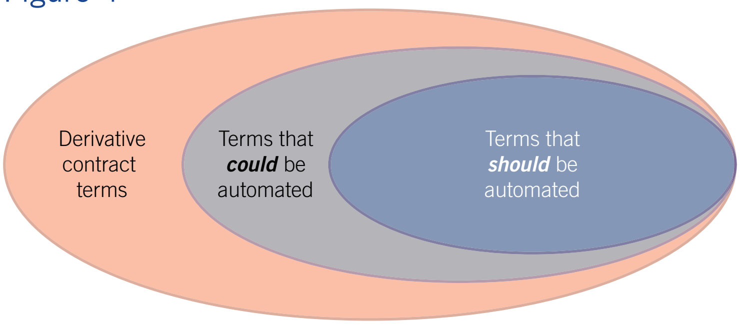
Laws have often evolved over centuries to adapt to many circumstances and possibilities. Although laws can comprise rules and regulations, the application of law often involves flexibility and judgment. In derivatives contracts, examples include flexibility in the calculation of 'close-out amount' within the ISDA Master Agreement[23], and flexibility over the determination of a 'potential adjustment event' within the ISDA equity derivatives definitions[24]. Prescribing rules in advance to automate these parts of contracts present considerable challenges.

Automating Parts of a Derivatives Contract

Not all of the terms of a smart derivatives contract need to be automated. Automated terms can form a single contract with those that are not automated, in the same way that an ISDA Master Agreement forms a single agreement with the confirmations of the transactions entered into under it[25]. It is therefore critical to identify what parts of a derivatives contract should be represented in automatable form. There are two parts to this:

- Determining which parts of a contract it is possible to automate (the parts for which automation could be described as being effective); and
- Determining which of those parts there is sufficient benefit in automating (the parts for which automation could be described as being efficient).

Figure 4



[22] Hanson, R., Reeson, A., and Staples, M., Distributed Ledgers: Scenarios for the Australian economy over the coming decades, page 16 (May 2017, Data61), https://publications.csiro.au/rpr/pub?pid=csiro:EP175257, Data61 is part of Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO)

[23] The definition of close-out amount in Section 14 of the 2002 ISDA Master Agreement continues for more than a page of its printed form, providing the determining party with a range of bases on which it can be calculated. This flexibility proved very valuable in calculating these amounts in the aftermath of the global financial crisis due to the significant disruption in markets that took place

[24] A potential adjustment event in Section 11.2(e) of the 2002 ISDA Equity Derivatives Definitions is defined to include a number of generally described events, such as subdivisions, consolidations and reclassification of the relevant shares, certain distributions, issues or dividends to holders and other events. It also includes "any other event that may have a diluting or concentrative effect on the theoretical value of the relevant Shares"

[25] The possibility of representing only a part of legal contracts in smart contract code has been noted by Clack and ISDA/Linklaters. In a conceptual sense, it is similar to different parts of the one legal contract being expressed in different natural languages, on the basis that the parts to be performed in different countries are expressed in the language most easily understood in the relevant country of performance

Selection for Effective Automation

Considerable thought has already been applied to how to determine the parts of a legal contract that could be automated.

One approach, outlined in the ISDA/Linklaters *Smart Contracts and Distributed Ledger – A Legal Perspective* paper, divides a legal contract into 'operational' and 'non-operational' clauses. Operational clauses are described as those that embed some form of conditional logic – that upon the occurrence of a specified event, or at a specified time, a deterministic action is required. Conversely, the non-operational clauses of a contract are those that relate to the wider legal relationship between the parties[26].

The intent of this distinction is that operational clauses are more appropriate for automation. However, the Legal Perspectives paper recognizes that this distinction can be difficult to draw in some cases, and this difficulty has also been noted from a computer science perspective[27].

Another approach considered is to rewrite contracts in a more formal expression based on a logical framework that can easily be converted into a programming language[28]. However, there are limitations to this approach in terms of feasibility. It would be a massive task to rewrite the entirety of derivatives contracts in a new semantic form. Furthermore, unless all contracts are changed at the same time, those expressed in the old form would need to have the same meaning as those expressed in the new form, otherwise basis risk could develop between them. This would be problematic if they are intended to be matching transactions. Given these practical limitations, it is perhaps unlikely that the parties would be comfortable with this approach.

Nonetheless, there could be another method that combines each of these two approaches with the perspective of the parties to the contract whose performance is to be automated.

Need for Legal Validation

Before agreeing to use a new form of derivatives contract that includes automated terms, the parties are likely to require confirmation that the new form has the same legal effect as the form they would otherwise have used. One reason for this is that the parties will need to know what they are agreeing to. As mentioned above, another reason is because derivatives contracts are often used in connection with each other.

26 The operational / non-operational distinction is also made in other works, such as that of Clack et al. who describe the 'operational aspects' as:
"the parts of the contract that we wish to automate, which typically derive from consideration of the precise actions to be taken by the parties and therefore are concerned with performing the contract."
And the non-operational aspects as:
"the parts of the contract that we do not wish to (or cannot) automate"

27 *"Development of smart contract code for large, high-value legal agreements is a complex matter – it is not simply a matter of 'lifting' operational phrases out of the legal text and turning them into code, because operational and non-operational aspects of the agreement are intertwined". Clack, C., Smart Contract Templates: Legal semantics and code validation (2018), Journal of Digital Banking*

28 *"In the far future, we may see an increasing use of a formally structured style of expression embedded in legal prose; if all business logic in legal prose could be replaced with arithmetical or logical expressions, such as the higher-order parameters discussed in the previous paragraph, this should lead to reduced ambiguity in legal prose and fewer errors. The adoption of formal logic into legal prose would require such formal constructs to gain acceptance in the courts and to be admissible as evidence of the intentions of the parties".* Clack et al, page 9

For example, the risks under one interest rate swap might be hedged with another, provided the effect of their terms is the same. Ensuring they have the same effect is normally based on ensuring they have the same form – that the two interest rate swaps look the same – and they are governed by the same law (or different laws that will interpret the contracts in the same way). If the form of one of those interest rate swaps is different, then it is critical it retains the same legal effect, otherwise it won't be an effective hedge for the other and basis risk could develop.

If parties need confirmation that a smart derivatives contract produces the same legal effect as an equivalent traditional derivatives contract, then this can guide what parts of a derivatives contract are selected for translation into automatable form. Only those parts of the derivatives contract that a lawyer can confirm will not change their legal effect when automated should be selected. In other words, selection for effective automation should be based on an ability to conduct legal validation of the automated terms[29].

Selection for Legal Validation

Automating the performance of a derivatives contract involves the translation of contractual terms from legal drafting in a natural language that can be understood by humans into a form of a program in a programming language that can be converted for use by a machine. Legal validation of the contract will be challenging if lawyers are required to understand the programming languages or programmers to understand legal drafting.

However, this translation could occur in two steps. The legal drafting could be translated by a lawyer into a form that could be used by a programmer to convert into a program that a machine can use for automation. From a legal perspective, this intermediate form could be described as a more strict and procedural expression of the drafting. From a programming perspective, it could be described as the use of a domain-specific language[30].

Using such a shared, formal representation takes the benefit of the expertise of the lawyer and the programmer: the lawyer can confirm that the formalized representation is consistent with the legal drafting, while the programmer can confirm that the program is consistent with the formalized representation[31]. The ISDA CDM is an example of how shared, formal representations can assist efficiency in the market, and ISDA could have an important role in developing this formal representation for smart derivatives contracts.

An example of how legal drafting could be translated into such a shared, formal representation is set out in the *Constructing a Smart Derivatives Contract* section of this paper. Such a representation needs to use defined variables, functions, precise language and control structures such as sequencing, selection and repetition of processes. From a lawyer's perspective, these are logical processes. Under the legal validation approach, only those parts of a contract that a lawyer believes can be reliably expressed in such a way should be selected for automation.

[29] Of course, technological expertise is essential to determine what form an automated expression could take. A combination of both of legal and technological expertise should be needed

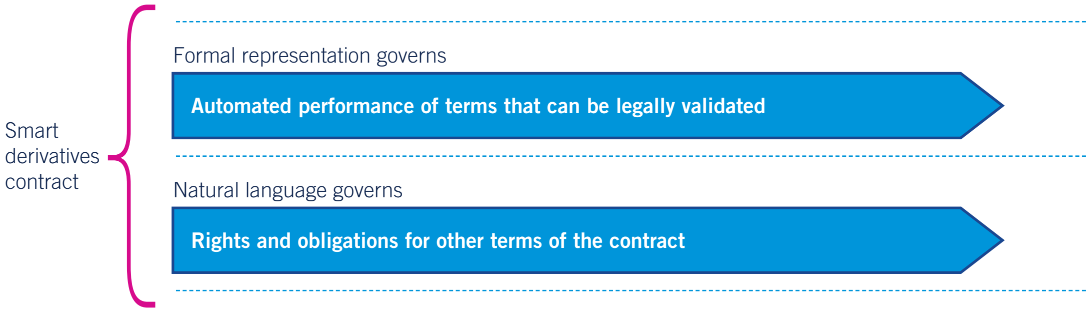
[30] Such a domain-specific language would be an informal description of the operating principles of an algorithm or piece of computer code. It uses some of the structured conventions of a computer programming language but is intended to be read and understood by humans, rather than a computer. There is no standard form of such a language, but it takes some of the style and syntax from programming languages, and it can be designed in whatever way the parties involved desire, provided each understands the constructs and precise rules involved

[31] In concept, this is similar to the manner of calculating the exchange rates between two currencies on a cross-exchange basis, through their respective exchange rates with the US dollar

Many parts of a derivatives contract cannot be expressed in such a manner and will need to be expressed in natural language. A lawyer is unlikely to be able to confirm that the legal drafting in a contract that requires the exercise of reason or conscience (for example, that something is to be determined by a person in good faith and a commercially reasonable manner) has the same meaning when it is represented in a form that is based on logical processes. Even if this were possible technologically, a lawyer is unlikely to be able to validate that its outcome is the same as the application of legal reasoning to the traditional contract, because the determination of these matters from a legal perspective is not simply the result of following clear, precise and logical steps[32].

For this reason, it is likely that an iterative process between lawyers and programmers will be needed to work out what parts of the ISDA documentation framework would be legally effective if converted to an automatable form[33]. ISDA is well positioned to facilitate this work.

Figure 5



Selection for Efficient Automation

Not all of the provisions of the ISDA documentation framework that could be effectively represented in an automatable form should be. For some, the level of effort required will not produce a sufficient benefit and will not be efficient.

One example is events of default (as defined in the ISDA Master Agreement). Assuming the non-defaulting party is rational, it may be possible to conceive a logical progression of steps that it will take in order to determine whether it will call an event of default and terminate the outstanding transactions.

Under the current form of the event of default mechanism, the determination will be based on a range of factors beyond the scope of the contract itself, potentially including the relationship with the defaulting party – for instance, the impact on other contracts or relationships or information on the circumstances of other, unrelated entities.

Theoretically, it is possible to comprehensively catalogue all these influences. However, it would be an immense task to even identify all the potential factors, let alone determine the way they influence the decision. This would involve such an extensive data set and heavy use of code to contemplate the range of possibilities that its use would be inefficient, even if theoretically possible.

32 It is possible for smart contract code to be programmed to pause for human input. However, this does not mean the code takes the place of the exercise of reason or conscience. It simply allows for it to occur before restarting

33 This iterative process will not only need to bridge differences in meaning between the written expressions used by lawyers and programmers, but also the unwritten differences in meaning in the use of expressions by lawyers and programmers. There is an analogy here to working out if the same contract terms have the same legal meaning when governed by two different laws

A number of factors are likely to influence the choice of what is efficient to represent in automatable form:

- **Standardization:** The provisions selected for automation should be standardized, so they are used in common form by many parties in many contracts. For example, although it would be possible to automate a provision agreed by two parties in the schedule of the ISDA Master Agreement, this would not be efficient if the provision is not commonly used by others.

- **Complexity:** The provisions selected for automation should not be overly complex. If the selected provisions require the operation of a large number of interconnected or interdependent rules at each stage of execution, then this could mean that the process is difficult to establish, operate and maintain.

- **Externalities:** If the provisions selected for automation are triggered by factors that are external to the contract, then the ability to import that trigger into the automated form needs to be considered. For example, if the trigger is an observable market-based event, then it may not cause any concern. If it is the exercise of some discretion, including by someone not party to the contract, then the ability to have the result of this event incorporated into the contract needs to be carefully considered. If it is not a simple matter, then the automation of this provision may not be efficient.

- **Commonality:** Smart derivatives contracts that are to serve as functions in the ISDA CDM would be more useful if they are used with more than one derivatives product. That's because the ISDA CDM seeks to avoid making functions product-specific where possible. Commonality of the functions performed by the automation provisions is therefore important.

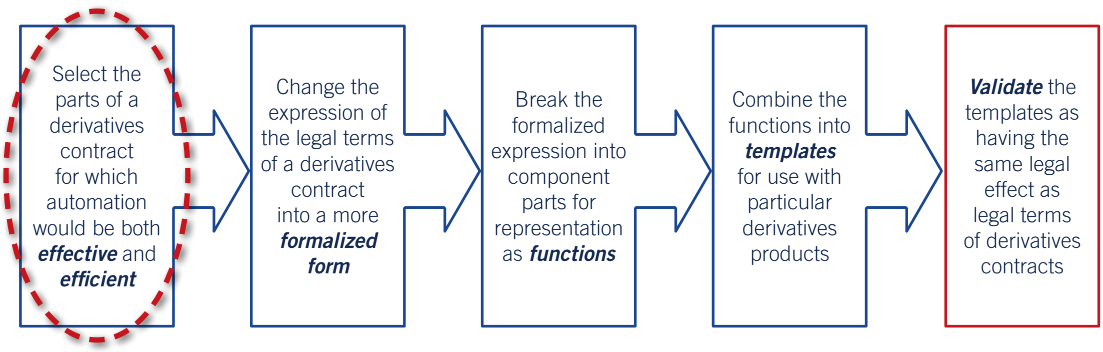
Further Work in Developing Selection Principles

The selection of the provisions within the ISDA documentation framework that could be chosen for automation in smart derivatives contracts is important further work for ISDA and its members. It should be based on what is effective (meaning what can be automated without changing legal effect), as well as what is efficient (meaning the work required to standardize its automated form will be used enough to make it worthwhile).

A simple example of this would be the calculation of an amount based on a formula, such as a fixed-rate payer amount calculation in an interest rate swap. An illustrative example of how this could be done is set out in the *Constructing a Smart Derivatives Contract* section of this paper. This selection of effective and efficient provisions for automation is the first step in the framework suggested in this paper (see Figure 6).

However, before demonstrating how the next steps could be taken, it is necessary to consider another stream of legal complexities – those caused by laws operating beyond the contract.

Figure 6



COMPLEXITY OUTSIDE THE CONTRACT

A legal contract can be affected by a number of external events, which must be considered when developing smart contracts

"Tamper-proof code might not be suitable for high-value, long-duration, highly-regulated financial contracts. Discretion is a key issue with many such contracts, and there must be support for the smart contract code to request human input. Furthermore, a change in applicable law might require smart contract code to be stopped and perhaps modified before continuing." [34]

The impact of laws on the performance of contracts is not limited to the meaning of their terms. Binding parties to perform the terms they have agreed is only one aspect of the law's influence on contracts. In some circumstances, laws will change or prohibit performance of a contract. Furthermore, agreement to a contract's terms does not mean that laws will always cause it to be performed. It is important to take these laws into account when constructing smart derivatives contracts.

Laws Affecting Contractual Performance

Laws can interrupt the performance of contracts or cause the reversal of performance of contracts. These laws express the public policy that interrupting or reversing a contract is more important than compelling the parties to fulfill their obligations in accordance with contractual terms.

Examples include laws that render obligations under a contract void or voidable. This can happen if a contract is found to be unauthorized, improper or fraudulent, if the purpose of the contract or the conduct of parties is unlawful or upon the bankruptcy or insolvency of one of the parties. In the case of derivatives, this includes insolvency laws that would render the close-out netting provisions of an ISDA Master Agreement unenforceable or open to challenge if not for the safe harbors and special legislative protection offered to them in many jurisdictions.

Laws can also change the terms of a contract expressly agreed between parties. Terms can be implied by law (such as under consumer protection legislation), they can be found void and removed, and they can be changed by rectification if a court finds they do not reflect the true agreement between the parties.

The complexity created by these laws cannot be avoided by the terms of a contract, as these laws override contractual terms. In the context of smart derivatives contracts, the focus should be on managing the impact of these laws on the automatic operation, so the contract is not performed when it no longer represents the legal obligations of the parties, or when it is unlawful.

Laws Relevant to Non-performance

From a legal perspective, parties agreeing to perform obligations under a legal contract does not ensure that performance will actually happen. A party may not be able to perform because of a range of possible practical or legal constraints, such as impossibility or bankruptcy. The contract sets out what the parties agree they will do for each other. Of course, the parties could do more for each other than what they specify in the contract, but the contract sets out the minimum requirements of the parties' performance and it serves as a benchmark to determine the consequences if they do not.

[34] Clack, C., *Smart Contract Templates: Legal semantics and code validation (2018), Journal of Digital Banking*

If a party defaults on its obligations, then the consequences of the non-performance can be varied, even when non-performance is contemplated by the terms of the contract. For example, the ISDA Master Agreement contemplates a termination process that can be initiated in the case of a party's default. However, the other party has a range of possible choices of what it can do next, beyond calling an event of default and initiating that termination process. It could choose to suspend its own performance under Section 2(a)(iii), or it could choose to ignore the default and continue to perform. It could also choose to take separate legal action to recover amounts that have not been paid to it, or seek to set them off against its own obligations or enforce against collateral. There are many interdependencies involved in making these choices, and the approach taken is not possible to predict with certainty.

A further complication related to non-performance arises because parties to a contract can choose not to perform by willingly breaching the contract. If it is a legally enforceable contract, then there are consequences if this happens, such as an obligation to compensate the other party, usually through the payment of damages.

Nevertheless, it is a choice that parties to a contract can make, and in certain circumstances (such as pending insolvency), it is an option that can be important and valuable.

These create complications for smart derivatives contracts, as they mean that automation of performance of the agreed terms of a contract so they are executed in a tamper-proof way is not always going to be consistent with the legal outcome of the contract.

Managing Complexity Outside of the Contract

There are at least three approaches that could be taken in constructing smart derivatives contracts to manage complexities that are introduced by laws beyond the contract.

One approach is to attempt to set out all the possible circumstances and the consequences. Due to the huge amount of possibilities and complexity, this would not be feasible and would seem impossible. Any approximation would change the legal substance of the relationship between the parties, which would no longer represent the agreement they otherwise would have had with each other.

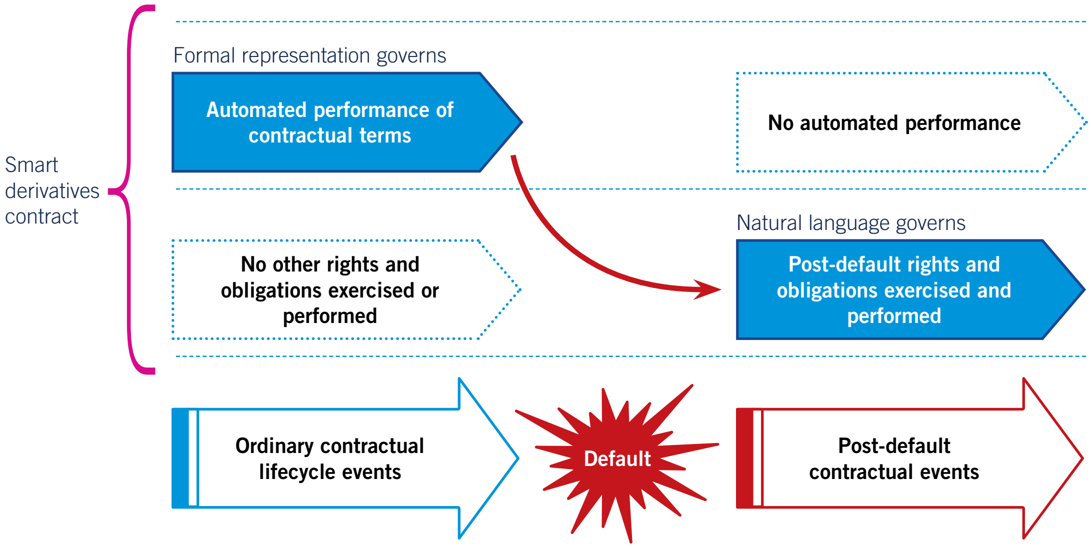
Another approach is to let the smart derivatives contract continue to perform automatically in ignorance of these laws and for the parties to deal with the consequences outside of its operation. Legally speaking, this can be risky. The consequences of continuing to perform obligations originally required by a contract but that have become contrary to law are not limited to significant economic loss (for example, amounts paid may not be recoverable in insolvency), but also include potential legal action and penalties (such as for breach of anti-money laundering laws). This too would therefore appear to be a sub-optimal outcome.

Suspending Automatic Performance

A further approach is to build in a right for either party to suspend the automatic performance of a smart derivatives contract. This is not suspending the contract between the parties – just its automatic performance. The parties' rights and obligations continue to exist. For example, if there is a default under a smart derivatives contract, the non-defaulting party could suspend the automatic performance of the obligations under the transactions and exercise its rights to close-out those transactions. Using the approach suggested in the previous section of this paper, the performance of the contract ceases to be governed by the parts expressed in formal representation. Instead, they are governed by the parts expressed in natural language.

This right to suspend does not have to be limited to when a party defaults. It would be useful in other circumstances, such as when errors have been identified that need to be corrected. The ability to suspend automatic performance would be particularly important where the technology on which the automatically performed parts of the smart contract operate is, from a technology perspective, immutable. This could be the case for smart contracts held on a blockchain or other distributed ledger technology[35]. This approach has the advantage that the automatic performance does not complicate the resolution of the legal complexity.

Figure 7



Further Work

Including a right to suspend the automatic performance of the smart derivatives contract's terms need not be considered to nullify its utility. The automatically performed terms would apply where they still accurately reflect the parties' legal relationship and then cease apply where they do not. Automatic performance of the smart derivatives contract could be recommenced after the suspension with a new state or modified parameters (or both).

Taking such an approach removes some of the challenges that arise in trying to automate the nuances and complexities of financial market contracts. Where flexibility is required that is beyond what is possible to express in a formal representation of the terms, then it can be left to the natural language provisions, on the basis that either of the parties could choose to suspend the application of the automated provisions.

Assessing how such a suspension right can be constructed, and if there should be any conditions to its use, is an important area of further work for ISDA and its members.

[35] The immutability of a blockchain arises from its 'append only' nature. This means that new information can be added, but the existing information cannot be altered

CONSTRUCTING A SMART DERIVATIVES CONTRACT

An important step to developing smart contracts is to construct a shared, formal representation of legal terms

"We now have at our disposal a rich language for describing financial contracts. This is already useful for communicating between people – the industry lacks any such precise notation. But in addition, a precise notation lends itself to automatic processing of various sorts."[36]

There are similarities between legal drafting and programming languages because each uses rules and constructs. The commonality between them is important to constructing smart derivatives contracts that can be validated legally, because it allows a shared representation of contractual provisions between them.

This section of the paper seeks to identify key areas where the similarities exist and shows how they might be used to construct a smart derivatives contract through the formalization of legal terms. To do so, it uses provisions from a sample interest rate swap transaction to illustrate the issues and steps formalization could take.

Variables and Functions

Legal drafting uses defined terms as names to refer to objects. For example, an interest rate swap confirmation could include the following:

Party A: *ABC Bank Ltd*

Party B: *DEF Corporation Plc*[37]

Programming languages also use names to refer to objects, often referred to as variables. For example, Party A is a variable given the value is ABC Bank Ltd and Party B is a variable given the value of DEF Corporation Plc.

Legal drafting also uses operative clauses to carry out procedures using defined terms. An example of this is Section 5.1 of the 2006 ISDA Definitions, which sets out how to determine the fixed amount payable by the fixed rate payer (a defined term itself). Programming languages can use functions to carry out procedures using variables, or the results of other functions.

Using this commonality, the calculation of the fixed amount under Section 5.1 of the 2006 ISDA Definitions could be described as a function using variables such as the payment dates, the fixed rate and the fixed rate day count fraction. The values of these variables are set out in the relevant confirmation and the function is the procedure set out in Section 5.1. The result of following these steps with these variables is a value being given to 'fixed amount' for a payment date. This connection between operative clauses and functions is also shown by the ISDA CDM.

[36] Peyton Jones, S.L., Eber, J.M., and Seward, J., Composing contracts: an adventure in financial engineering, ACM SIGPLAN International Conference on Financial Programming (KFP'00), Montreal, September 1, 2000

[37] Defined terms in a contract can be much more complex than this example, consisting of lists of objects, a number of other defined terms or even a procedure that is applied to a number of defined terms having a particular result (which can be akin to a function in a programming language)

Drafting Precision

Although legal drafting and programming languages share similarities in use of variables and functions, there is a difference between them in the precision required in the use of language. This is because of the difference in the user of the language. Legal drafting is used by humans and programming languages are used by machines[38]. Although both humans and machines can learn the rules of a language, humans are more able to work out the meaning of statements that are not expressed in accordance with those rules. This means legal drafting can use different words, or a different word order, to mean the same thing.

For example, it would not be unusual for an additional payment to be specified in a derivatives confirmation in the following manner:

Party A Payment Amount: *$1,000,000*

Party A Payment Date: *August 1, 2018*

Although this expression is not strictly in compliance with the framework stipulated in the 2006 ISDA Definitions[39], it would be understood to mean that Party A must pay $1 million on August 1, 2018.

Programming languages are used to state things precisely. If a word is used incorrectly, or is not defined, then it either cannot operate or cannot operate in the manner intended. This means that a greater level of precision is required in preparing legal language for adoption for automation[40].

In the case of derivatives, such precision is not just a question of following the relevant ISDA definitions more strictly. In some cases there is insufficient precision within the ISDA definitions themselves. An example of this within the 2006 ISDA Definitions are the terms 'relevant' or 'applicable' when used in conjunction with a defined term that contains more than one date or period of time, or the terms 'in relation to' or 'in respect of' particular terms, dates or things. Understanding the meaning of these provisions and whether they intend to have the same meaning requires a level of flexibility that is beyond that of rule-based machines used in automation.

Control Structures

Structural rules are often applied in legal drafting, from grammatical rules to drafting rules written into a contract. These are important in carrying out functions in the right manner.

Examples of these in the 2006 ISDA Definitions include:

- The requirement for a sequence of steps to be followed in the process for the exercise of an option transaction in Section 13.2;
- The requirement for a selection to be made using logical conditions in determining the correct floating rate in Section 6.2; and

38 This is a necessary over-simplification. Programming languages are used by human programmers. Machines use the machine code that the programming language is turned into

39 The 2006 ISDA Definitions provide for floating amounts, fixed amounts, initial exchange amounts, interim exchange amounts and final exchange amounts

40 This is another necessary over-simplification. A good programming language can also permit the programmer to model alternative inputs and apply methods to understand human inputs

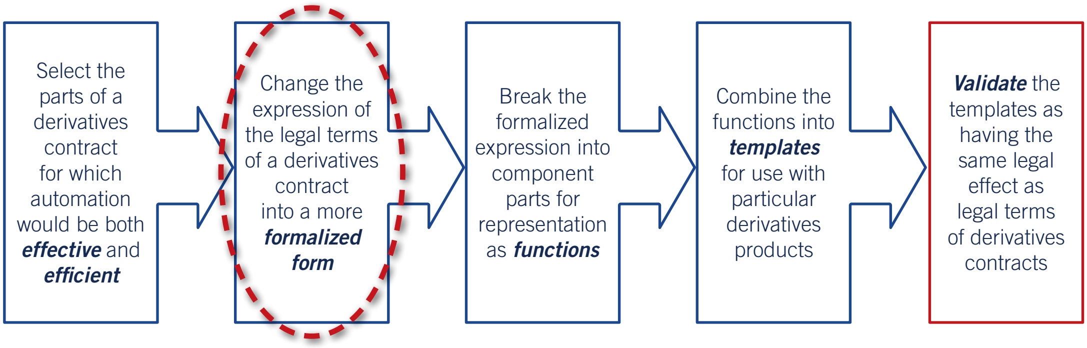
- The requirement for repetition of steps multiple times until an answer is worked out in determining the fallbacks that apply if a particular rate is not displayed on the relevant screen at the relevant time in Section 7.1.

Programming languages also use similar structures. However, there is a need for more precision in preparing these structures for the same reason as applies for precision in meaning of words – a human user has more flexibility to work out the right method to follow to understand legal drafting than a machine has to understand the right method in programming languages. This is perhaps most evident from the principle that the ultimate user of legal drafting (a court) will try to give some meaning to it, rather than to conclude there is no meaning at all.

Example of Formalization

Using these principles, it is possible to attempt the formalization of selected parts of legal drafting in derivatives contracts. It is not necessary to learn a programming language to do this – the intent is to bridge the gap between legal drafting and programming languages in a manner that lawyers and programmers can both use and understand. This is the second step in the framework suggested in this paper.

Figure 8



Here is an example using the 'fixed amount' definition in the 2006 ISDA Definitions. Section 5.1 reads as follows:

Section 5.1. Calculation of a Fixed Amount. The Fixed Amount payable by a party on a Payment Date will be:

(a) If an amount is specified for the Swap Transaction as the Fixed Amount payable by that party for that Payment Date or for the related Calculation Period, that amount; or

(b) If an amount is not specified for the Swap Transaction as the Fixed Amount payable by that party for that Payment Date or for the related Calculation Period, an amount calculated on a formula basis for that Payment Date or for the related Calculation Period as follows:

Fixed Amount = Calculation Amount x Fixed Rate x Fixed Rate Day Count Fraction.

A first step could be to turn the natural language text into a series of instructions, with one function (where possible) per line:

The Fixed Amount

payable by a party on

a Payment Date will be:

If an amount is specified for the Swap Transaction as the Fixed Amount payable by that party for that Payment Date or for the related Calculation Period,

That amount; or

If an amount is not specified for the Swap Transaction as the Fixed Amount payable by that party for that Payment Date or for the related Calculation Period,

an amount calculated on a formula basis for that Payment Date or for the related Calculation Period as follows: Fixed Amount = Calculation Amount x Fixed Rate x Fixed Rate Day Count Fraction.

A further step is to further formalize the wording using some of the principles set out earlier in this section:

Fixed Amount (PARTY):

FOR Payment Date(n):

IF

EITHER

amount is specified as Fixed Amount(PARTY) for Payment Date(n)

OR

amount is specified as Fixed Amount(PARTY) for Calculation Period(n) THEN

EQUALS amount specified

ELSE

EQUALS Calculation Amount × Fixed Rate × Fixed Rate Day Count Fraction

This formalized version differs in its drafting from the original natural language drafting as it uses 'IF', 'THEN', 'ELSE' as control flow statements, 'OR' as an operator, 'EQUALS', 'FOR' and 'EITHER' as logic statements, 'x' as a mathematical symbol and () to apply a term to a particular party or date. The result is a more structured and formal version of the original legal drafting without losing the optionality and meaning within the clause. There also remain some natural language elements to assist understanding of the text[41].

[41] For example, attempts to formalize what 'specified' means have not been attempted at this stage, on the basis that the parties understand that it is the amount specified in the relevant confirmation of the transaction, however that may end up being recorded in a smart contract format. If this is determined to be a particular repository or piece of code, reference could be made to it if desired. In addition, things that are 'specified' might also be specified dynamically by a party during performance of a contract

This is only a sample to show what could be meant by a shared, formal representation of the provisions selected for automation. Much more work would need to be conducted to make this useable. Furthermore, this uses one of the simplest examples that can be taken from ISDA documentation. Increasing complexity produces more complicated results, especially if it is to run multiple times.

However, even this simple example shows that it is important the parties agree the precise notation to be used, so they can trust that the formalized version reflects the legal drafting version and the parties' intentions. That notation would be an important standard for use in smart derivatives contracts, and this represents another stream of potential further work for ISDA and its members, perhaps through the ISDA CDM and/or as part of ISDA's proposed update to the 2006 ISDA Definitions[42].

To illustrate this point, the ISDA CDM 1.0 describes the calculation of the fixed amount using a further formalized version. This is expressed as:

*fixedAmount number: calculationAmount * rate * dayCountFraction*

currencyAmount CurrencyEnum: currencyAmount

Each of the elements set out in the calculation are expressed as a set of arguments (sign posts) to locate their inputs (or point to further calculations to calculate their values). The calculationAmount, rate or dayCountFraction arguments used for an 'InterestRatePayout', are expressed in the ISDA CDM 1.0 as follows[43]:

calculationAmount: is InterestRatePayout -> quantity -> notionalSchedule -> notionalStepSchedule -> initialValue

currencyAmount: is InterestRatePayout -> quantity -> notionalSchedule -> notionalStepSchedule -> currency

rate: is InterestRatePayout -> interestRate -> fixedRate -> initialValue

dayCountFraction: is InterestRatePayout -> dayCountFraction

Breaking Down into Component Functions

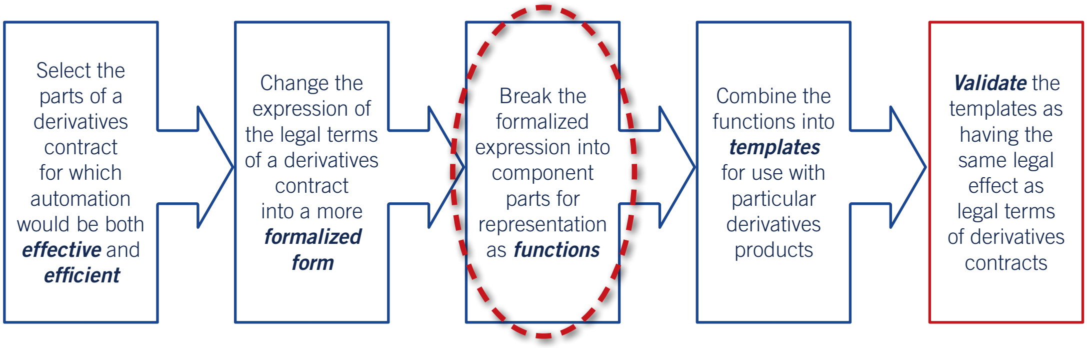
The expression of a legal term in a formalized form that can be understood clearly by both lawyers and programmers should be an important step in its conversion into a programmatic form. However, use in the ISDA CDM would also require that the term be broken down into component functions. As noted above, the ISDA CDM contemplates that functions should not be product-specific, and can be combined to form templates relevant to particular products. The ability to develop component functions that can be used with multiple products is an important factor in selecting which parts of a derivatives contract should be initially selected for representation in smart contract form[44]. This forms the third step in framework suggested in this paper.

[42] ISDA has recently commenced a survey of its membership to obtain feedback on a proposed update to the 2006 ISDA Definitions. The update aims to refresh the definitions, consolidate existing supplements into a single version and include results of work across each of the various global benchmark reform initiatives. As part of the survey, ISDA is consulting with members as to whether they would like ISDA to consider redrafting the definitions in a more formal or machine-readable way as a means of supporting industry adoption of new technology, such as smart contracts

[43] For more detailed explanation of the ISDA CDM 1.0, see the ISDA Common Domain Model (ISDA CDM) Supporting Material

[44] Using operative provisions from different types of products in the one derivatives transaction is not new. It is common for equity derivatives to have payment obligations described by both the 2002 Equity Derivative Definitions as well as the 2006 ISDA Definitions

Figure 9



An initial step to identifying operative legal drafting that can be broken down into functions is to identify the same calculation being used for different reasons. For example, both the calculation of the fixed amount and floating amount within the 2006 ISDA Definitions use a very similar mathematical calculation. Both multiply the calculation amount by a particular rate and a particular day count fraction. The difference between the fixed leg and the floating leg of the transaction is the result of the values of the variables applied to them, not the function that calculates them. This makes it possible to develop one function for the determination of an amount by reference to an interest rate (either fixed or floating), as long as the correct elements are input into that function to produce the correct derived observation.

Using the same formalization principles used above, the way the ISDA CDM 1.0 has grouped features together[45] and the use of '(leg)' to refer to the relevant fixed or floating elements[46] (expressed in the ISDA CDM 1.0 as different 'payouts', each comprising a leg of the trade), this function could be written as:

InterestRatePayout(leg):

FOR PaymentDate(n):

EQUALS calculationAmount × interestRate(leg) × dayCountFraction(leg)

The relevant interestRate and dayCountFraction applicable to the leg would be need to be specified (being the observations as described in the ISDA CDM). For example, taking an Australian dollar fixed/floating interest rate swap where the fixed rate is 3.00% and the floating rate references the Australian dollar bank bill swap rate plus a spread of 1.50%, this could be expressed as:

leg(fixed):

interestRate(fixed) -> fixedRate:

EQUALS 3.00 per cent. per annum

dayCountFraction(fixed):

EQUALS Act/365 (Fixed)

[45] In particular, see Figure 6 of the ISDA Common Domain Model (ISDA CDM) Supporting Material, page 16

[46] The term '(leg)' is used in this manner in ISDA's 2011 Equity Derivative Definitions

leg(floating):

interestRate(floating) -> floatingRate:

EQUALS AUD-BBR-BBSW-Bloomberg + 1.50 per cent. per annum

dayCountFraction(floating):

EQUALS Act/365 (Fixed)

Of course, each of the *dayCountFraction* elements and *interestRate(floating)* element are themselves calculations that could be described as functions and should be further defined and formalized[47].

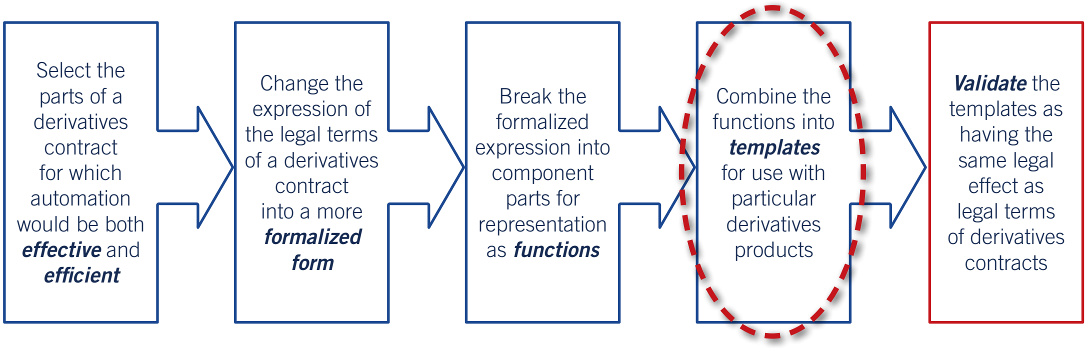
Combination of Functions into Product Templates

The interest rate amount function described above could be utilized in any product where there is an amount payable calculated by reference to an interest rate, or even some other rate. Similar functions are used in credit derivatives, equity derivatives and commodity derivatives, for example.

Other functions could be built that set out other operations used commonly in derivatives. The ISDA CDM 1.0 utilizes this concept by inferring the product through the economic terms and payout classes used, and by identifying features of the components of the transaction. For example, a credit default swap would have a 'CreditDefaultPayout' leg and an 'InterestRatePayout' leg. These functions could also be used in combination with each other to create more complex bespoke derivatives transactions, just as lawyers and market participants use elements of different definition booklets in highly structured transactions today.

This combination of functions into templates for particular products is the fourth step in the framework suggested in this paper. It is also an opportunity for important collaborative work between ISDA and its members, as is currently being progressed through the ISDA CDM 1.0. As noted previously, this step offers the greatest opportunity to make smart derivatives contracts 'smart', and will require a significant amount of cross-disciplinary attention and effort to make them truly effective.

Figure 10



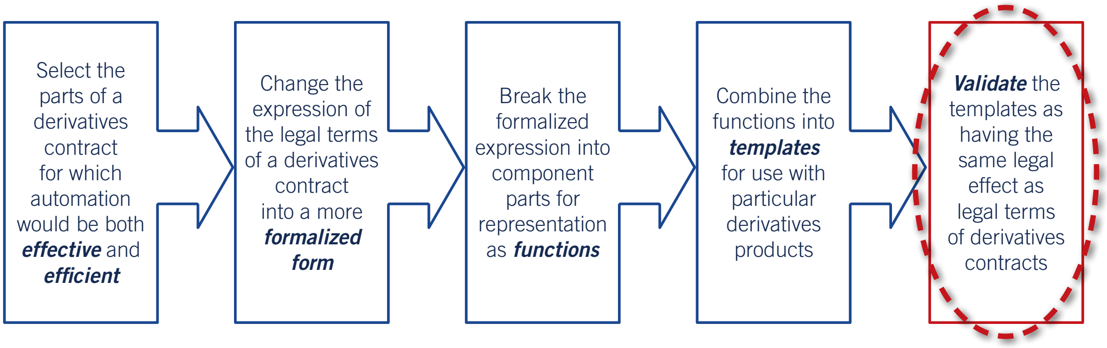
[47] Within the ISDA CDM, these are described as basic elements to highlight the different levels in the hierarchical lineage (see pages 35 and 37). Within the ISDA CDM 1.0, these have been formalized further by including specific day count fraction calculations and arguments, as well as an argument for determining the spread for the particular trade. See common domain model documentation file 'model_cdm_calculations.rosetta'

Validating the Legal Effect of the Product Templates

The final step in the framework suggested in this paper is the validation of the legal effect of the templates of the formalized terms of the selected contractual provisions prepared in the previous four steps. The importance of this was described earlier in this paper in the *Complexity in the Contract* section.

There is no doubt that this will be a challenging task, but perhaps no more challenging than the tasks coordinated by ISDA in the context of its existing documentation framework, which provides legally valid templates to complex financial transactions. A key part to managing this challenge is to involve lawyers in the previous four steps of the framework, rather than waiting until the end of the process. That way, validation becomes the logical end of a discursive process between lawyers, programmers and market participants. There are many ways in which this process could be conducted, and ISDA has many examples from the development of its documentation that it could draw upon to facilitate this.

Figure 11



CONCLUSION

Collaboration between lawyers, technologists and market participants is vital in the creation of smart derivatives contracts

Taking smart derivatives contracts from a promising concept to practical construction in a complicated market-place is a complex task. Not only is it necessary to maintain compliance with technological, commercial, regulatory and legal standards, but it is also necessary for there to be confidence that the legal effect of the derivatives contract is the same whether or not its performance is to be automated. The areas of legal complexity described in this paper mean that this requires coordination of expertise in technology, market practice and law.

ISDA has a proven track record in coordinating expertise to solve complicated problems in the derivatives markets, and the ISDA CDM provides guidance on the way forward for smart derivatives contracts. It could create a representation 'standard' for derivatives contracts and their lifecycle that can be shared across multiple uses – including the construction of smart derivatives contracts.

This paper suggests a practical approach (from a legal perspective) that could be taken to developing smart derivatives contracts, and suggests a number of areas where further work could be beneficial. This includes work in determining principles for selecting which parts of the ISDA documentation framework lend themselves to automation, the framework that should be used for their more formal representation, the distillation of functions from them, and the creation of templates from those functions. It could also include principles for the suspension of automatic performance.

Each of these requires the collaboration of the users of smart derivatives contracts – the participants in the international derivatives market – and each of these would benefit from the involvement of ISDA. This work is important in facilitating safe, efficient markets for derivatives, in whatever form or representation they take in the future.

ABOUT ISDA

Since 1985, ISDA has worked to make the global derivatives markets safer and more efficient. Today, ISDA has over 900 member institutions from 68 countries. These members comprise a broad range of derivatives market participants, including corporations, investment managers, government and supranational entities, insurance companies, energy and commodities firms, and international and regional banks. In addition to market participants, members also include key components of the derivatives market infrastructure, such as exchanges, intermediaries, clearing houses and repositories, as well as law firms, accounting firms and other service providers. Information about ISDA and its activities is available on the Association's website: www.isda.org. Follow us on Twitter @ISDA.

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