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DATE: April 6, 2020

RE: Answers Submitted by ACTUS to the Questions Posed in the BoE Discussion Paper

"Transforming data collection from the UK financial sector"

Introduction

The discussion paper "Transforming data collection from the UK financial sector" poses a
number of questions for consideration. The not-for-profit ACTUS Financial Research
Foundation, which focuses on establishing open-source financial contract/instrument standards
that support forward looking dynamic analysis, is responding to the subset of questions that
directly relate to the work of the Foundation. As a general matter, we support moving to a
"pull system" of data collection using a financial contract/instrument standard for granular
transaction and position data that enables current and forward-looking analysis. With such a
standard, a regulator would no longer have to rely on static snapshots of financial condition
prepared at a moment in time. In contrast, the regulator will be able to follow the dynamics of
evolving firms' conditions in near time, as well as the implications for the financial system.

These capabilities create an entirely new infrastructural layer that transforms regulatory understanding of the financial system and makes regulatory oversight highly adaptable to current and evolving needs. Advances in information technology have made a "pull system" both feasible and cost effective. These advances include high-performance computing, broadband networking technologies, low-cost digital storage, and the demonstrated ability to work with "big data." The technological advances that are able to support a pull system are already in use by industry. They have changed the substance of financial markets and the economy, by enabling speed, automation and globalisation, in ways that make much of the traditional reporting approaches ineffective. The traditional reporting practices will fail, even if granular data is reported, if the relator cannot use the data to support timely and adequate measurement in the event of a shock of unexpected nature that unfolds rapidly, globally, across markets and sectors, in complex, turbulent ways.

We make first some general points that apply to all of the questions for which we provide our views. These points include: 1) What we understand a "pull system" to be; 2) the importance of the right kind of standard; 3) the key element of finance that underlies a financial contract standard; 4) the availability of a financial contract standard; 5) benefits regulators derive from the collection of analysable granular transaction and position data; 6) benefits that financial firms can derive from such an initiative; 7) the need for regulators to take the lead in this effort; and, 8) the importance of establishing a path to the envisioned ultimate end point for major reform of regulatory reporting. We discuss these matters first to provide a clear overview of what we see as the best approach to meeting the needs of 21st century regulatory reporting

1)   **What we understand a "pull system" to be:**
There is a shared understanding that a "pull system" would collect data on the individual financial contract/instrument level. However, beyond that consensus, there can be alternative views on what this means, in practice. One interpretation is that it involves the collection of analytical results data about individual contracts/instruments under different states of the world. For example, the fair market value of the individual

contracts/instruments under a specified stress scenario. We believe that using this approach to collecting granular data would be a serious mistake. Collecting such data would not be a meaningful improvement over the current state of regulatory reporting because that data would be static, it would provide answers only to the specific questions posed by the regulator, and not suitable for further analysis. For example, it would not enable regulators to better understand systemic vulnerabilities under alternative scenarios nor would it provide the specific insights needed to react to rapidly unfolding crises of an unforeseen nature.

Only a "pull system" that collects granular data in a financial contract/instrument standard that makes it possible to perform current and forward-looking analysis can transform and radically improve the quality and efficiency of regulatory reporting and oversight. In other words, only a financial contract standard that enables the generation of current and state-contingent cash flows across the system (which is formed by all financial contracts/transactions, products, and firms) would be a major improvement over the current state of affairs. A standard with this ability is essential because financial analysis starts with the promised cash-flow (i.e. payment) obligations of individual financial contracts/instruments. It provides the regulator with the capability to answer new questions without imposing additional reporting requirements on the banks and, more importantly, having to wait for the banks to respond, with insight possibly coming too late, as a consequence.

2)   **The Importance of the Right Kind of Standard**:
Regulators can collect and analyse granular transaction and position data to gain better insight into both the condition of individual financial institutions (microprudential regulation) and systemic risks to financial markets and the real economy (macroprudential regulation). The two fields of insight will be consistent with one another, as both are generated from the same granular data; they will therefore also enable much richer analysis, linking micro to macro as the situation demands. As noted above, a standard for financial contracts/instruments that enables current and forward-

looking dynamic analysis and flexible aggregation is essential for such a task. We use the terminology "standard for financial contracts/instruments that enables current and forward-looking dynamic analysis" as opposed to a "data standard" for a very important reason. Current data standards in the financial world typically include only the terms of financial contracts, such as interest rates, notional amounts, or day-count methods. Contract terms of this kind are not, by themselves, sufficient to generate the precise payment obligations with respect to amounts and timing that are needed for current and forward-looking analysis.   Only a standardised contract representation that can generate promised payment obligations can enable the type of analysis needed for better informed regulatory oversight. It can also enable better operations, lower cost and risks, in industry. Regulators, by fostering and using a standard with these capabilities, would gain the ability to aggregate analytical results according to any desired criteria (by portfolio, product, institution, etc.) to realize better informed regulatory oversight. Actually, much of the analysis needed in a digital-age crisis would become possible only with such an approach.

Widely used financial industry data standards were neither created for analytical purposes nor are they able to support financial and risk analysis. They were primarily created for electronic messaging needed to support the automated clearing and settlement of financial instrument trades. These data standards are unable to support dynamic analysis on their own. Such analysis requires both the contract terms and a mathematical representation/interpretation of the meaning of the natural language contracts.

The importance of this observation cannot be overstated. All financial institutions' operations that involve the analysis of their financial instruments/contracts start with their contracts' promised payment/cash-flow obligations. In other words, the cash flow obligations created by a contract's terms interacting with the meaning of the contract. The transaction processing systems compute on a daily basis what a bank expects to receive (and from whom), and what a bank has to pay (and to whom). Risk management starts with the promised payments and then proceeds to analyse how

different states of the world might affect the promised payments. Similarly, liquidity

analysis starts with the promised payments and expected receipts in order to determine

the need to access financial markets to supplement internal liquidity. Pre-trade analysis

starts with the payment obligations of the traded instruments to determine an

appropriate price for the trade. Even the accounting reports start with the payments

made and received in order to establish the income and balance sheet accounts.

The following provides a graphic representation of what we are discussing. On the left is

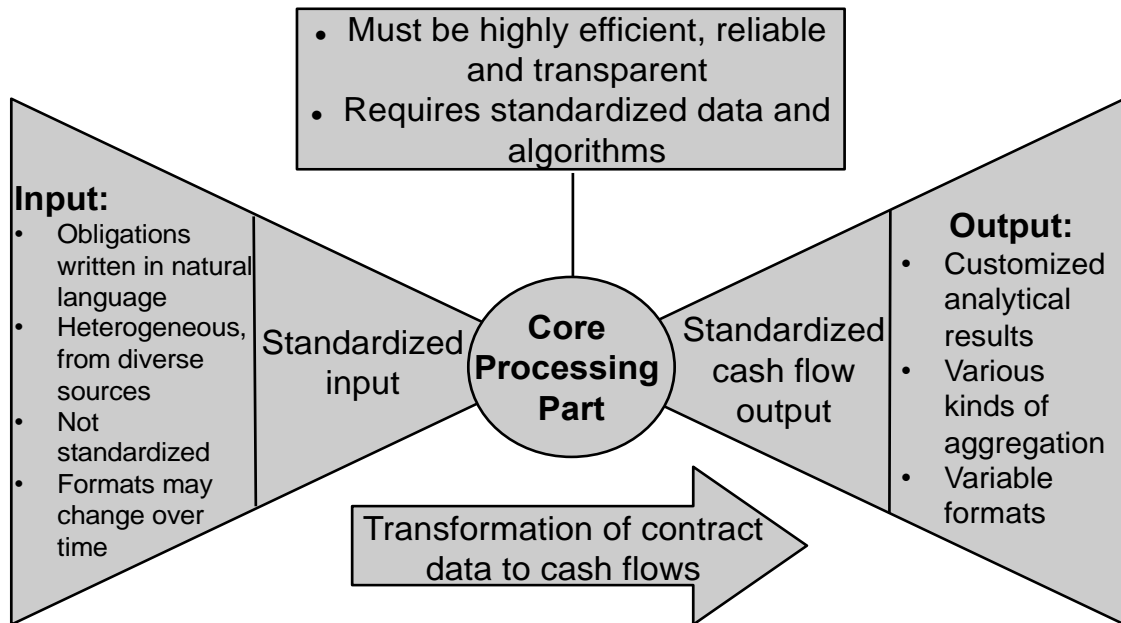the current non-standardized financial data. On the right is the critical analytical output

Figure 1 The Bowtie structure of financial information transformation represents the placement and role of an algorithmic standard for financial contracts/instruments. While input and output are diverse, the core can be represented by a limited number of financial Contract Types with a standardized data dictionary and standardized algorithms. This combines flexibility of both inputs and outputs with a higly robust and efficient core.

needed by both regulators and bank leadership. The best way to connect the two

wings of this bowtie-like structure[1] is with at standardized representation of the

granular financial contracts that makes it possible to simultaneously achieve reliability,

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[1] This type of structure is found in many complex systems such as metabolism in biology or infrastructure layers of complex (global) IT systems. In such representations it is called the hour-glass structure. Standardization should be carried out in the center of this structure in a way that fully supports its function.

flexibility, efficiency, and robustness in the analytical outputs. This is made possible by a new standardized infrastructure layer for the core processing systems of finance.

Only a financial contract/instrument standard that incorporates both 1) a data dictionary with all necessary contract terms, and 2) a mathematical representation of how to compute the payment obligations that are embedded in the natural language financial contracts can play the role of the core in Figure 1, specifically because it supports financial analysis.

The proposal is for a shift from a description of contracts, where each type of contract is described in a different language inherited from practitioners, to a mathematically rigorous representation of any contract as an algorithm, whereby all types of contracts would be represented in the same language. This can be viewed as analogous to the universal "genetic code". With the language of genetics all species are built from the same toolbox of genes and, hence, they can all be treated as part of a single pool. This is in contrast to the old descriptive phenomenological approach of the zoological ontology, which treats each species as different and unique. For risk analysts, markets have now become a single, global, fast-moving pool.

3) **The Key Element of Finance That Underlies a Financial Contract Standard**:
The financial markets contain many thousands of different financial products whose obligations are described in natural language. They reside in the far left of the bowtie in Figure 1. However, their payment obligations can all be derived from the modular and possibly recursive application of a very limited number of cash-flow patterns which represent the core of the bowtie in Figure 1. In fact, less than three dozen such patterns are required to represent the cash flow obligations of almost all financial contracts extant in financial markets. Those patterns can be represented most precisely in mathematical (algorithmic) form. This insight underlies the work of the ACTUS Financial Research Foundation in building the ACTUS Algorithmic Financial Contract Standards. The ACTUS standard begins with bottom-up empirical observations of the financial

markets and distils from these observations the essential theoretical structure, rather than imposing an artificial structure created by a top-down approach.

4) **The Availability of a Financial Contract Standard**:

The only publicly available, open-source financial contract standard that enables forward-looking dynamic financial analysis that we are aware of is the ACTUS Algorithmic Financial Contract Standards, developed and supported by the not-for-profit ACTUS Financial Research Foundation.[2]

The ACTUS standard was created from the outset to be a public good[3] that is available without any charges or fees to anyone who is interested in using it, and consists of:

- the ACTUS Data Dictionary, which includes all needed contract terms and is available in a human readable format;
- the Technical Specification of the ACTUS Contract Types (CTs), which together represent almost all of the payment/cash-flow patterns that are extant in financial market contracts; and,
- an open-source Github repository that includes:

  (a) a Java library reference implementation of the ACTUS Contract Types;

  (b) a machine-readable JSON version of the Data Dictionary and the business rules for conditional dependencies among groups of optional contract terms whose combinations determine the characteristics expressed by different financial products; and

  (c) an open-source web application that demonstrates not only the cash flows of different financial product configurations generated by ACTUS, but also

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[2] A proof of concept of this standard has been published in Wolfgang Breymann, Nils Bundi, Jonas Heitz, Johannes Micheler, and Kurt Stockinger, Large-Scale Data-Driven Financial Risk Assessment. In Martin Braschler et al. [eds.], Applied Data Science. Cham, 2019.

[3] The theoretical foundations of ACTUS can be found in Brammertz, W, et. al., Unified Financial Analysis: The Missing Links of Finance, John Wiley & Sons Ldt, UK, 2009. The ACTUS initiative has benefited from the generous support of the Alfred P. Sloan Foundation and Zurich University of Applied Sciences.

the ease with which a cloud-based, microservice application can be realized with ACTUS.

5) **Benefits Regulators Derive from Collecting Analysable Granular Transaction and Position Data**:

Current regulatory reporting tends to be focused on responding to specific mandates which result in reports that are inflexible, costly to modify, and – frequently -- not timely. Regulatory reports typically start with a particular question in mind that the report is intended to answer. This approach may have certain advantages; however, the big disadvantage is the fact that answers are provided only for the questions asked, and the form of the answers might be neither directly revelatory nor useful for further analysis. On the other hand, the collection of analysable granular data enables the regulator to emulate a senior risk officer who can analyse the data at will with a multitude of possible perspectives, classifications, aggregations and scenarios.

The ACTUS standard starts out by describing the "happy path" of the contracts, the path a contract takes if all commitments are followed and if the surrounding environment is favourable to meeting the contractual obligations. It provides the "unhappy path" when the risk environment is disruptive to meeting the contractual obligations. A regulator is, of course, interested in all the possible "unhappy paths", i.e. those in which actual payments may diverge from the original, contractual commitments and obligations. To understand the net impact in such circumstances, the analyst must start out with the promised payments and then derive the state-contingent cash flows that reflect the potential impact of various risks or interruptions of the promised payments. Therefore, as new questions arise and new threats emerge, the regulator can independently analyse the financial contract data of reporting institutions to more quickly understand the implications of the new risk environment. Hence, the regulator is assured timely insights into the implications of the emerging threats. In addition, it would no longer be

necessary to impose new reporting requirements on regulated firms, thereby alleviating the burden placed on them.

In addition, such analyses can include something individual bank reports can never provide to the regulator; direct insights into the quantifiable interconnectedness between major firms in the market and the risks that they pose. This analysis, of course, also requires unique identifiers for counterparties, such as the Global Legal Entity Identifier (LEI) or some other widely used system of counterparty identifiers.

6) **Benefits Financial Firms Can Derive from Such an Initiative**:

Data in the financial sector is highly problematic and, in fact, rather chaotic. Data systems evolved as needed for operational purposes without any global standardization. Systems deployed to perform the same function for different financial products use different logic, different programming languages, and refer to the same contract terms with different names. The same contract may be represented multiple times in different systems in different ways.

The result is that the many functions of a financial institution that rely on the granular transaction and position data of the firm have a hard time getting what is needed, and when it is obtained, it involves significant costs. The maintenance of disparate systems and silos is very costly and makes complying with regulatory requests unnecessarily burdensome.

Deploying a financial contract standard can significantly reduce the operating costs of a financial institution. The current situation can be replaced with a "write once, read many times" alternative. A single standardized representation of each contract can be used to feed all of the systems that start with or rely upon an understanding of promised cash-flows: transaction processing, risk management, pre-trade analysis,

asset-liability management, liquidity analysis, profit and loss estimation, financial planning, and even accounting records.

There is – we think – no need for regulatory efforts to directly promote the adoption of the standard for internal uses by financial institutions. We believe that it is sufficient for the BoE/FCA to collect the data for their own use in this standard. Banks will see the benefits of the financial contract standard and adopt it voluntarily for internal use.

7) **The Need for Regulators to Take the Lead in this Effort**:

The case for standardizing the representation of financial contracts/instruments in a standard that supports analysis appears to be an easy one to make. Nevertheless, the financial sector, on its own, has not been able to make it happen. The internal systems in banks have not been standardized because for many years they have grown incrementally, as needs have arisen. Incompatible systems were cobbled together as acquisitions have occurred and extended as time went by. This state of affairs has resulted in a large number of different systems that use different programming languages, apply different logic, and even call the same financial terms by different names. That history has made many systems more complex than necessary, adding risk but no value, and making them costly to maintain and expensive to adapt to meet new needs. In this way the industry as a whole has added "technogenous" opacity to markets that are already overly complex. Nevertheless, despite their costs, they still work "well enough" to avoid sufficient pressure for wholesale change. Additionally, because all banks suffer from the same inefficiency, they feel no competitive pressure to transform their internal systems. Lastly, to the extent that capturing some of the potential benefits relies on network effects, there is less incentive for a single firm to be the first mover. Being an early adopter would still leave a firm exposed to messy data coming from its counter-parties after having invested in the new technology.

The only times that the industry has come together to create and adopt a data standard were to meet a critical operational need that directly affected revenue. One example was the development of a messaging standard that was needed for automated clearing and settlement of derivatives. This data standard was developed when rising trading volume for derivatives overwhelmed the ability of manual clearing and settlement to keep up, thus adversely affecting derivatives trading and revenues. As this example indicates, establishment of a data or a financial contract/instrument standard requires sufficient impetus to overcome the difficulty of collective action needed for significant improvement.

The regulatory need for better data and analytics would be the lever to overcome the impediments to significant improvement by removing the need for collective action to start the process. Once the regulator requires the submission of data in the standard, the conditions will be set for the banks to start using it for their own purposes in order to capture the inherent benefits. Broader use of the standard will require no regulatory intervention beyond the requirement that financial institutions report their granular data in the standard. Once financial firms map their granular data into the standard for regulatory reporting purposes, the marginal cost of capturing the benefits of a "write once read many times" data management solution would be significantly reduced.

8) **The Importance of Establishing a Path to the Envisioned Ultimate End Point of Regulatory Reporting Reform**:
Regulatory reporting typically imposes high costs and rarely yields benefits commensurate with the costs. This state of affairs creates the potential for a win/win reform of regulatory reporting. If reporting reforms are done in the right way, they hold out the potential for greatly improved regulatory insight into both the condition of individual firms and systemic risks. Financial institutions can realize a windfall benefit, as well, from reduced reporting costs and significantly reduced operating costs made

possible by shareable, standardized representations of financial contracts/instruments that support analysis.

In addition, the efficiency of financial markets can improve with the greater transparency that comes with a clearer understanding of the obligations of financial contracts/instruments.

However, if a partial reform is established that represents only an intermediate or partial improvement over the current circumstances, it will make it harder to ever realize all of the benefits and cost reductions that are waiting to be captured. Intermediate solutions always create a new status quo, which itself creates resistance to further changes. Resources are expended to meet the obligations of the intermediate solution, which, in turn, makes it all the harder to move from that new status quo to the best long-term, strategic reform. Success in this effort requires a clearly articulated vision on where the reform effort will conclude, as well as, the path that will be taken to get there. In particular, it would be a counterproductive blunder to start the process of standardizing financial contract terms (i.e. the contract data) in a data standard that is not an integral part of a financial contract standard that includes both data and algorithms. You will not be able to reliably generate the necessary output of the algorithms needed for analysis if the contract terms are standardized without regard to what terms are needed to run the standardized algorithms.

Responses to the specific questions posed by the Discussion Paper

Overall

A. Which of the solutions identified (or combination of solutions) do you see as most attractive to explore further as a long-term goal, and why? Are there other promising options we have not considered?

The most promising alternative that you have proposed is the "pull system". This alternative holds out the promise of far greater near-time insight into risks to both individual financial firms and the financial system, as has been pointed out by Kavassalis, et al. (2018).[4] The rapid spread of the COVID-19 virus with its attendant major economic and financial disruptions highlights the need for the ongoing collection of such analysable granular data. Once a crisis begins it is too late to begin identifying and collecting data needed to understand what is happening. Furthermore, the infrastructure required for such a system holds out the promise of significantly lower regulatory reporting costs, as well as large reductions in financial institution operating costs. We received some insight into likely cost savings while we were developing a proposal to move to a regulatory reporting system built on the collection of granular data in a standard similar to what we have been talking about above. A major investment bank estimated that moving to such a system would reduce the bank's annual operating costs by 20 to 30 percent. However, it is important to emphasize that the "pull system" can only work if it is combined with the type of financial instrument/contract standard discussed above.

- *Granular data*: By this we mean data on the level of individual financial instrument/contracts.
- *The Standard*: By this we mean a standard for financial instruments/contracts that encompasses both the algorithmic representation of a contract's obligations and the contract terms *which together* are needed to generate payment obligations. A contract

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[4] Petros Kavassalis, Harald Stieber, Wolfgang Breymann, Keith Saxton, Francis Joseph Gross (2018). An innovative RegTech approach to financial risk monitoring and supervisory reporting. J. Risk Finance **19** (1), pp.39-55, https://doi.org/10.1108/JRF-07-2017-0111.

can then be written once and then consistently analysed in multiple independent systems because of the standardized cash-flow generating algorithm.

We are not aware of a more promising option that can significantly improve the quality of regulatory oversight and reduce the burden of regulatory reporting.

B. What do you see as the most useful actions to take as interim steps towards such a goal?

It is important to have a path to reform with step-by-step adoption. However, it is very dangerous to focus on interim steps without a clear articulation of the end goal of the reform. The most important first interim action is a clear articulation of the end goal of the regulatory reporting reform: the collection of granular financial contract data in a standard that enables the regulator to perform all desired analysis. It is critical that everyone involved in and affected by these reforms understand at the very beginning of the process the type of financial contract standard that will be adopted, where the reform will end up, and the benefits that will be realized by achieving the reforms.

After the articulation of a clear path forward, the interim steps should include the gradual phasing in of the infrastructure needed to move to a "pull system". The interim steps should start with the granular data that is easiest to standardize and collect. These include the types of financial contracts that are most widely used by financial institutions -- such as, loans, mortgages, deposits, bonds, stocks and interest rate swaps. These types of contracts are generally easy to map into a contract standard and cover a very large share of all existing contracts by number and aggregate amounts. It would be a good way to start familiarizing the financial community with the concepts needed to put a "pull system" into operation.

Such initial steps would not be very difficult to complete. Nearly all banks have deployed Asset Liability Management (ALM) models, and hence would be familiar with the basics of this approach because they all have had to map the granular data on their balance sheets into their ALM models.

Subsequent steps could cover more complex instruments, as well as, ancillary information necessary for regulation. Such ancillary information would include:

- Counterparty information
- Additional information necessary for grouping and aggregation, which might be for either regulatory uses or to meet internal operational needs.
- Accounting rules. Accounting values are primarily derived from the expected cash-flows provided by the standardized representation of the instruments/contracts. Therefore, if accounting values are desired, accounting rules could be added by which accounting values can be derived

C. Which sectors/reports should be prioritised, or excluded, in relation to the long-term goal and the interim steps?

As discussed above, reporting reform should focus on the collection of standardized financial contract data. Over time, the requirement to provide most static reports should be eliminated. The reports that can be eliminated first are the ones that the regulator can easily produce internally with the reported standardized granular data. At some point the only remaining financial risk related regulatory reports would most likely relate to what regulators need to assess how risk factors are modelled internally by the banks. Of course, reports that depend not only on the financial analysis of standardized granular contract data would still be needed. Examples of such types of reports include compliance with Know Your Customer (KYC) and Anti-Money Laundering (AML) regulations. However, when the contract standard is combined with standardized counter-party identifiers it could contribute in such areas, as well. The answer we have provided to question B lists the types of financial products that should be initially mapped into the standard and subsequently collected by a "pull system". In addition, banks would be the best sector with which to start because they are fully in the regulatory orbit and should react positively to an initiative that can both reduce their regulatory reporting burden and increase their insight into the operations of their own institutions. In the longer term, all

financial sectors /activity could be included, such as that of insurance companies, asset managers, non-bank lenders, etc.

D. In what respects do you consider it most important that the Bank coordinates reforms to data collection with other UK or international authorities?

We think the advantages of a common standard are clear and, therefore, coordination with other authorities that leads to broader use of the financial instrument/contract standard is important. Broader adoption of the standard can further expand the realized benefits because of network effects.

The obvious starting point is coordination with the FCA. However, once a decision is made to initiate such reforms, coordination with other nations' regulatory agencies and multinational bodies is the next logical step. The BoE would be in a unique leadership role as the "first mover" for this type of reform. As such, candidates for coordination should include the Financial Stability Board (FSB), The Basel Committee, the U.S. regulatory agencies (the Federal Reserve Board (Fed), the Comptroller of the Currency (OCC), the Federal Deposit Insurance Corporation (FDIC)), and the U.S. Office of Financial Research (OFR), the European Central Bank (ECB), the European Banking Authority (EBA), the European Securities and Markets Authority (ESMA) and other nation's central banks and regulatory authorities.

E. What do you see as the most significant wider benefits to firms or to the financial system from improvements to data collection, beyond cost reduction?

The adoption of a financial instrument/contract standard as part of a "pull system" would improve transparency in financial markets and contribute to the reestablishment of trust. One of the recognized problems in financial markets is asymmetrical access to information. The "buy side" seems to always be at a disadvantage when it comes to investing its funds. A standard like the one discussed above provides a way to better assess how an investment will perform as the risk environment changes. Hence, deploying such a standard would help level the playing field between the buy side and the sell side. The importance of such an approach to

a better understanding of finance is reflected by the integration of the ACTUS standard into the course of studies of the joint Master of Science in Quantitative Finance offered by the University of Zurich and ETH Zurich.

Similarly, retail customers would have an easier time understanding the liabilities they assume when borrowing from financial institutions. Mortgages, car loans, credit cards, and other consumer debt are typically described in terms of interest rates and other components of a term sheet. However, most retail borrowers really need to know how much they are going to have to pay every month on new debt so they can better evaluate whether the debt service will fit within their household budgets. The use of a contract standard would make it easier to offer reliable web-based services for retail borrowers to better understand the obligations they are taking on.

We also believe that such a standard would be a powerful tool for promoting financial literacy and the democratisation of finance. Using the financial contract standard to teach basic finance as part of a standard school curriculum could reverse the current low level of financial literacy amongst students and the population more broadly. Zurich University of Applied Sciences has already initiated course work built around the ACTUS standard and has reported good results in using the standard to more effectively convey financial concepts and understanding.[5] Similar results have been achieved at a higher technical level in the previously mentioned University of Zurich/ETH Zurich joint Masters of Science in Quantitative Finance.

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[5] Wolfgang Breymann, Introduction to Integrated Risk and Profitability Management, Lecture Notes, Winterthur, 2019, unpublished.

Costs (Chapter 3)

F. What are the most significant areas of avoidable cost and challenge associated with the current reporting process, and what is the relative burden associated with different steps and types of report, as set out in the discussion paper?

As it stands now each regulatory request spurs a flurry of activity. First there is the effort needed to understand the substance of the request and how to "make the regulator happy." This phase of the response does not usually include an examination of whether the request makes sense to the firm. The next phase is what can be a long and costly process involving the provisioning of IT resources and development efforts needed to extract the data to create the requested report. The last phase involves the dedicated business teams that produce and format the requested report which ultimately includes more or less precise results. Most significantly, under the current approach each request can initiate a new stand-alone – and ongoing -- project with few synergies between projects responsible for the responses to other regulatory requirements and requests.

In contrast, while a "pull system" based on the collection and analysis of standardized granular contract data does require upfront investments, in the longer run it will eliminate all of these ongoing and reoccurring reporting costs. Hence, a "pull system" would be far less costly for reporting institutions. A paper presented at the European Commission's Data for Policy 2017 conference spoke to this question directly.[6] The paper explains the main features of a "report once" demonstrator for regulatory reporting using, among other components, granular contract data in the ACTUS standard. They found that such a system could generate (financial risk) reports in semi-real time. In addition, when they focused on the efficiency of such an approach, they concluded that it could generate these reports at "virtually zero marginal cost."

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[6] Sel, Marc and Diedrich, Henning and Demeester, Sander and Stieber, Harald, How Smart Contracts Can Implement 'Report Once' (September 6, 2017). Available at SSRN: https://ssrn.com/abstract=3111508 or http://dx.doi.org/10.2139/ssrn.3111508

The mapping of assets and liabilities into the standard will not be costless. However, in the long run, the costs of the new system will be significantly lower than the current status quo. We can even provide a relative cost estimate of such an undertaking. Banks go through such exercises whenever a new enterprise risk management (ERM) system is implemented or a new asset/liability management (ALM) system is installed. Such acquisitions require the mapping of a bank's contract data into the data model of the new system, a process that is comparable to mapping a bank's contract data into a new standard like ACTUS. The upper bound for the cost of mapping a bank's assets and liabilities into a new standard would be what is currently required to implement a new ERM or ALM system. The costs are not excessively high because banks execute such mapping exercises whenever a new model is implemented, which happens every so often. We have carried out such projects many times in our professional careers and can attest to how they are done.

In addition, a new IT infrastructure for reporting the granular contract data will need to be built along with an enhanced analytical capability at the regulator. While the initial reporting would include all of the contracts in a portfolio or on a balance sheet, subsequent reporting would be far more limited. That is, that reporting would only need to include the incremental changes that take place to the portfolio or balance sheet. As to the computational burden of processing the analysis of the large volume of granular contract data, it has been demonstrated that the execution time for 96 million contracts is around 15 minutes when it is performed on a cloud with 512 nodes.[7] A research proposal is currently being prepared for the purpose of determining a reliable cost estimate of what would be required to adopt the new IT infrastructure needed by such a system. The project will build a real-world sized demonstrator that will highlight the needed reporting infrastructure, the technological components that need development, and its costs. The investigators intend to be in close contact and coordinate with interested regulators.[8]

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[7] Kurt Stockinger, Nils Bundi, Jonas Heitz, Wolfgang Breymann (2019). Scalable architecture for Big Data financial analytics: user-defined functions vs. SQL. J. Big Data 6 (46), pp 1-24, https://doi.org/10.1186/s40537-019-0209-0.
[8] Wolfgang Breymann, Walter Farkas and Tim Weingärtner, Data-Driven Financial Risk and Regulatory Reporting. Proposal for a Bridge Discovery Project of the Swiss National Science Foundation to be submitted by 11 May 2020.

G. What non-regulatory developments might have a significant effect on reporting costs and challenges over the next decade (e.g. systems redesigns, use of cloud, AI, market developments)?

The system we propose isolates the information needed for regulation (and other analytic uses) and removes or reduces many system dependencies. This is represented in Figure 1 as the core of the bowtie. The isolation of the granular data to be collected from system dependencies means that system redesigns and new technologies should not cause increases in regulatory reporting costs. As a result, the regulatory reporting burden associated with system and technological changes will be much smaller than is currently the case. There will be new services using new technologies, such as AI and distributed ledgers, that are outside the traditional banking sphere. These emerging services will provide significant new regulatory challenges. However, they will ultimately rely on the same type of cash-flow patterns as traditional financial contracts and, therefore, will be covered by the ACTUS standard. Hence, the system we propose will also provide an efficient way to understand what is happening as these new services evolve.

As we have said, infrastructure upgrades and enhancements are not without costs, but the "non-invasive" approach of extracting settled data in a read-only fashion from systems of record obviates any requirement to get into the existing transaction processing plumbing or message busses of a bank's IT infrastructure. Such extractions can be repeated on an as-needed basis (monthly, weekly, or even daily) without disturbing the ongoing operations of an institution. Furthermore, most firms are not aware of how current metadata mapping tools and utilities can greatly facilitate this process.

Most importantly, the up-front cost of strategic improvements in extracting and mapping financial contract data will provide ongoing efficiencies and cost-reductions in so many downstream uses that the return on investment of such efforts makes them extremely compelling.

There is a major difference between implementing traditional, proprietary (and "monolithic") risk management and regulatory reporting systems versus implementing data management and analytics using the ACTUS standard. Once implemented, the new standard would remove the need for future re-mapping of assets and liabilities into yet more proprietary, custom, or dedicated solutions. The standardization exercise and mapping that we propose would be well worth its cost since it would lower both future operating costs and significantly reduce regulatory reporting costs.

Common data inputs (Chapter 6)

H. What are your views on the benefits and challenges from seeking to define a common set of data points as the basis for reporting?
As we have pointed out in the introduction, the potential benefits are tremendous. However, whether the common data points can deliver the potential benefits depends on how they are defined. The benefits can only be realized if the common data points are derived from a financial contract standard that can generate contract level cash-flows. We refer the reader to our introductory discussion in topics 2 and 3.

I. What additional benefits and challenges would arise from seeking to use industry data standards as the basis for defining reporting requirements? What should the role of regulators be in the development and adoption of such standards?
Widely used existing industry data standards are not able to represent granular data in a way that supports the analysis needed by regulators. Therefore, any attempt to start the reform of regulatory reporting by relying on data represented in a widely used industry data standard is doomed to fail. A standard has to be fit for purpose, and only a standard that supports analysis can realize the objectives of reforming the current approach to regulatory reporting. The importance of the right kind of standard is discussed in depth in topic 2 of our introductory comments. If granular data is collected using the right kind of standard, regulators would find it

much easier and quicker to receive needed reporting in response to evolving circumstances. Such an approach ensures that regulatory reports remain relevant in whatever the current circumstances happen to be. It will also eliminate regulatory window dressing and other optimizing behaviour by the banks.

As discussed in our introductory comments, the use of an algorithmic financial contract/instrument standard is required for a successful "pull system." However, despite the significant benefits that will accrue to industry from the use of such a standard, industry has not been able to make it happen on its own. Hence, the only way that a "pull system" can be effectively implemented is if regulators take the lead in defining the standard and requiring its adoption for regulatory reporting. We believe that once the process starts and financial firms realize how much they are likely to gain, they will be supporters of the reform.[9]

Modernising reporting instructions (Chapter 7)

J. What are your views on the benefits and challenges of the possible improvements to reporting instructions set out in the paper?
We believe that the advantages of a "pull system" are so great that they outweigh by far any benefits that could be gained by the alternative of digitizing current reporting instructions.

Most of the efforts of the industry have gone into standardising "natural language" contract terms contained in data bases that have been called, over time, by various names: data warehouses, data marts, data lakes etc. Even efforts to create financial instrument ontologies

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[9] There has recently been an increase in the interest in the ACTUS standard by organizations serving legacy financial firms. The ACTUS Foundation and BIAN, the Banking Industry Architecture Network, are collaborating to show the synergy and alignment between their respective standards as a way to bring greater value and benefits to the financial sector. In order to demonstrate these benefits, we are working together on a proof-of-concept that illustrates the integration of the two organizations' standards and the value add for the whole industry

are, in essence, efforts to standardize the meaning of financial contract terms expressed in natural language.

We believe that semantic definitions and models typically capture only a partial picture of the contractual cash flow obligations. It is the cash-flow generating algorithmic code that generates promised and expected cash-flows representing the terms of the contracts. In other words, the impact and effect ("meaning") of contract terms can only be fully understood in combination with the algorithms that faithfully embody and express, in mathematical terms, the natural language contract. Furthermore, these algorithms need to operate on the granular contract level.

When the contract terms (interest rate, principle, etc.) and the algorithms are standardized it is possible to consistently generate both a contract's promised payment obligations and the expected cash-flows resulting from alternative risk scenarios that can be used by any involved party, whether a lender, a borrower, or a regulator. We refer the reader to the discussion in our introductory comments.

We also believe – based on much practical experience in the field – that the difficulties in adopting a financial contract standard are not that great and are well worth the effort when compared to the significant reduction of the regulatory reporting burden and the potential for lower operating costs for the banks.

Governance and architecture (Chapter 8)

K. What are your views on the benefits and challenges of the possible changes to architecture and governance set out in the paper – in particular moving to a "pull" model for certain types of data, or moving some functions to a central service provider?
We think we have discussed the benefits and challenges of the "pull" model in the discussion above. We are convinced that the benefits clearly outweigh the costs.

From a governance perspective, a "pull" model does create a new requirement. The effectiveness and value of such a system depends on how accurately a financial institution's assets and liabilities are mapped into the financial contract standard.

The regulator can rely on the analysis of the granular contract data only if the mapping is done accurately. Without assurance of an accurate mapping the regulator will not be able to realize better oversight of risk. Therefore, the regulator will need to create a mechanism to check the accuracy of the mapping of banks' contracts into the algorithmic standard. This quality assurance check can be carried out at the individual contract level by comparing the promised cash-flows calculated by each bank's transaction processing systems and the cash-flows calculated by, for example, the ACTUS code. This test is proposed because the transaction processing systems are the de-facto algorithmic representation of each bank's contracts because they are used to determine daily payment obligations. If a comparison of calculated cash-flows between the transaction processing systems and the standard are within a very small predefined difference, the mapping into the algorithmic standard is correct. While, the mapping would be the responsibility of the bank, establishing oversight of the mapping would be the responsibility of the regulator. This task can be performed by the regulator directly or by a trusted third party, such as the banks' auditors.

How does this oversight process compare with the existing situation? The current state of affairs is far more error prone than an approach that relies on a "pull" model for granular data represented in a validated algorithmic standard. Current regulatory reporting is mostly on the analytical results level. For example, in the annual stress test exercises, the regulator stipulates the stress scenarios and the banks return their resulting capital levels for each stress scenario. There are many ways in which errors can creep into the long chain between the banks' contracts and the analytical results. It is very difficult to identify the extent of such errors and what causes them. One important source of errors is the failure to rigorously separate cash-

flow generation from risk factor models (e.g. the modelling of market risk and credit risk). These inherent model risks cannot be overstated.

The most reliable way of reducing inherent susceptibility to errors and model risk is by 1) clearly separating the deterministic contract data and algorithms from the stochastic risk factor models, and by 2) assuring consistency between the cash-flow generation of the transaction processing systems and the analytical systems.

In addition, the regulators will need to assess how moving to a "pull" model will alter the required skill mix of their staff in at least two ways:

1. Regulators will have the same capabilities as a risk manager, e.g. they will have the same data and analytical capability at their fingertips. Sufficient staff numbers and skills need to be available to work with the new data, build and/or use models of risk factors (such as market risk, counterparty risk, and behaviour risk), and produce the required reports in near time. Hence the regulators will need to increase the numbers of their currently available staff with those skills.

2. Regulators will need to bolster their information technology capabilities. Regulators will need more computing power than they currently have (cf. footnote 7), along with the skills and support of technical staff, to maintain and operate such capacity. Computing resources can be provisioned in-house or secured through cloud computing.

Regulators will also have to build a security layer around this data, especially with respect to the protection of data containing private information. In order to protect privacy, laws must be developed and enforced to restrict access to and the use of some counterparty details. The value of many types of analysis do not depend on detailed counterparty information. And, it is technically easy to anonymise contract level data.

Once the decision is made to move to a "pull system" regulators can explore ways to reduce the cost or to improve the speed of analysis of the granular contract data. Financial contract data

compression can be used to make working with the raw data more manageable. Such techniques can be based on the foundation provided by the ACTUS Data Dictionary and Contract Type specification while still producing reliable analytical results. In order to check the reliability of the analysis of the compressed data, regulators could alternate between periodically analysing the complete data set and the compressed data set.

Lastly, we do not see a role for a central service provider at the individual contract level. In fact, such a function could be problematic if the financial institutions do not trust that the service provider can insure protection of business confidential information. It could also stifle competition, invention and progress in general.

We envision that an entire competitive industry providing analytic services will develop organically around the algorithmic financial contract standard. This will happen without any regulatory intervention other than requiring that data be reported to the regulator in the algorithmic financial contract standard. Regulators will be able to benefit from vendors offering analytic services by comparing, for example, the results of different ways of modelling risk factors, such as market risk and credit risk. Additionally, new analytic techniques or better data compression approaches could be developed by such vendors. These developments with a stable financial contract standard in the centre should not only reduce model risk, but drive innovation in the financial sector, as well.

We are also convinced that banks will see the benefits and use the algorithmic financial standard for internal operational purposes. And, in the end, they could turn out to be the biggest beneficiaries from these developments.