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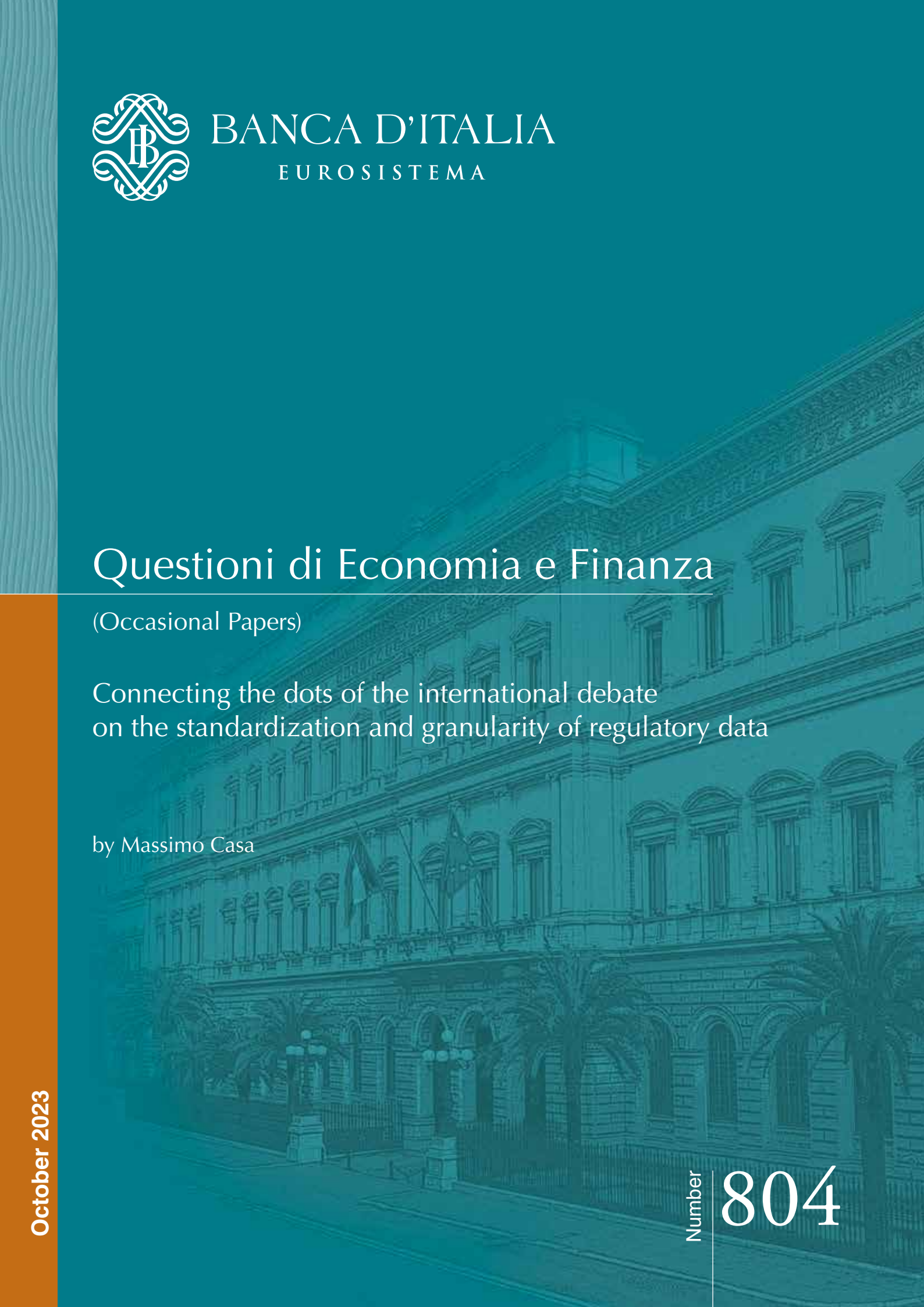

Questioni di Economia e Finanza

(Occasional Papers)

Connecting the dots of the international debate on the standardization and granularity of regulatory data

by Massimo Casa

October 2023

Number 804

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CONNECTING THE DOTS OF THE INTERNATIONAL DEBATE ON THE STANDARDIZATION AND GRANULARITY OF REGULATORY DATA

by Massimo Casa[1]

Abstract

The European banking reporting 'ecosystem' for statistical, prudential and resolution purposes has become increasingly complex and costly for both authorities and financial institutions. We are confronted with a significant number of surveys nowadays, combining aggregated, item-level and transactional data. The underlying business phenomena are often overlapping and not always defined in a consistent, integrated and reconcilable manner. Against this background, this paper tries to (i) connect the dots of the intense debate that has taken place in various European and international fora over the last five years, focusing on how to rationalize the overall reporting framework, and (ii) map out a possible way forward. Two main streams of innovative initiatives, high-level reports and studies are reviewed. The first aims to define a mandatory, common granular layer of multipurpose (integrated) data, located in banks' IT systems, which would provide programmable code to reference these data in order to generate the reporting of regulatory metrics. The second stream aims to standardize banks' operational systems by generating granular contractual information in near real-time. This paper argues that, despite the attempts to demonstrate the potential benefits of these innovative approaches, their adoption to replace the existing setup still appears premature even in the medium term. While exploring new ways to benefit from 'on demand' access to timely and integrated sources of data, the authorities in Europe have already launched strategic initiatives for the rationalization, standardization and integration of the existing reporting framework. In this respect, the ESCB's IReF and the wider integration initiative at European level, following the EBA's feasibility study, are important and tangible actions to significantly reduce the reporting burden on all stakeholders in the medium term. The cooperation between the European authorities and the banking industry will be key in achieving this general goal; this paper argues that the ESCB's BIRD would provide an important contribution.

JEL classification: C81, G21, M15.
Keywords: standardization, granularity, integrated reporting, machine-executable reporting, smart contracts.
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Contents

[1] Bank of Italy, Statistical Data Collection and Processing Directorate.

Introduction[1]

European banks are required to report a wide range of data to central banks and other competent authorities on a regular basis to enable them to carry out their institutional functions (e.g. monetary policy, financial stability, banking supervision and resolution).

These reports have undergone profound changes over the last two decades[2], which has led to faster response times and increased volume,[3] granularity, and a growing complexity in the regulatory requirements. As concluded by the European Commission (2021), on the one hand, stricter reporting obligations have 'helped address information gaps identified during the global financial crisis and reflect the increasing complexity and interconnectedness of the financial system'; on the other, they have 'placed an increasing burden on both the reporting entities and the supervisory authorities receiving and analysing the data'.

In 2019, as part of the comprehensive fitness check of European Union (EU) supervisory reporting requirements in EU financial services (European Commission, 2019), the European Commission (EC), while concluding that the current reporting requirements are necessary and effective for supervisory purposes, identified significant inefficiencies in the way they are defined and data are collected, specifically: (i) the reporting requirements are not sufficiently harmonized; (ii) data are not efficiently shared and reused among authorities; (iii) the reporting requirements are not always consistent across reporting frameworks; (iv) the reporting requirements are often developed by different authorities in silos, without coordinating and considering what is already in place; and (v) the current design of the reporting requirements does not allow for automated processing, and the lack of standardization hinders the application of modern technologies. Such inefficiencies not only negatively impacted the quality and usability of the reported data, but also generated additional costs for the reporting entities. Furthermore, it was noted that the reporting frameworks do not make full use of modern IT tools.

One of the most significant changes has been the growing demand for increasingly granular data. Important collections of granular data have been launched in recent years. In September 2018, the Eurosystem central banks launched AnaCredit, which contains harmonized, detailed information on individual bank loans (with a minimum threshold of €25,000) granted in the euro area to counterparties identified as legal entities. At the same time, all banking groups under the direct supervision of the ECB started reporting granular information on global securities holdings (SHSG data). Other initiatives included: (a) money market statistical reporting (MMSR), launched in 2016, which collects transaction-by-transaction data on a daily basis for more than 50 large euro-area banks in four different segments of the euro money market; (b) European Markets Infrastructure Regulation (EMIR) reporting on derivatives transactions and (c) securities financing transactions reporting (SFTR).

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[1] The views expressed are solely those of the author and do not necessarily reflect the opinion of Banca d'Italia. A preliminary version of the work was presented at the satellite seminar on 'Granular data: new horizons and challenges for central banks' co-organized by the Irving Fisher Committee on Central Bank Statistics and the Bank of Canada and held in Ottawa on 15 July 2023 in conjunction with the 64th World Statistics Congress of the International Statistical Institute (https://www.bis.org/ifc/events/ifc_230715_agenda_final.pdf).

[2] The importance of European harmonized information needs 'grew over time together with the progress of the integration process that resulted in the launch of the single monetary policy and, later on, in the reform of the European architecture of the micro and macro prudential supervision and the establishment of the SSM and SRM. With the data gaps that emerged after the global financial crises at the end of the first decade of the current century and the initiatives of the G20, Financial Stability Board (FSB) and International Monetary Fund (IMF), new requirements for credit and financial data, and the related information projects, have transcended the European dimension to become global' (Casa et al., 2022b).

[3] 'In aggregate, financial institutions in the EU are subject to more than 500 reporting obligations comprising more than 1,000 tables with more than 70,000 individual data points' (European Commission, 2019, pp. 52-55).

1. Criticalities in the current regulatory reporting framework

Reporting agents find it increasingly difficult to respond, in a timely and accurate manner, to the numerous new requests for information received from multiple authorities and to the frequent changes to pre-existing reports. In turn, such difficulties might also impact on data quality to the extent that the authorities cannot guarantee that the various surveys are collected on the basis of consistent (regulatory) interpretations across reporting entities.

Table 1 – The current framework of regulatory reporting for European banks

Survey	Regulating Authority	Purpose	Frequency	Granularity	Business scope	Banks required
BSI – Balance Sheet Items	ECB	statistical	monthly	aggregated	assets and liabilities	all banks (some derogations)
MIR – MFI Interest Rate statistics	ECB	statistical	monthly	aggregated	interest rates	sample of banks
AnaCredit	ECB	multipurpose	monthly quarterly	item-level data	loans	all banks (some derogations)
SHSG - Securities Holdings Statistics Group	ECB	multipurpose	quarterly	item-level data	holdings of securities	all banking groups
EBA-ITS on Supervisory Reporting	EC + EBA	supervisory and resolution	monthly quarterly semiannual yearly	mostly aggregated	accounting, risk and resolution data	all banks
SRB Resolution Reporting	SRB	resolution	yearly	aggregated	resolution data	significant institutions (banks under SSM direct supervision)
MMSR - Money Market Statistical Reporting	ECB	statistical	daily	quasi-transactional	money market	sample of banks
EMIR reporting	EC + ESMA	multipurpose	daily	quasi-transactional	derivatives	all banks (market operators)
SFT reporting	EC + ESMA	multipurpose	daily	quasi-transactional	securities financing transactions	all banks (market operators)
Locational banking statistics	BIS	multipurpose	quarterly	aggregated	assets and liabilities	internationally active banks
Consolidated banking statistics	BIS	multipurpose	quarterly	aggregated	consolidated positions	internationally active banking groups
Survey of FX and OTC derivatives markets	BIS	multipurpose	triennial	aggregated	OTC derivatives	sample of institutions
Local reporting	local authority				in many countries central credit registers	
Ad hoc data collections	supervisory competent authority	supervisory				

As shown in Table 1, the current regulatory reporting framework is composed of a set of national and European statistical, prudential and resolution requirements, as well as 'ad hoc' data collections. The proliferation of surveys and the lack of an effective *ex ante* coordination among the various authorities

(which adopt different 'languages' and collect partially redundant data) contributed significantly to the sharp increase in the reporting costs. According to the available official estimates for harmonized supervisory reporting, these costs have almost doubled over the past decade for reporting agents[4] .

The process described above is continuously evolving. The implementation of the upcoming CRR III banking regulation package, the new information requirements in relation to the environmental, social and governance (ESG) factors and risks and the further shift towards more granular data for statistical reporting, as part of the Eurosystem's Integrated Reporting Framework (IReF) due to be completed by 2027, will introduce further innovations in the coming years. As a consequence, financial institutions will be called once more to 'translate' new reporting requirements into their high granular terms and into changes to their internal data models. Since the regulations cannot define the connection to that granular level, each institution will individually interpret, translate, implement and manage the high amounts of necessary rules and data elements that allow to map their internal data to the information requirements defined by the authorities.

In the described framework, the level of cooperation between the authorities could be strengthened. Synergies that could arise through the exchange of data between different authorities are not leveraged because processing is organized in administrative silos and the legal basis for data exchange, that would prevent overlaps among the different regulatory frameworks, needs to be made more effective and efficient[5]. Moreover, the reporting system does not make use of modern technological capabilities as it would be required.

Furthermore, the current regulatory reporting is not aligned to the changes in the financial landscape. A transformational shift in the volume, speed and variety of data is driving the innovative use of financial technology (the so-called FinTech), leading to rapid changes in the financial environment.

Supervisors, for example, are faced with the challenge of having to assess rapidly evolving risks to business models and technology-driven changes that may affect financial stability, with regulatory data that are infrequent, backward-looking and collected according to legacy frameworks and not support new tools or applications that could enable real-time or early warning analytics. Technology solutions could enable supervision to be more forward-looking, insights-based and data-driven. In addition to regulatory data, in fact, supervisors use other sources of information to help inform their prudential assessments, unstructured data not organized in a specific or unified format, unlike regulatory reporting which is based on data that are structured. Gathering intelligence from these unstructured data sources in addition to regulatory reporting requires a fundamental shift away from current processes to ones that are enabled by technology.

2. Ongoing innovative initiatives focused on standardization and granularity

Since 2016 there has been a proliferation of studies trying to find innovative solutions to the criticalities described in the previous section, leveraging standardization and granularity on one side

[4] As far as supervisory reporting regulated by EBA is concerned, it has been estimated for the period 2018-2020 that European banks overall bear an annual cost, including ongoing costs and implementation costs, of about 5.5 billion euros (European Banking Authority, 2021a). Based on the results of a questionnaire addressed to institutions, the most prominent areas of concerns are complexity, the amount of information to be reported, internal data extraction and calculations and the stability of the EBA supervisory reporting framework.

[5] This aspect has been highlighted also by the industry: 'Share Information: amongst the authorities instead of asking several times for data that has been already provided' (European Banking Federation, 2021).

and technology on the other side; such studies are classified under the general heading of 'Regulatory Technology', better known as RegTech.

While there is a consensus that future improvements to the reporting framework should be the result of an intense and effective cooperation between the various authorities and the industry, the solutions proposed so far are quite different in terms of standardization and granularity of the data.

In particular, they differ with respect to the layer of the data they suggest to standardize in the information system of the financial institutions: in the more 'visionary' proposals, their operational system, impacting directly on the way transactions are recorded; other solutions their data warehouse/data lake, which hosts the so-called input layer; in the more conservative ones, the reports that they have to submit to the authorities (i.e. the output layer).

Also in terms of level of granularity there is a great difference between the various proposals which are debated, in descending order:

i. granularity at the level of operational data (smart contracts in pure business language);
ii. granularity at the level of common input data (business-oriented in its design but also contaminated by regulatory definitions);
iii. item-level reporting (e.g. loan-by-loan or security-by-security, as it is the case, respectively, for AnaCredit or SHSG in the euro area) combined with multidimensional structures for more aggregated data.

Below the focus is on the first and second types of solutions, starting with those based on common input data, the so-called 'machine-executable reporting solutions'.

The most interesting aspect of these solutions is that a reporting regulation would be drafted in a form that allows for its automatic implementation by the financial institutions. This would contribute not only to facilitating compliance with regulatory requests but also to reducing the times necessary to obtain new structured and periodic information and to transform a new information requirement into a reporting obligation (a process which might take a relatively long period of time).

Two main features characterize these new regulatory reporting solutions: (a) a very high level of granularity of the information requests from the authorities; (b) the regulatory authorities bear the responsibility to define the transformations of primary data into the aggregated information necessary for their analyses.

In general, these solutions rely on a single data dictionary, which allows data standardization and must be shared and applied by all the parties involved. A first possibility is that the authorities use the dictionary to regulate in detail granular input data and their transformations to calculate aggregated information. In this framework instructions are defined 'as a code' and the authorities describe the transformations as a machine-executable code that reporting entities can perform directly to calculate the required reports from input data. Alternatively, in the case of the so-called 'data-pull models', authorities shall describe in the dictionary the data that reporters must deliver in a staging database, i.e. an information storage area that the authorities will access in order to carry out the necessary processing for their own purposes; hence, the responsibility for processing granular data to obtain regulatory aggregates is left to the authorities. In addition, the concept of predefined reporting frequency is overcome, as an authority can potentially pull available data when needed.

The BIS Innovation Hub Project Ellipse[6] is a prototype that aims at offering to the community of authorities an opportunity to reflect, explore and collaborate on common innovative granular solutions to streamline data collections and enhance the analytical capabilities of supervisors. The primary objective of the project was to perform a proof-of-concept (PoC) of an integrated regulatory data and analytics platform – known as Ellipse - that combines structured granular data and unstructured sources of data relevant to analyze specific, new events in real-time; in particular, it allows to apply advanced data analysis techniques to generate early warning indicators, analytics and prudential metrics (Bank for International Settlements Innovation Hub and Monetary Authority of Singapore, 2022). So far, Phase 1 of the project - the collection of information - and Phase 2 - the advanced use of data – have been completed. For the purposes of this paper, the Phase 1 is particularly relevant to the extent that it investigated how data-driven supervision could be enabled by machine-executable digital reporting, using a cross-border common data model. It was shown that regulatory reporting requirements can be expressed in unambiguous machine-readable logical reporting instructions underpinned by a consistent data model[7]. A coded version of the calculation steps for generating regulatory reports can also be published alongside regulations to ensure a clear understanding of the expected data at the most granular level.

The Bank of England, in partnership with the Financial Conduct Authority (FCA) and a small group of financial institutions, has carried out a pilot of technology (Digital Regulatory Reporting - DRR[8]) to explore the feasibility for regulators to publish a code version of their instructions – so called 'machine-executable regulation', which financial institutions could automatically convert into code that runs directly in their internal systems. The pilot tested the concept using synthetic mortgage data supplied by the institutions in a standardized format, running on a dummy system. Authorities could then run reports according to their needs or pull data directly from institutions via an application programming interface (API). In a second phase of DRR, a collaboration with the International Swaps and Derivatives Association (ISDA) Common Domain Model (CDM) project for derivatives was also carried out. This collaboration investigated how to build derivative reports and digital regulation using the technology that ISDA was developing, with the intention to extend their tools to meet DRR needs. Four data points for two separate transactional derivative reports were described using the CDM's version of digital regulation. A single data model covering the production of multiple regulatory reports suggested that the DRR approach could be scalable across reports, and therefore more convenient from an economic point of view. The digital version of the reporting instructions was linked to the CDM and the CDM to real test files of operational data provided by institutions. To the extent that they adopt the CDM, this could significantly reduce the cost of implementing a DRR approach for derivatives reporting. This work also proved how regulators could modify reports by adopting digital regulation, defining a single common data model for a product type and reports generated from this single model.

The German financial supervisory authority (BaFin) - in partnership with Deutsche Bundesbank, credit institutions, service providers, industry associations and a consultancy firm – carried out a feasibility study for 'A reporting system for the future' (BaFin, 2022) with the aim to develop options for redesigning the reporting system in the direction of i) reducing the burden on institutions (and supervisors), ii) improving supervisors' analytical capabilities, and iii) ensuring the interoperability

[6] See https://docs.bis.org/ellipse/ .

[7] The PoC's mortgage attributes have been modelled using the Common Domain Model (CDM) developed by the International Swaps and Derivatives Association (ISDA) for OTC derivatives, cash securities, securities financing and commodities. Testing the CDM's use and extensibility for other product domains such as mortgage loans was key to the PoC, as globally applicable common data models that can be used across products could reduce the number of data models in use by financial institutions and ease the mapping burden. In addition, as the CDM is open-sourced, this allows the model to be more widely accessible for testing within existing environments.

[8] See https://www.fca.org.uk/innovation/regtech/digital-regulatory-reporting .

of new approaches with the European legal framework. The study examined whether the institutions' heterogeneous source and result data could be mapped centrally on the basis of a common granular data model. The model should be[9]: 1) 'comprehensive': it should cover the reporting requirements of banking statistics, and the supervisory (CoRep, FinRep, etc.) and resolution regimes; 2) 'standardized' and 'proportionate': it should be commonly applicable to all institutions; 3) 'sustainable': it should be continuously extensible because the model grows with its requirements; 4) based on the 'report once' principle: data that can be expressed on granular level should only be contained and queried in the model once; 5) 'mixed granular': the model should be capable of mapping both granular and, when necessary, aggregated data. Institutions would have to submit a mixed granular data set for each group entity (solo) and for each consolidated subgroup and group in order to comply with the current reporting requirements. Aggregates that are summable could be calculated based on the mixed granular data provided and the common machine-readable transformation rules that are uniformly defined for all institutions[10].

The European Commission is also exploring new approaches to data collection. To this end, it initiated a project with the aim of assessing how regulatory reporting could be made ready for the digital age (European Commission, 2022). The project, developed in close cooperation with the European Securities and Markets Authority (ESMA) and PwC, had three key objectives: 1) developing, a PoC for a machine-readable and executable representation of reporting requirements on derivatives specified in the European Market Infrastructure Regulation (EMIR, level 1 regulation) and the connected Regulatory Technical Standards and Implementing Technical Standards (RTS and ITS, level 2 regulation)[11]; 2) assessing whether a machine-readable and executable reporting (MRER) system can lead to more effective and efficient development of reporting requirements and reduce the reporting burden for reporting entities, including an assessment of the costs and benefits of such an approach; 3) identifying regulatory obstacles to MRER technology-enabled innovation in the financial sector. One of the key elements for an effective implementation of MRER is the appropriateness of the data model. The project team has recommended the selection of one input data model that is supported by the majority of the industry, as its adoption by the financial institutions would be key in order to decrease the reporting burden. The project team has researched and tested different options but no immediate fit-for-purpose data model has been identified. Both the evaluated data models– the Common Domain Model (CDM) proposed by ISDA, and the ISO20022 Business model –require some kind of extensions in order to be incorporated into the MRER-solution. The project team has identified the necessary requirements and has recommended ESMA to play a leading role in guiding the industry in designing a fit-for-purpose data model for selected reporting frameworks.

Table 2 contains a summary of the pros and cons of the machine-executable reporting solutions, as they were assessed during the projects described above.

[9] The study assessed that, in its November 2021 edition, the 'Banks' Integrated Reporting Dictionary' (BIRD) developed by the European System of Central Banks (ESCB), in cooperation with the banking industry, comes very close to the criteria in terms of its own objectives, governance setup and model structure.

[10] The study has revealed that between 75 and 90 per cent of all data aggregates in the current banking supervisory and statistical reporting system could be generated from granular data.

[11] These regulatory texts specify the technical standards on the minimum details of the data to be reported to trade repositories.

Table 2 - Pros and cons of the machine-executable reporting solutions

PROS	
Consistency across reports	Where multiple reports rely on the same underlying data, this approach could eliminate some duplication by mapping to a consistent, underlying input layer (Bank of England, 2020).
Consistency across institutions	The introduction of standardized, consistent central master data for institutions in addition to reference data for securities were cited as additional potential types of relief (BaFin 2022). This could also lead to reducing possible misinterpretations of certain regulation by different market participants (European Commission, 2022).
Flexibility	A greater cost saving from this approach could come from making new requests cheaper and faster to respond to, since institutions would avoid having to identify and extract data from elsewhere in their systems if it existed in a common input layer (Bank of England, 2020).
Compliance	Various types of relief, such as easier interpretation, improved interaction or a reduction in ad hoc queries (BaFin, 2022).
Transparency	Digitizing regulatory reporting rules may lead to other benefits, such as increased transparency of regulation, which is a priority for institutions (Bank of England, 2020). Compared to the current situation, during the publication stage of a new regulation, the new system would allow for less effort in explaining the new regulation, as this would be unambiguously expressed in the published code (European Commission, 2022).
Regulatory efficiency	If parts of the reporting instructions are published as code the need for the publication of guidelines and Q&As is lower (European Commission, 2022).
Common understanding	'Instruction as a code' has the potential to be both readable for reporting domain experts and unambiguously executable by machines. This potentially limits misunderstandings between business analysts and software engineers, and therefore the number of software defects (European Commission, 2022).
CONS	
Lack of incentives	The initial investment and costs needed to achieve this outcome can steer decisions based on business incentives and risk appetite. While data standards initiatives would ultimately benefit if financial institutions and authorities were to adopt a greenfield approach, and do indeed require them to do so, the perceived scale of such an exercise could also deter stakeholders from embarking on it (Bank for International Settlements Innovation Hub and Monetary Authority of Singapore, 2022).
Reporting entities' implementation costs	The introduction of a new data model together with a comprehensive data set for trade record could impose significant costs on the reporting entities, the actual cost differing per reporting entity depending on their size, the complexity of their internal systems and their level of digital maturity (European Commission, 2022).
Legacy lock-in	Dealing with legacy systems in institutions is too great a challenge and too big a risk for the rewards on offer. Legacy systems are about more than just IT. For some long dated financial products, like residential mortgages or interest rate derivatives, changing the system might mean changing financial payments for the product itself (Bank of England, 2021).
Lack of standardization	The lack of standardization of the definitions and descriptions of data by institutions is a significant barrier to improving institutions processes (Financial Conduct Authority, 2020). Regardless of the level at which to define common data inputs, it will be hard to create them and to reach a fair agreement on what the common data inputs are and what they mean (Bank of England, 2021). For some products, there can be a lot of heterogeneity in the way institutions record data about a product, including whether they even capture certain information. This can affect calculations about the optimal level of granularity to aim for in the common input layer (Bank of England, 2020).

Reporting entities' adaptation costs	Defining and creating a new common input layer clearly involves up-front costs. The return on that investment would depend on institutions being able to meet new requests by reference to data already in the input layer. New requests that required data outside this would still generate additional costs, and require time to source and integrate the extra information (Bank of England, 2020).
Only partial feasibility	These solutions may be more feasible for some types of reporting than others. Where the transformations are deterministic aggregations of data from a clearly defined input layer, it should be easier to agree on the transformations and even to write them as code, facilitating automation. However, where the transformations reference concepts that require expert interpretation – such as dynamic references to accounting principles and regulatory constructs like capital metrics – it may be harder to agree on transformations and those transformations may require expert human inputs, such as judgements on classification or valuation (Bank of England, 2020).
One size does not fit all	The transition costs will vary substantially from one institution to another because they depend on various factors, for example institution size, the number of group companies or applicable accounting standards (BaFin, 2022). Large institutions may face additional complications in aggregating certain data across multiple legal entities, and the need to take account of factors that apply across a group such as master netting agreements, set off rights or portfolio credit mitigation (Bank of England, 2020).
Data quality management costs	Various types of relief, such as easier interpretation, improved interaction or a reduction in ad hoc queries, are offset by considerable challenges, such as more granular data quality assurance or the additional data repository (BaFin, 2022).
Regulatory costs	Under the 'instruction as a code' approach the regulator has to develop and maintain the code. This is connected with higher initial costs for the initial development that might be higher than the costs for drafting a legal text in the current form (European Commission, 2022).
Legal issues	When (parts) of the regulation are published as code, which is deployed by the reporting entities, keeping the responsibility for correct reporting with the reporting entities creates additional challenges[12]. It is therefore beneficial to remove the responsibility for correct implementation of the reporting rules from reporting entities and make them responsible for a correct ingestion of a trade into the common input layer. As this is done for the first time: • it has to be assessed whether legal basis can be provided to reporting requirements that are written as code. The 'instruction as a code' could partly replace certain regulatory text and therefore requires a sound legal framework; • further analysis is needed on whether reporting entities can be held responsible for the mapping of the common input layer to the reporting fields, as the 'instruction as a code' will provide for the mapping from the input data model to the reporting code. (European Commission, 2022)
New skills and competencies	For the development and maintenance of the code, the regulator needs to have developers to implement the reporting rules for each field, resources to maintain the IT architecture and regulatory experts who understand both the regulation and the trade records data model (European Commission, 2022).

[12] The issue of the possible assumption by authorities of the responsibility for direct production of regulatory aggregates from granular data was also discussed during the work that led to the publication of the 'EBA report on a feasibility study of an integrated reporting system under article 430c CRR' (European Banking Authority, 2021b).

The other type of solutions may be denoted as ‘smart contract-based’.

The most promising innovation in FinTech is the introduction of the smart contract. If implemented correctly this innovation can allow significant reductions in operating expenses. There will be some reductions in transaction processing costs. However, more important savings will come from reductions in analytic costs (treasury functions, business planning, risk management, financial statements, regulatory reporting, etc.)[13].

Important gains will come from the use of smart financial contracts. Their contribution is three-fold: 1) they are unchangeable and hence create a right which has all the functionalities of a property right; 2) they are self-executing when it comes to generating payment obligations; 3) the same mechanisms of the smart contract that compute a contract’s payment obligations for transaction processing can also reduce analytic costs.

The adoption of smart financial contracts will improve the efficiency of the operations of financial institutions and increase transparency and security for investors and consumers as well as for regulators.

Under the above mentioned European Commission initiative, the MRER (machine-readable and executable reporting) project team has explored various degrees of adoption of the MRER-system (European Commission, 2022). The ‘end-to-end trading system’ is used for reporting of trades as well as for the execution of the trades themselves. The smart contracts are also used for the execution of trades, based on a shared, common data model and executed on a distributed ledger. Regulatory reporting is one of the features of these smart contracts. Within the ‘end-to-end reporting system’ framework, reporting is an afterthought of trading and it is the responsibility of each reporting entity to implement and maintain an adapter that translates trade records from the domain of trading to the domain of MRER and smart contracts. Since in these options explored by the team authorities and financial institutions are already connected to a distributed ledger, it could be possible to leverage this for trading itself, as opposed to limiting its usage for reporting purposes. An end-to-end trading system is an extension to the end-to-end reporting system, as it adds a set of smart contracts that implement trading across regulated entities, without any need for individual adapters. The MRER-code interfaces with the trading code so that it can directly process trade records and generate regulatory reports according to the regulator’s needs. In such a future, MRER automatically and instantly leads to correct reporting and there is no risk of errors in the process. In case of error-free reporting, the quality of financial institutions' data (consistency, integrity, etc.) would no longer be a crucial issue in exchanging information with authorities.

The study ‘An innovative RegTech approach to financial risk monitoring and supervisory reporting’ was published by several authors (Kavassalis *et al*, 2018) with different professional background (academic, consultancy, authority)[14]. Its purpose was to propose a bearer service, which generates and maintains a ‘digital doppelgänger’ for every financial contract in the form of a dynamic transaction document (DTD). In other words, it is a standardized ‘data facility’ which automatically makes important contract data from the transaction counterparties available to the requesting authorities. This would be achieved by sharing certain elements of the DTD on a bearer service, based on a federation of distribution ledgers; such a quasi-simultaneous sharing of risk data is possible because the DTD maintains a record of state in semi-real time, and this state can be verified, also in semi-real time, by any entity with access to the distribution ledgers. The DTD provides a unique representation of each financial contract to be used at every step in the processing chain, including

[13] See also Crisanto *et al* (2020).
[14] See also Sel *et al* (2017) and Triantafyllou *et al* (2018).

all types of regulatory reporting. In terms of process logic, the reporting takes place only once and the users of the DTD (mainly authorities, but potentially also research institutions and other representatives of 'society at large') are those who define how information will be aggregated. The granular data on transactions are transmitted to the DTD supporting infrastructure where it is automatically aggregated and made available for analytical purposes. According to the authors, 'consistent transaction processing and nearly instantaneous regulatory reporting of financial transactions and their associated risks would become possible'.

In the paper 'Effective measurement of the economy in the emerging digital age' the three authors (Gross *et al*, 2021) claim that the benefit of the IReF and BIRD Eurosystem projects in terms of reducing reporting burden while improving its outcomes will increase if they are integrated into a more comprehensive vision and strategy to accompany ongoing digitalization. In the current situation, for instance, reporting agents still need to bridge the BIRD input layer with their operational systems where information on contracts, counterparties and other facts is represented in heterogeneous ways. Hence, further standardization in the representation of the operations underlying financial markets is needed for a more effective measurement in the digital age. To achieve true digitalization, standardization is needed in the foundational level of identifying and representing financial contracts, counterparties and other facts, i.e. the operational data. This will have to take place involving market participants, and possibly leveraging on-going initiatives. The digitalization of financial services opens new possibilities towards the standardization of the technical representation of financial and other contracts. Many initiatives are on-going in order to develop standards for specific financial instruments; however, such initiatives are mostly local, while an effective solution would need to be far wider, being ideally global and covering all contract types. The risk of continuing with uncoordinated and siloed initiatives is to deliver another wave of heterogeneous legacy solutions which would likely cost more. Coordination across jurisdictions is thus key. The strong opinion of the authors is that such standardization will need to be radical and that compromises will be counterproductive. Voluntary adoption could be too slow as time is a critical factor. Legislating the use of standards and public data infrastructures will likely be required. Public authorities will need to intervene and catalyze change to achieve the common good. Focus should initially be on building global infrastructures for the identification of contracts and counterparties. The authors' conclusion is that the digital transformation 'offers a unique opportunity to authorities to strengthen their catalytic role by leading the development of a comprehensive vision and the design of a conceptual architecture that would provide a frame in which local initiatives could flourish while forming a coherent system, sustainable in the digital age'.

Table 3 shows the pros and cons of the solutions based on smart contracts.

Table 3 - Pros and cons of the solutions based on smart contracts

PROS	
Automation	In the long run, the whole ecosystem is expected to benefit by the comprehensive representation of a trade record, which will be a one-off effort that can be reused in the implementation of future regulations. With the machine-executable reporting approach, a regulation can be updated much faster and with less effort for the reporting entities. Moreover, the reporting of existing trades upon a regulation update could then be integrated as an automatic process, requiring little to no human intervention (European Commission, 2022).
Standardization	The smart financial contracts (highly granular and semi-real time modelling of a financial contract's life-cycle, mirroring specific, real contracts) provide a unique presentation of each financial contract to be used at every step in the processing

	chain, including, but not limited to, all varieties of regulatory reporting (Kavassalis *et al*, 2018). Since everyone is looking only at a single record of financial contracts, 'data standardization' effectively happens at the level of the operational data. A main benefit of this approach is that it would make reconciliation efforts a thing of the past. Distributed ledger technology (DLT) has the potential to fundamentally transform the way data is managed by replacing today's practice of financial institutions keeping different records of the same transaction (Crisanto *et al*, 2020). A key aspect of the concept is that the single record of a financial contract stored on the distributed ledger may replace the separate records of all parties of the financial contract (Kavassalis *et al*, 2018).
Efficiency	Most models foresee that authorized parties, such as supervisors, would be able to connect directly to the ledger. In such a system, the current regulatory reporting process could be simply replaced by sharing relevant data aggregates with the supervisor in the DLT network (Crisanto *et al*, 2020).
Accuracy	At the same time, DLT may prevent unintentional, practical reporting errors and reporting of deliberate, e.g. fraudulent, misinformation (Crisanto *et al*, 2020).
Time-to-market	Essentially, consistent transaction processing and nearly instantaneous regulatory reporting of financial transactions and their associated risks would become possible (Kavassalis *et al*, 2018).
Consistency	Smart contracts would integrate in a fully consistent manner both risk views for monitoring and reporting purposes; as a result, they could help reduce compliance costs and progressively close the gap between the operational and the analytical departments, i.e. integrating front, middle and back office (Kavassalis *et al*, 2018).
Transparency	Overall, transparency of the global financial system will increase – firstly, benefitting supervisory authorities and regulators, secondly, financial research and legislation and, last but not the least, society at large (Kavassalis *et al*, 2018).
Compliance	Using this approach simplifies the compliance landscape that financial institutions are subjected to. Specifically, expressing the behavior of real world contracts through algorithms obsoletes a class of complex challenges related to structuring reporting data that at this point deny high fidelity reporting aggregates for the regulator (Sel *et al*, 2017).
New opportunities	This solution also opens new paths to data analytics. Stress tests could be envisaged as frequent, quasi-automated exercises flexible enough to address many questions and test diverse scenarios (Gross *et al*, 2021).
CONS	
Need for public intervention	Smart contracts cannot be expected to be provided by institutions left to themselves, creating a need for specific regulation that will initiate the new construct (Kavassalis *et al*, 2018).
Need for global vision and strategy	Coordination across jurisdictions is key. Authorities have to strengthen their catalytic role by leading the development of a comprehensive vision and the design of a conceptual architecture (Gross *et al*, 2021).
Lack of economic design of smart contracts as public good	Need of a mechanism design theory for smart contracts, i.e. identify the institutional properties of smart contracts that make them economically efficient and successful (Triantafyllou *et al*, 2018).
Lack of design principles of a network	Need a robust evolvable network supporting smart contracts creation, diffusion and sharing (in conditions of data privacy and non-disclosure of sensitive financial data) based on the combined use of: • blockchain and smart contracts; • financial analytics intelligence; • formal reasoning and methods for precise design. (Triantafyllou *et al*, 2018)

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Overall, the outcome of these two streams of initiatives is that the potential benefits for financial institutions and authorities to move towards a digital reporting framework based on data standards outweigh, in the long run and with a number of assumptions, the initial and running costs.

However, apart from the pros and cons evaluations, it has to be underlined that the available case studies and trials are not yet convincing. It is quite evident, in fact, the attempt to demonstrate the applicability of these innovative solutions starting from simple business cases. In fact, the proof-of-concepts carried out so far have taken into consideration quite standardized financial products (e.g. derivatives or mortgage loans) and very granular (e.g. EMIR reporting) or non-complex requirements, for which the necessary transformations rules to produce the output from the input are extremely linear. But typically this case tends to be the exception rather than the rule. More frequently, writing a version of the reporting instructions in code can be very complex.

These new fields therefore need to be further explored in order to verify their practical applicability.

Nevertheless, it's worth pointing out that real-time transactional data based on smart contracts appears to be more promising for a number of reasons. First of all, they would require higher standardization of the operational system of the institutions at the global level, hence preventing a wave of heterogeneous solutions, which would make the current statistical ecosystem even more complex and somewhat chaotic. Then, this data would enable forward-looking analysis. Moreover, data would be available almost in real time. Finally, in an extreme case, it could even replace reporting (or at least part of it) since granular data could be interpreted using a standardized cash flow generation process inferred from the contractual obligations.

In parallel to further explorations, it will be crucial to meet certain organizational and strategic preconditions for these regulatory reporting initiatives to succeed, as evidenced in a study of the BIS Financial Stability Institute (Crisanto *et al*, 2020). These include:

a. strong commitment and support from top management at both financial authorities and institutions;
b. alignment of vision by engaging transparently, collaboratively and openly with key stakeholders;
c. a culture of innovation that relies on data-driven decision-making, openness to experimentation and questioning ‘legacy thinking’ within financial authorities;
d. a well-defined centralized data strategy and data governance framework within financial authorities; and
e. effective management of the transition to new regulatory reporting processes, particularly by taking a step-wise approach.

3. A more feasible and likely scenario for the future

While exploring innovative and more technology-based solutions to benefit from ‘on demand’ access to granular, timely and integrated sources of data, European authorities have identified five main areas for improvement to modernize and integrate EU reporting and put in place a system that delivers accurate, consistent, and timely data to authorities at EU and national level, while minimizing the aggregate reporting burden for all relevant parties.

Achieving this goal is feasible through gradual modifications of the current reporting frameworks and methods for collecting and processing financial data. Drawing on the lessons learned from the fitness check and further discussions with stakeholders, the EC, in its 'Strategy on supervisory data in EU financial services' (European Commission, 2021), concluded that such a reporting system should include the following main building blocks[15].

1 - Consistent and standardized data: 'Data standardization and a common understanding of the data collected under different reporting frameworks will make it easier to use digital technologies and simplify the transmission, validation, and analysis of the data. Data specifications should rely on clear and common terminology, as well as on common standards, formats and rules for the use of unique identifiers. This will avoid ambiguity in their interpretation and make compliance easier'. 'The Commission will coordinate the development of a common data dictionary to ensure consistency and standardization across the financial sectors'. 'A key element for ensuring data consistency is the full use of internationally accepted common identifiers, such as the unique product identifier (UPI), the unique transaction identifier (UTI) and the legal entity identifier (LEI)'.

2 - Data sharing and reuse: 'Facilitating the sharing and reuse of reported data among national and EU supervisors [but this holds for any other authority imposing reporting obligations] will reduce the burden on reporting entities by avoiding duplicative data requests. It will also allow supervisors [or other authorities] to overcome legal and technical barriers to using data held by another supervisor [or other authority]. Improved data sharing and reuse will require a dedicated regulatory framework and a secure IT environment to streamline data flows, validation and exchange mechanisms. It will also rely on the common specification and standardization of data sets'. 'Data should be reported only once and then shared and reused as needed by the different authorities in the EU'. 'The Commission will identify other legal obstacles to sharing of supervisory, statistical and resolution data and stands ready to address them where necessary'. 'Together with a common data dictionary, this will lay the foundations for a European data space where data can be accessed, shared and reused by all relevant authorities while protecting data confidentiality and security'.

3 - Improved design of reporting requirements: 'Well-designed and drafted legislation is essential for implementing an effective and efficient reporting system. An improved process for the design of reporting requirements should be based on current best practices in applying EU Better Regulation principles to supervisory [or other] reporting, both in the legislation and in the specification of technical standards. It should also ensure that these principles are applied consistently and systematically across reporting frameworks, from the development of the initial requirements to subsequent reviews'. 'The Commission also calls on the ESAs and other EU and national authorities to fully assess the impact of technical reporting instructions they develop'. 'Finally, the Commission will assess options, including a new legal instrument, for streamlining the current lengthy and often complex process of developing regulatory and implementing technical standards for supervisory [or other] reporting'.

4 - Joint governance: 'Designing, implementing and maintaining a modern and improved supervisory [or other] reporting system will require sufficiently robust governance arrangements. These will improve coordination and foster greater cooperation between different supervisory [or other] authorities and other relevant stakeholders, allowing them to share their expertise and exchange information'. An appropriate governance structure will 'provide technical advice on any legislative

[15] In the 'EBF response to the EBA discussion paper on the feasibility study of an integrated reporting system under article 430C CRR' the industry has represented similar views for the way forward to an integrated reporting system (European Banking Federation, 2021).

or non-legislative actions that may be needed'. 'In addition, any future governance structure should encompass the national competent authorities (NCAs) [or other authorities] and include arrangements to bring in industry expertise as needed'. 'In line with the Commission's gradual approach, and in order to minimize resource constraints and avoid a proliferation of bodies dealing with supervisory [or other] reporting, existing structures will be used to the extent possible'. 'By 2023, working together with the relevant EU authorities, the Commission will formalize the governance arrangements as the work on the strategy progresses'. 'Given the global nature of the financial system, the need for cooperation and coordination extends beyond the EU to our international partners. International alignment and more consistent reporting across jurisdictions allows for more effective supervision at global level and helps avoid arbitrage between jurisdictions'[16].

Delivering these building blocks will enable a more effective and efficient use of modern technologies, including RegTech and SupTech[17]. The use of such solutions will further reduce the compliance burden for reporting entities and increase the accuracy and timeliness of the data received by authorities and improve their capacity to analyze it.

While modernizing and improving reporting is expected to bring significant long-term benefits and cost savings, it also inevitably implies an investment of resources during the transition. Therefore, the modernization of reporting in the EU will require a gradual approach to reduce implementation risks and costs.

Specifically, the Commission will use the regular review process to introduce the following targeted improvements: '(i) removing identified overlaps or inconsistencies within a legislative act or across multiple acts; (ii) removing redundant or outdated reporting requirements; (iii) providing or clarifying specific definitions; (iv) streamlining data flows between authorities; and (v) where appropriate, strengthening the proportionality of the reporting requirements'.

Regarding the possibility to increase, where feasible, the level of granularity for the reporting requirements in the context of an integrated reporting system, as a way to further increase the efficiency of the reporting process, it has to be considered that this is not as a pre-condition for having such a system. Further investigations on the scope and possible design of such a solution and a thorough cost/benefit assessment should be conducted before any change is proposed[18]. Reporting requirements in statistical, prudential and resolution are defined using a mix of different levels of granularity, ranging from very granular (e.g., item-level data) to highly aggregated. Having in mind that there could exist some similarities in the concepts requested across frameworks, further efficiency gains could potentially be obtained if some concepts defined at a more aggregated level could potentially be derived from more granularly reported ones by means of transformations. Preliminary evidence gathered during the EBA feasibility study shows that 'in many cases it may not be cost efficient or feasible to report with a level of granularity which ensures that data is reported at one single (highest) granularity level and more aggregated views could be derived, especially in the area of prudential and resolution reporting' (European Banking Authority, 2021).

[16] 'Standard setters and authorities may wish to consider evaluating the scope for common data standards and taxonomies for relevant regulatory areas, including the potential for international collaboration, in order for reporting solutions to be made more scalable and interoperable'. (Financial Stability Board (2020), 'The Use of Supervisory and Regulatory Technology by Authorities and Regulated Institutions', October.

[17] Supervisory technology (SupTech) is the use of innovative technology by supervisory authorities to support supervision. It helps supervisory authorities to monitor risk and compliance of the financial institutions more efficiently and proactively.

[18] Also the banking industry has expressed a preference for a transition to a data-driven approach from a template-based one rather than data to be reported at one single (highest) granularity level: 'A stepwise design of the transition to the data driven approach from the current template driven approach is a key matter to avoid a high-cost rework that could be the consequence of a poorly designed or hasty race for granularity' (European Banking Federation, 2021).

Even if data at the highest level of granularity is not collected by the authorities, it should be available in the input layers of the institutions and its governance and operational management is crucial to grant effective and efficient reporting processes. Institutions need to have in place and implement strong (risk) data aggregation and (risk)-reporting capabilities, which are also assessed as part of their internal governance within the SSM supervisory priorities 2023-2025[19] (which for large institutions might also include compliance with the BCBS 239 principles[20]).

To facilitate these complex tasks and to reduce the room for interpretation of reporting regulations, which have a significant impact on data quality, the Bank of Italy implemented a strategy, based on a structured and voluntary collaboration with reporting entities (PUMA), which has been producing remarkable results over the past thirty years (Casa *et al*, 2022b). In particular, 'the value of this collaboration is two-fold: *ex ante*, it makes it possible to carefully scrutinize new proposals for reporting regulations in order to identify options that favour the production of high-quality data while containing their costs; *ex post*, through the preparation of the PUMA documentation, it describes the calculation steps from banks' input data to the outputs requested by the authorities, combining participants' regulatory knowledge and operational experience with regulators' fundamental contribution to clearing any interpretation doubts. The concrete results achieved by the PUMA cooperation project have contributed to improve the quality of reporting and support banks and other financial intermediaries in the production of statistical information. Furthermore, the spirit of cooperation and frequent interactions between the industry and the regulator have enabled the Bank of Italy to become more aware of the costs borne and challenges faced by reporting entities'.

Italy's PUMA project has been an example for European authorities. In 2015, in fact, the European System of Central Banks (ESCB) launched the Banks' Integrated Reporting Dictionary (BIRD), a cooperation initiative involving a significant number of European NCBs and commercial banks[21]. Both experiences are based on the assumption that, with few exceptions (both in the statistical field, e.g. AnaCredit and SHSG, and in the supervisory one, e.g. large exposures), reporting requirements are defined by the authorities at an aggregate level and that the calculation processes and related responsibilities for the preparation of the regulatory reports remain a prerogative of reporting entities.

This kind of documentation, which contains the transformation rules to generate the aggregate data, can also be considered a sort of RegTech solution - PUMA even *ante litteram* (see Signorini, 2018) - as it constitutes an important reference point for intermediaries in applying the reporting regulations. In spite of that, PUMA-like solutions and the machine-executable ones, represented in the previous section, actually differ substantially. While both approaches require a standardized input data layer for all recipients of reporting obligations, in the case of PUMA-like documentation the timely production, consultation and use of this data layer are entirely voluntary. On the contrary, in a pure

[19] See https://www.bankingsupervision.europa.eu/banking/priorities/html/ssm.supervisory_priorities202212~3a1e609cf8.en.html .

[20] See https://www.bis.org/publ/bcbs239.htm .

[21] In light of a wider integrated reporting system in Europe, it has to be noted that the EBA feasibility study claims that further assessment of the institutions' appetite for a common approach to compliance is needed. In particular: 1) the institutions' commitment to develop a common compliance solution, 2) the institutions' commitment to apply the outcomes of the common compliance solution, 3) the role and contribution of authorities in a solution that is in the sphere of the institutions' compliance obligations, 4) the expected cost of the common input approach for compliance, 5) the ways to assure a fair playing-field for the small Fintech, Regtech and SupTech improving the market competitiveness on compliance solutions, and 6) the possible decrease on the value of a common compliance solution due to: i) the benefits of having a common regulatory data dictionary with all reporting requirements defined under the same data dictionary; ii) the impact of potentially more granular regulatory frameworks in reducing the amount and costs of transformations needed.

RegTech solution, in which the reporting instructions are published in the form of an executable code, the production of the input data is regulated and therefore constitutes an obligation for the reporting agents, with all the cost implications discussed earlier in this paper.

Conclusions

The cost of traditional approaches to the collection of data from the banking (and financial) industry is rising for both the reporting agents and the authorities; due to the increasing number of reports, the current reporting system will become progressively less efficient. An important investment in how data are collected is urgently needed, which would also contribute to ensuring adequate quality assurance, a common interest of both financial institutions and authorities, despite their different roles.

The European and international debate has identified some possible solutions. The two most innovative ones - machine-executable reporting solutions and those based on smart contracts – require a high level of standardization and granularity, as well as a massive use of technology; as such, they would have a huge impact on the status quo for both authorities and institutions. A less disruptive approach points to the gradual standardization and harmonization of the current reporting system and is based on better governance and a general rationalization of the existing information requirements.

The two innovative approaches seem premature, mainly because of the insufficient standardization in the operational systems of financial institutions; they also imply a deep change in the roles and responsibilities of the different stakeholders in data processing, and some major legal obstacles must be overcome for their implementation. In addition, the available empirical case studies and trials are too simplistic and therefore not yet convincing. Smart contracts seem to be a more promising area for further investigation; they might lead to potentially huge savings and could make information available in near real-time. This is why it could be worth investing in proof-of-concepts for specific business cases, possibly in the context of international cooperation (involving or with a leading role for the Financial Stability Board and the Bank for International Settlements) and with the due involvement of the industry and the end users of the data.

A feasible path for changing the reporting system has already been undertaken at European level. It envisages the creation of an integrated reporting system for European banks (to then be extended to other segments of the financial market) by establishing appropriate governance and by standardizing, harmonizing and rationalizing the existing European and national frameworks, while leveraging technology as much as possible.

Dialogue and joint work with the banking industry will be crucial in this process. In this regard, continuing to invest in cooperation initiatives on the more operational and technical part of reporting, such as the strategic BIRD project launched and promoted by the ESCB, will provide fundamental support for maintaining a close connection between the data production of the reporting agents and the data collection of the authorities.

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