Digital Infrastructures for Monitoring Circular Economy Investments by Financial Institutions and Government: A Research Agenda

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Abstract
Circular Economy (CE) and sustainability are getting high on the political agenda of governments on the global level. Businesses and supply chains are at the heart of that transition, and need to make big steps in the coming years for making the transition from a linear model of make-use-dispose towards a circular model. For this transition, financing plays a key role. Financial institutions operate in a highly regulated environment. In this context, we see two particular, yet complementary, areas where digital infrastructures can be of value to support this transition. They can (1) help the financial institutions gather data about supply chain operations and address the performance of financial instruments used for the green and circular transition (i.e. bottom-up, micro view); and (2) help regulators monitor the activities of financial institutions to ensure that provided financing is indeed used to stimulate circular supply chains (i.e. top-down, macro view). In this paper, we explore the scene for digital infrastructure deployment for CE monitoring when it comes to CE funding, and propose a framework and a research agenda on the topic.

Keywords
eGovernment, circular economy, sustainability, finance, digital Infrastructures, public values, data analytics, risk management

1. Introduction

Governmental agendas of different levels (e.g. national, European, international) increasingly emphasize Circular Economy (CE) and sustainability. Regulatory measures exist to stimulate the market transition and related financial measures accordingly. For example, on the European level, the Sustainable Finance Taxonomy [1] defines which economic activities contribute substantially to the transition to a circular economy, with the aim that "economic operators would find it easier to raise funding across borders for their environmentally sustainable activities". Businesses and supply chains are at the heart of that transition, which attempt to transform a linear model of "make-use-dispose" into a circular model of "reuse and recycle-leverage". For this transition,

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proper financing is necessary. Financial institutions (the unit of observation of this paper) that provide funding (further referred to as fund providers) thus will play a key role in that transition. The financial sector is a highly regulated sector. On the one hand, one might perceive regulation as a burdening innovation, as institutions need to comply with strict criteria for their operation. On the other hand, as Tufano [2] in his seminal paper on financial innovation also argues, changes in regulation have always been stimulating institutions for a change; in other words, for innovation. (Financial) regulators and public financial institutions monitor investments that shall facilitate the transition into a circular and sustainable economy. Fund providers thus need to comply with strict measures regarding monitoring and detecting fraudulent transactions that potentially signal opposing intentions (e.g. green washing, fraud), and, at the same time, perform proper credit risk assessment to maintain a positive balance of their portfolios. These latter operational goals especially lead the everyday-decisions of fund providers. Performance is a crucial quality measure in a competitive, market-driven environment of fund providers, while penalty for non-compliance is also significant [3].

The International Monetary Fund states an urgent need to maintain financial flows that contribute to the Sustainable Development Goals (SDG) worldwide. Current flows are estimated at around three trillion USD per year, whereas the need peeks at four trillion USD annually [4]. In recent literature it has been argued that digital infrastructures can play an important role to enable CE [5] and CE monitoring [6, 7], however, research in this area is still in the developing phase. In the context discussed above, we see two potential areas where such digital infrastructures can be of value. First, they can help financial institutions realize better monitoring of the supply chains that are acting as beneficiaries for the funds received, thus mitigating the risk of non-compliance and/or false credit risk assessment. Second, they can help regulators monitor the activities of fund providers to ensure that provided funds meet the regulatory requirements regarding CE, and assess how funds stimulate circular supply chains. Focusing purely on the state-of-the-art academic literature in Finance, research related to CE manifests in the rapidly emerging sub-field of sustainable finance. Not surprisingly, though, the mainstream literature in sustainable finance focuses on financial transaction-based topics addressing performance effects of sustainable investing [8], such as empirical analysis and asset pricing of green bonds, as opposed to the mainstream literature in Economics, which captures the problem domain of CE from the welfare-optimization point of view.

In this research-in-progress paper we motivate why the feasible design of digital infrastructures for CE monitoring is of high relevance for both academic research and R&D activities of the industry. Focusing on the former, as we argue, the feasible design requires a complex requirements engineering exercise from multiple viewpoints, asking therefore for academic research combining different, state-of the art scientific knowledge and methodological underpinning. Therefore, the next sections are dedicated to motivating this claim, and to introducing our CE research framework that we instrumentalize to reach our research goal: to address the role of digital infrastructures in monitoring the flow of CE funds, emphasizing the impact of digitalization for regulatory compliance, data governance and for funding decisions.

2. Toward a research agenda: Methodological underpinning

The market liberalization of the 1980s boosted innovation of different financial instruments, which then provided easier access to capital for firms. The volume and frequency of financial transactions thus increased, leading as well to the increase of transaction risk. The Financial sector has become a highly regulated sector ever since. No wonder, therefore, that to structure our research activities, we first conducted exploratory research to address the regulatory context and its institutional implications, as variables of CE directives and of digital infrastructure design. We structure our findings by three elementary pillars for research.

2.1. Understanding the role of regulation in the context of digitalization and CE monitoring

To design our research framework, we first conducted an in-depth literature review using both scientific papers and regulatory publications. Based on our findings, we can conclude that the same phenomenon regarding regulatory adoption exists as a response to different macro-economic and societal factors that push markets toward sustainable operations. Using the global SDG goals as we motivated in the Introduction section, the European Union has already taken steps towards sustainable financing and the SDG's, such as launching the European Green Deal (EGD) [9] (European Commission, 2019). Adding to that, and focusing further on the European market, the European Financial Reporting Advisory Group (EFRAG) is committed to delivering sustainability-reporting standards, in line with the Corporate Sustainability Reporting Directive (CSRD) (see EU Sustainable Finance Package, 2021), as an extension of the already existing reporting rules of the EU on non-financial information (see EU NFRD, 2014/95/EU). These extra measures shall ensure full alignment in corporate reporting among all EU initiatives on sustainability. These directives also put operational pressure on banks to measure and disclose calculated ESG (Environmental, Social, & Governance) risks, as well as projected and realized ESG impact across different banking activities, such as fund provision.

It is important to mention that financial regulation is not homogeneous on the global level. There are different regulatory areas posing different regulatory frameworks for the financial system in place, and rules to comply with on the institutional level. Even though there are important examples of efforts for regulatory harmonization, often there exists no homogeneous view on control (see e.g. the Schrems case in Chander [10] or in Rotenberg [11]). Therefore, we restrict our further analysis to the European Regulatory Framework as reference, keeping our analysis open towards international, i.e. cross-border supply chains and fund providers. EU law defines that that the concrete implementation of EU directives and enforcing compliance are sovereign issues, putting the realization of operational goals in the hands of regulators (i.e. government) per country. It is the financial regulator on the sovereign level, which assures regulatory compliance of fund providers, and which defines local legislation and decision-making, to implement EU directives. This regulatory setup, where cross-border operations of fund providers are subject to central EU regulations that are refined and implemented nationally, i.e. decentralized manner, may result in segmentation of concrete implementation practices (because every EU Member State may have somewhat different regulations and compliance requirements, while business operations cross country borders), influencing fund providers' data

governance activities for monitoring and control (see [4] as example on (cyber) data security). Simandan & Paun [12] stipulate furthermore, that monetary authorities need to reorient their approach from short-term liquidity management to supporting the long-term sustainability agenda, corresponding with the liquidity concerns and funding difficulties of CE investments. In this context, the European market is of special interest, as Luxembourg hosts the second biggest hub for fund management globally, and residing institutions report an increasing volume of issued funds that support ESG goals (see e.g. [13]).

Government regulation of financial instruments and of cross-border activities is not new though, for example in healthcare, in social benefit schemes and in global trade, where financial stimuli exist to stimulate imports of certain products from certain countries against reduced import duties. Experiences from the field of international trade [14, 15, 16, 17, 18] also provides examples of how digital infrastructures innovations can serve as enables for monitoring of international trade flows in the context of customs regulation. To summarize our findings, in order to perform our research and to address the role of digital infrastructures to monitor the flow of CE funds, as a first fundamental pillar of our framework, we aim at addressing the role of regulators in this context. Furthermore, we hypothesize that regulatory bodies could as well play a role in fund provision to support CE goals.

2.2. Exploring the role of fund providers in the context of CE

An important unit of our observation is the financial sector, as our research aims to support the feasible design of digital infrastructures for CE monitoring, with a specific focus on fund flow. Therefore, we conducted also an in-depth literature review in Finance, as well as analyzed different cases in Finance where digitalization has measurable impact and implications for institutions. We developed a conceptual framework to structure different financial institutions as a function of their roles in fund provision for CE. For the sake of brevity, we only mention here this latter, but exclude the framework from this particular paper. We only summarize the important findings of our first two activities.

Academic papers in Finance that we treat as relevant for our research cover two main research streams. First, there already exists solid literature analyzing the difficulty of monitoring and reporting data related to ESG investments on the institutional level, see e.g. [19], leading toward opportunism and falsely reported performance. Another stream of literature analyzes the institutional attitude toward corporate social responsibility and ESG, which is also framed as a result of regulatory directives, or lead by corporate incentives (see e.g. [4]) or by firm value considerations (see e.g. [20, 13]). Based on our findings we thus argue that fund providers are incentivized to boost the realization, i.e. the financing, of CE goals. As we conclude, an important challenge exists in fund provisioning, which is the function of properly addressing, assessing and monitoring (performance) data across the entire value chain of issued investments.

Financial institutions have become heavy users of digital infrastructures. As a recent industry report by Deloitte argues, the ratio of IT spending as a percentage of revenue in the financial services industry is substantially higher than in other industries [21]. This high percentage is the result of maintaining complex IT systems and aligning with evolving regulatory rules, especially in the context of cross-border data flow. This observation is the result of our desk-based case study on data privacy. The European Data Privacy Framework (GDPR) imposes, among others,

a strong, consensus-based storage and access of personal data. Fund providers that are active on the global scene must consider it while handling corporate data of cross-border supply chains. Funds managing HNWI (High-Net-Worth Individual) portfolios in particular are keen on data privacy, so GDPR is a positively enhancing regulatory measure to protect client data. Operationally speaking, however, it requires that data storage and management must comply with GDPR, too. This strong market and regulatory requirement translate to the fact that financial institutions must either operate with locally implemented (i.e. within the geographical borders of GDPR, i.e. the EU) infrastructural solutions, or restrict international cloud services with strict, thus costly contractual agreements to ensure GDPR-compliant data management (storage, orchestration, etc.). This phenomenon limits the ability of companies to benefit from economies of scale in their IT operations, as financial data is substantial, and infrastructure is costly. It also raises feasibility issues regarding interoperability of data management solutions across global, i.e. cross-border supply chains. The GDPR case study is highly relevant to our topic because both cases involve EU legislation, potentially with differences between how it is implemented in each EU Member State, and impacting cross-border value chains and having major impact on data and IT operations of fund providers as well as on their business models. Digital infrastructures for CE monitoring shall therefore consider data management as the function of different regulatory environments.

Our findings indeed show that digital infrastructures shall aim at monitoring the flow of CE investments accurately, as this is an important element for the accurate risk assessment of provided funds. However, to support the feasible design of those infrastructures, we aim at exploring the complex set of requirements of digital infrastructures for CE monitoring on the institutional level. We also hypothesize that the elicitation of requirements translates to an engineering exercise of multiple viewpoints; besides technological feasibility, market feasibility and the alignment of those play a crucial role to support the feasible design of digital infrastructures.

2.3. Focusing on networks of organizations in the context of digitalization and corporate data

Multiple large players in the private sector (see e.g. Blackrock, or Circularity Capital) are directing millions of dollars in funds towards circular practices at the firm level [22], in line with the emerging regulatory pressure that forces fund providers to comply with Environmental, Social and Governance (ESG) goals. These signals show that the private sector is increasingly committing to support circular economy projects [22]. Monitoring the flow of funds is an elementary activity for these financial institutions. Accessing, structuring and analyzing data on fund issuance, and evaluating related credit risk are of high importance. Greenwashing, i.e. the selective disclosure of positive sustainability information, without full disclosure of negative information, is an existing phenomenon (see e.g. [23]), undermining the incentives of institutional investors to fund CE initiatives. Difficulties of data monitoring arise as one considers the already-described diversity that regulatory segmentation can pose.

Conducting again an in-depth literature review and desk-based case analyses, we hereby conclude our findings to motivate yet another important angle of our research activities. Referring again to the GDPR case, as data protection rules diverge across different regulatory

areas, they incentivize corporates and SMEs differently regarding data sensitivity and reporting obligations. These different incentives thus can put fund providers in a difficult position while addressing and calculating the credit risk of ESG investments, hindering thus the access to funding channels, in the same way that lack of information about SMEs (whose reporting obligations may differ greatly per country, yet in general are lesser than those of larger corporations) is known to be a factor hindering fund providers from providing funds to SMEs (see e.g. [24, 25]). In the case of SMEs, it was found that alternative information solutions can mitigate fund providers' concerns, and enable fund provisioning (see e.g. [25]). We thus project fund provisioning difficulties to data collection and governance difficulties in particular, and investigate whether and to what extent an underlying ICT infrastructure can positively enhance funds providers' ability to give loans. As a consequence of this finding, we analyzed another case in the context of digitalization, in particular on maintaining transaction monitoring and settlement. Fund providers are implementing digital practices that allow complying with the Payment Service Directive 2 (PSD2, EU 2015/2366). PSD2 aims, among others, to foster innovation and competition in the payments industry by allowing third parties (TPPs: Third Party Providers) to offer payment services for banking clients, such as corporations. As it is an EU directive (i.e. recommendation), implementation remains on the sovereign level. By now, there exists a diverse set of protocols and standards that declare the operational implementation of the concrete APIs of the web services that connect with the existing digital infrastructure of financial institutions. Consequently, if a TPP wants to offer account management services for corporations, a TPP might need to implement different protocols for the same service to be competitive for the European market. Furthermore, designing business-to-business solutions for financial data monitoring or for payment support might as well imply that TPPs either provide (costly) tailor-made, individual solutions, or consider the diversity of different standards and protocols to be able to offer the service for an international financial institution.Merging these thoughts above, one might conclude that TPPs provide a good, market-driven alternative for financial institutions and for other corporations to realize transparency within complex supply chains, and hence their applicability also for CE monitoring. The concrete implementation requires, however, a careful elicitation of system requirements, such as interoperability and data privacy, as well as a careful alignment of different regulatory measures in case of cross-border supply chains. To summarize our findings, in order to perform our research and to address the role of digital infrastructures to monitor the flow of CE funds, as a third fundamental pillar of our framework, we aim at exploring the complex set of requirements of digital infrastructures as functions of complex, cross-organizational chains in the context of fund provision. Furthermore, we hypothesize that proper and feasible data governance mechanism that assures monitoring data across value chains is of high importance to support the feasible design of digital infrastructures.

3. The CE Research Framework

As a result of our explorative research that we described and concluded along three important dimensions in the previous section, we now present our research framework to formalize the leading research questions for further research. To start with, we put the public sector, in

particular the regulator and the government, in focus and assess its role and responsibility for monitoring CE investments, and for addressing their impact and implications. Based on our findings that we described in the previous section, we can safely conclude that public institutions shall have already implemented organizational, procedural and technological means to ensure regulatory compliance, to manage public spending, and to control for the abuse of financial instruments they issued. Therefore, we hypothesize that monitoring and analyzing the operations of both financial institutions and corporations to meet CE goals will be no different. In this respect, we formulate the following two topical questions: (R-R1): What is the role of the public sector in financing CE investments? (R-R2): To which degree are existing data management practices for data collection, structuring, processing and analysis by regulators suitable for CE monitoring? As a second important pillar, we also motivated the role of research to address and to analyze the financial sector, in particular the role of fund providers and the flow of funds in the context of CE regulation and compliance. As we argued, fund providers continuously adjust and develop their compliance policies, as operational decisions are subject to a diverse set of directives. Recent public signals indicate increasing efforts of governmental stimuli for fund provision, too, escalating further regulation (see e.g. US Infrastructure Investment and Jobs Act , 2021). In this respect, we formulate the following two topical questions: (F-R1): What are the systemic/design requirements of digital infrastructures that enable complying with diverse regulatory requirements? (F-R2): What are the potential interoperability bottlenecks of digital infrastructures across networks of stakeholders regarding regulatory compliance? To define the third pillar of our research framework, we turn to the corporate sector. As motivated, firms require financing to transform their business model compatible with CE goals, and therefore fund provision is essential. Fund providers already operate with complex digital systems to maintain everyday operations, which are subjects of strict regulatory measures. A straightforward element of our research strategy is to explore and to analyze already existing digital solutions for data management in Finance. We formulate the following two topical questions (C-R1): What existing digital data management practices do fund providers operate with? (C-R2): To which degree are existing practices for data collection, structuring, processing and analysis of corporates (i.e. fund requestors) suitable for CE investment monitoring by fund providers and regulators?

Although CE goals of corporations can be limited to a single organization, analyzing risk, compliance, long-term implications and impact of investment shall address the whole value chain, including the fund requestors as well as their suppliers, partners and end-customers. Understanding the networked nature of the research problem is therefore important. In addition, financing of large-scale projects can require several different fund providers, who might as well need to share data and coordinate analytical measures to address the impact of their investments. In this respect, we formulate the following two topical questions: (N-R1): How do existing digital infrastructures monitor data flow in a network (as opposed to monitoring a single company) for reporting? (N-R2): How do existing digital infrastructures enable information sharing in a feasible way among parties that may have different incentives and/or competing interests?

Figure 1 conceptualizes our framework and our research agenda, based on the above-described three pillars. In the left column we visualize the relationships between Regulation, Fund providers and Businesses, adding and positioning as well government and supply chain partners as important units of our research agenda. We summarize the topical questions discussed above

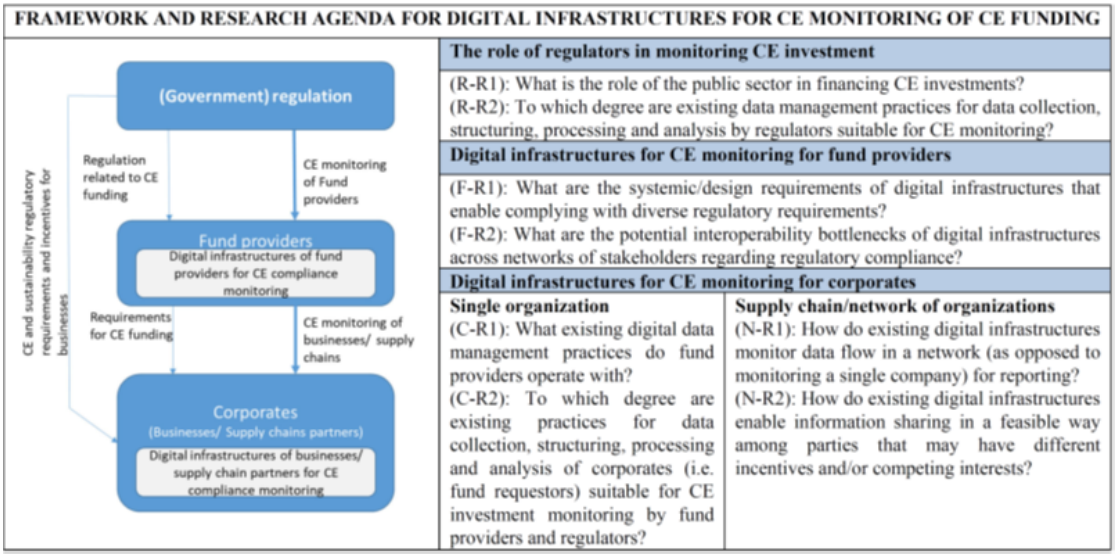

Figure 1: Framework for digital infrastructures for CE monitoring of CE Funding

in the right column. To execute our research, and to seek answers to our research questions, we are planning to operationalize both qualitative and quantitative research methods. Qualitative data is gathered via case studies and interviews. We also aim at instrumentalizing databases (e.g., Compustat, Bloomberg, Wharton) that are well-used for research in Finance, providing variables on ESG rating, on industrial segmentation and on corporate governance data.

4. Concluding remarks

A transition of corporates toward CE is ongoing. In our view, both the private sector and governmental instruments will likely play an important role in fund provision. Table 1 therefore conceptualizes our research agenda that we plan to operationalize in order to validate this perception. We foresee that much can be learned from studying the evolution and implementation of different regulatory directives that keep affecting the everyday-operations of the financial sector, such as the earlier mentioned GDPR (i.e. data protection mechanism), or PSD2 (i.e. the payment service directive). Our important claim is to include a strong network viewpoint to our investigation, as realizing CE initiatives often involve a network of different corporates, such as different service providers, production sites or even different fund providers. Last, but not least, we consider collecting data across different levels of refinement, using different viewpoints of the same case at hand. We treat as valuable data source a legal entity (i.e., a firm), its transactions, and the networked environment where it operates. All these viewpoints are required to arrive at feasible data orchestration and analytical solutions that monitor CE investments and, at the same time, argue about the impact and implications of funds provided.

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