



**Special Issue on Financial Infrastructure;  
Explanatory notes of “SBI Research Review vol.6”**

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In the sixth volume of the SBI Research Review (available only in Japanese), we focused on financial infrastructure. While the term “financial infrastructure” might appear straightforward, it encompasses a vast array of components. These include legal regulations, financial systems, IT infrastructure, the industrial structure of financial services and market and settlement systems, supervision and monitoring, corporate governance within financial institutions, governance of financial systems, various associations and self-regulatory organizations, related industries, such as accounting and law firms, consulting firms, credit information agencies, and telecommunications and data industries. It also involves standardizing information and rules, maintaining sound market practices and integrity, and fostering the business culture of the financial industry. These diverse components collectively form the financial infrastructure. The advancement and functionality of these components impact the overall quality of financial services, and consequently, economic growth and national economic welfare.

This volume highlights three primary themes across four papers within the diverse landscape of financial infrastructure: digital identity (explored by Shibata & Sakimura and Nakayama), the intersection of decentralized financial systems with traditional centralized finance (discussed by Saito), and generative AI (surveyed by Soejima). Additionally, since December last year, the SBI Financial and Economic Research Institute has established a “Study Group on the Creation of Next-Generation Financial Infrastructure,” engaging in various discussions on the challenges and future of financial infrastructure. This volume includes the first report published on July 5 and introduces a roundtable discussion by the study group members following the compilation of the report.

Papers included:

1. Shibata & Sakimura: “Global Trends in Digital Identity”
2. Nakayama: “The Background of the ‘European Digital ID Framework Regulation’ and the Common Specifications of the European Digital ID Wallet”
3. Saito: “Decentralized Finance Swallowed by Traditional Finance”
4. Soejima: “Generative AI Walkthrough: Basic Technologies, LLM, and Application”

Implementation”

5. Report by the Study Group on the Creation of Next-Generation Financial Infrastructure: “Guidelines for Considering the Creation of Next-Generation Financial Infrastructure”

## Shibata & Sakimura Paper and Nakayama Paper

Digital identity serves as the foundational infrastructure supporting identity proofing and verification, as well as authentication in a digital society. It is a collection of attributes and information used to identify individuals in a digital manner, including usernames, passwords, biometric data, and various records of personal behavior, such as location information and browsing history. This collection of attributes and information can also be used to identify not only individuals but also organizations and devices. Digital identity provides a basis for verifying who specific entities are and ensuring the reliability of the verification. Therefore, it is a crucial infrastructure not only for financial services but for all services in a digital society.

When using services that require personal information or settings unique to you, it is necessary to register by demonstrating “who you are” to the service provider. The veracity, amount, and accuracy of the identity information required vary significantly depending on the service. For example, many social networking services allow registration under pseudonyms rather than real names. The Identity Assurance Level required by various services is determined by industry laws or self-regulation and varies greatly. The Identity Assurance Level required for purchasing a mobile phone in Japan has changed over time, and there are different types of electronic moneys with diverse levels of identity assurance in Japan, where some require identity verification while others do not.

Generally, when applying for financial services, official identity verification, such as a driver’s license or My Number card of Japanese national ID, is required, followed by the provision of authentication methods. As an example of a digital service, consider transferring money from a bank deposit account using a smartphone app. The bank must confirm that the transfer instruction sent from the other side of the internet is indeed from you, the registered account holder. This process involves authentication, which requires prior registration with verified identity.

Digital identities are issued not only by public sector but also by private companies, which issue various digital identities to service users and utilize them for authentication and authorization during service provision. Customer management is crucial for both ecosystem players as well as small-scale service providers for marketing purposes. In these digital identity applications, technological advancements now allow selective sharing of specific digital

identity attributes, making it possible to disclose only necessary personal information when accessing a particular service. For instance, in services requiring only age verification, it is unnecessary to disclose one's name, address, or even age. It is sufficient to prove that the age requirement is met. There are many cases, such as COVID-19 vaccinations or obtaining certifications and degrees, where simply knowing whether something is true or false is sufficient.

While the appropriate use of digital identity is important for enjoying (or providing) excellent services, managing digital identity is also essential for ensuring privacy. The first two papers in this volume, by Shibata & Sakimura and Nakayama, discuss the latest trends in digital identity.

The Shibata & Sakimura paper outlines the current state of open banking in major countries and discusses the important roles of digital identity in privacy protection, financial crime prevention, and ensuring interoperability. The latter part introduces specific technological trends such as Verifiable Credentials (VC) and digital identity wallets, and examines international developments and challenges, particularly in the EU. VCs are digital certificates for personal attribute information issued by trusted institutions. They are protected by cryptographic technology, which utilizes techniques that enable the selective disclosure of necessary attribute information. The paper also introduces Japan's initiatives, such as providing the My Number card functions via smartphone and the signing of the memorandum of cooperation with the EU led by the Digital Agency, discussing the future brought by advancements in digital identity technology.

The Nakayama paper focuses on the leading EU, explaining the revision of the European Digital ID Framework Regulation and the specifications of the European Digital ID Wallet. In the EU, an electronic identification means called eID was adopted in 2014 (eIDAS Regulation) to ensure interoperability of electronic identification methods among member states, allowing electronic IDs issued in different countries to be mutually recognized and usable. Subsequently, its implementation has been promoted, but the uneven progress among countries hindered the widespread use of these IDs in private services. Therefore, the eIDAS Regulation was revised in May this year, obligating member states to provide European Digital ID Wallets to citizens within two years. These wallets are applications that manage IDs and attribute information, capable of handling a variety of digital identity-related information, such as driver's licenses, medical prescriptions, educational qualifications, and electronic signatures. To promote standardization, a toolbox specification for system development was established, and roles of various stakeholders were ingeniously set, including issuers, verification service providers, registration authorities, supervisory authorities, and certification bodies, to function as an ecosystem.

Digital identity is a crucial financial infrastructure for creating and providing excellent financial services, ensuring valuable functions and competitive advantage of the services. Understanding global trends and advanced grand designs through these two papers is extremely beneficial for considering national strategies related to Japan's financial economy and social welfare. Readers of the Nakayama paper, in particular, will become acutely aware of Japan's lagging national strategy in implementing and utilizing digital identity across the society.

## Saito Paper

In recent years, decentralized financial systems have emerged as a global trend in financial infrastructure. Distributed ledger technology plays a core role in the development of these systems. Our institute's Research Review series and web reports have extensively covered how distributed ledger technology is transforming financial infrastructure, including crypto assets, security tokens, stablecoins, DeFi, and NFTs. Additionally, the responses of financial regulators and central banks to these developments, or their attempts to utilize them themselves, are crucial for considering the evolution of financial infrastructure. We have also highlighted these developments in the context of financial regulations and CBDC. For example, looking back over the past year, the following papers and web reports from our institute explored those issues (those published in the SBI Research Review series are marked with an asterisk, and papers and reports are available only in Japanese):

Daiki Ishikawa, "Latest Trends of Financial Institutions Returning to Public Chain Technology to Realize future Generation Digital Finance," December 2023

Kimio Mikazuki, "Security Token Update and Future Prospects: Summer 2024," July 2024

Tatsuya Saito, "The Future and Trajectory of Financial Systems Brought by Tokenization\*," March 2024

So Saito, "Current Status, Future and Legislation of RWAs," April 2024

Ken Muramatsu, "Current Status and Issues of Security Tokens," December 2023

Koichi Hirata & Takako Masai, "Current Status and Future of the Security Token Market\*," August 2023

Yasushi Nakayama, "Consider the Sustainability of NFT ; Can NFTs Be Considered a Long-term Preservation Asset?" March 2024

Yasushi Nakayama, "Is the NFT Really "One and Only"?: Suggestions for One Way to Increase NFT's Credibility," November 2023

US Edition, EU & UK Edition, International Organizations Edition, "The Chronicle of Crypto Assets and Other Assets," 2023

Yutaka Soejima, "Challenges of Central Banks Exploring the Future of Financial Systems\*,"

March 2024

Shuji Kobayakawa, "Discussion on CBDC's Offline Settlement," August 2023

Tomoko Amaya, "The Function of Crypto Assets and the Evolution of International Regulatory Approaches," December 2023

Yasushi Nakayama, "Trends in Crypto Assets Regulation in the US\*," August 2023

Tomonori Yuyama, "Another Perspective on Cryptocurrency Regulation in the US: How to Handle DeFi (Decentralized Finance)\*," August 2023

Yasushi Nakayama, "Read the Summary Judgment in the Case against Ripple Inc.: Why XRP Sold to Individuals Is Not Considered a 'Security'," August 2023

Yoshikazu Yamaoki, "Defining and Highlighting Digital Payment Instruments (Cryptocurrency-Like) from the Revision History of the Payment Services Act and the Financial Instruments and Exchange Act\*," August 2023

Ken Kawai, "Six Key Points of the Stablecoin Regulation\*," August 2023

Makoto Yasukouchi, "Review of the 2024 Tax Reform (Related to Crypto Assets)," January 2024

Furthermore, we recognize the importance of historical perspectives when considering future financial infrastructure, such as the transition from decentralized financial systems during the Edo period, a time of samurai rule, to centralized government systems after the Meiji Restoration. In light of this, we have published the following papers and reports:

Masato Shizume, "Changes in the Monetary System and Currency Usage in Late Edo and Early Meiji Japan: Insights for the Coexistence and Integration of Multiple Currencies in the Digital Currency Era," August 2023

Yasuo Takatsuki, "Financial Innovation in the Early Modern Japan (1): Security Exchange Market," July 2024

A common theme among these papers and reports is the perspective on how to coexist and connect two fundamentally different systems: how to coexist decentralized and centralized systems, or how to connect old and new systems. This viewpoint is relevant not only from an IT infrastructure perspective but also in terms of diverse aspects that constitute financial infrastructure, such as governance, legal regulations, supervision and monitoring implementation execution, financial system stability, user protection, AML/CFT, and the industrial structure of the financial sector. For example, achieving KYC involves organizations, such as cryptocurrency exchanges, that play a crucial role as connection points between decentralized systems and traditional financial systems. This structure did not exist in the world envisioned by Satoshi Nakamoto. The approach of financial institutions and central banks towards distributed ledger technology has also created private chains, which were not part of Nakamoto's vision. The aforementioned Ishikawa report highlights the recent trend of financial

institutions and financial infrastructure companies that govern private chains showing strong interest in cross-chain technology to connect private chains with public chains.

The Saito paper clarifies that even new decentralized financial systems cannot function without traditional financial systems. It further posits that recent developments, such as cryptocurrency ETFs in the US and the approval of LLC DAOs in Japan, suggest that decentralized systems are being subsumed by traditional financial systems rather than move closer together. The paper asserts that “the fundamental issue may lie in the ledger systems themselves, which cannot sustain themselves without connections to traditional finance, despite their decentralized aspirations.” This, however, should not be seen as a negative criticism. The concluding argument in the paper emphasizes the need to reassess the advantages of distributed ledger technology and to strive for the emergence of ledger systems that function under different conditions independent of traditional finance. The bottom line represents the author's main intention. This is a proposal that involves the redesign of the entire financial system, specifically how to coexist and connect two systems, in various aspects of financial infrastructure such as IT infrastructure, governance, and legal regulations. A similar perspective is also presented in the report by the “Study Group on the Creation of Next-Generation Financial Infrastructure.”

## Soejima Paper

In the past one to two years, generative AI has garnered significant attention as a foundational technology poised to transform not only the financial industry but also socio-economic activities in general. Currently, the most attended events in the financial industry, at least, are conferences and workshops focused on generative AI, which are creating a significant wave in conjunction with DX, big data, information utilization, and new trends of IT system development. Readers who briefly experimented with ChatGPT when it first appeared a year and a half ago but have since distanced themselves are encouraged to explore the latest services. They can experience the frontier of current generative AI, which can instantly read long PDF documents and provide accurate and flexible answers to questions based on the documents, for free. Besides GPT, many other large language models have emerged, demonstrating dramatic improvements in knowledge volume and language generation capabilities.

Generative AI has two implications. First, it has enabled direct communication with computers using natural language, the most fundamental human tool of communication. Previously, operations were performed by instructing through writing programs or using programs and applications created by others. While voice commands and chatbots, which were precursors,

have appeared, the versatility of current generative AI extends to a completely different level. It is now possible to issue commands in language and generate various types of information, including text, images, audio, and programs. Such technology could only exist in the realm of science fiction a few years ago.

Second, language generation models now function as databases of knowledge and information. These models, based on neural networks, learn language patterns from vast databases of documents, such as large collections of texts from the internet and extensive libraries of public domain books. The basic algorithm of language generation models is remarkably simple, creating sentences by repeatedly inferring the most appropriate next word, word by word, based on the context in which the words appear. Although it seemed unlikely that human-like text generation could be achieved this way, rapid technological advancements have made it possible in a short period. Naturally, the nature of these language generation models inherently involves hallucinations (plausible falsehoods). However, as language generation models scale up and their training datasets grow larger, the information embedded in sentence development and patterns is assimilated as knowledge within the models. Current large language models have already acquired knowledge comparable to that of experts in various fields and can be further fine-tuned with specialized information.

Despite the rapid evolution of generative AI technology, many financial institutions struggle to take advantage of it. The financial industry is an industry that produces and processes vast amounts of information. The information is produced and processed not only as numerical data but also as textual data. Therefore, the potential for leveraging generative AI, particularly large language models, in the financial industry is significant. However, challenges such as information security issues, IT system development and operational policies, and a shortage of specialized personnel have hindered the application of generative AI in both financial services for customer and internal operations, resulting in only gradual progress. Furthermore, the absence of an in-house development culture, where business operations are deeply involved in system development, means that these organizations are unable to respond swiftly to rapid functional improvements or the emergence of new technologies and services.

The Soejima paper provides a historical overview of the development of generative AI, especially large language models, technical explanations of representative models, introductions to the latest models and services, and explanations with demonstrations of implementation techniques. It particularly introduces implementation examples, focusing on methods for handling confidential information (internal corporate information and secured customer information) in generative AI models. Written with a tutorial approach to learning how to utilize generative AI, the paper serves as a “pilot” for enjoying the democratization benefits of generative AI technology.