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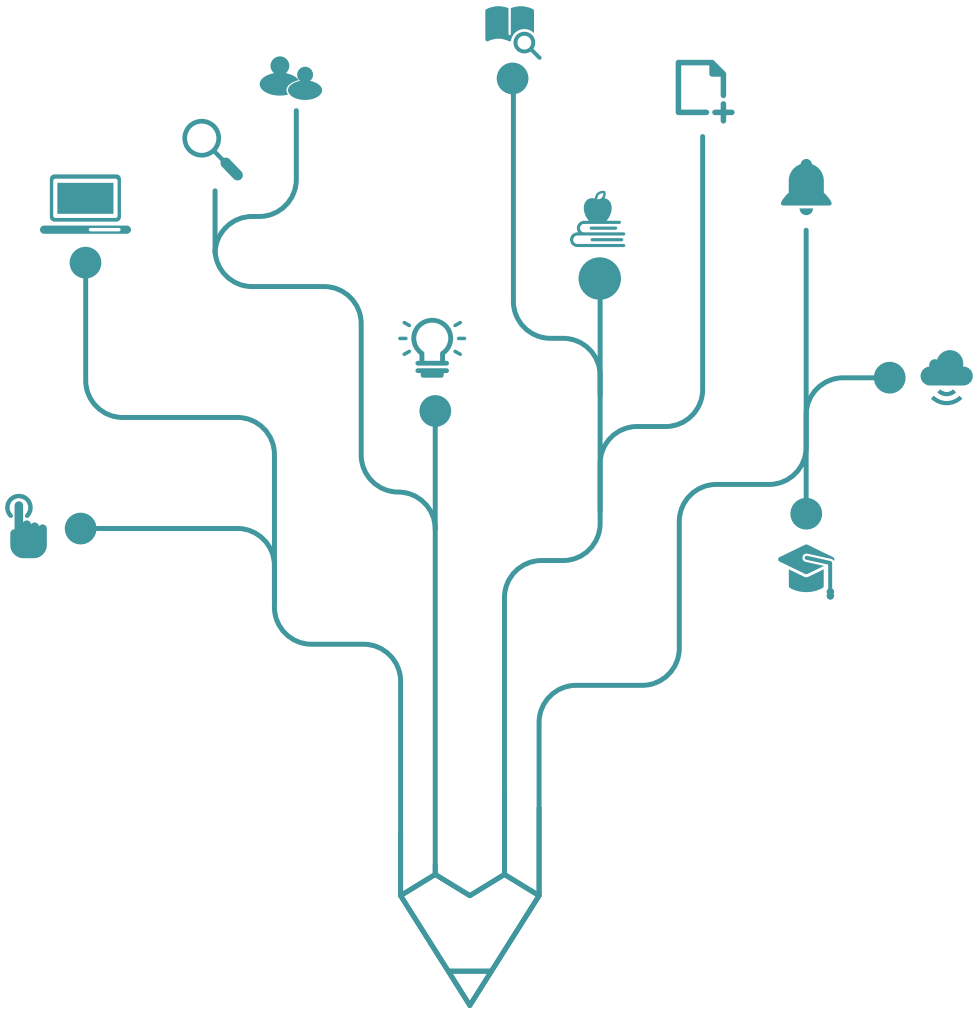
Protecting Financial Consumers in the Era of BD· ML Innovations: What behavioral patterns to be tamed? And how?

(*BD·ML: BigData and MachineLearning)

Man Cho (KDI School of Public Policy and Management)



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Abstract

The main objective of this study is two-fold: first, deriving specific behavioral patterns to be tamed, in both demand-side and supply-side of the financing markets, in the viewpoint of protecting financial consumers in the era of BD·ML innovations; and, second, elaborating a set of policy remedies to nudge the consumers as well as the intermediaries to improve each behavioral pattern identified. To that end, two particular optimization frameworks are specified - (1) a two-period (working age vs. retirement) intertemporal utility maximization framework for financial consumers, and (2) a profit (or NOI per-period) maximization framework for financial intermediaries, out of which eight specific behavioral patterns are identified as those that should be targeted in designing and instituting a welfare-enhancing regime of consumer protection policies. Those behavioral patterns are further linked to real world cases of abusive and fraudulent intermediation practices as well as to policy remedies to deal each behavioral pattern included. In so doing, the study aims to offer a template with which one can formulate future research agenda and policy instruments to be collaborated in the global research community as to how to protect financial consumers in the current environment of rapidly-advancing technologies.

1. Introduction

In November 2022, a star technology was born, ChatGPT, whose impacts are permeating virtually to all sectors of economy in many countries. As a type of Generative-AI[1], this neural net based AI system achieved the phenomenal 500 million subscriptions around the globe before its one-year anniversary, faster than any other pervasive technological breakthrough ever introduced. In a broader context, pundits argue that the BigData·MachineLearning (henceforth, to be termed as BD·ML) driven AI systems like ChatGPT should now be regarded as a new General Purpose Technology (GPT)[2], in addition to those milestone GPTs out of the information and communication field during the last half century (e.g., the invention of microprocessor in 1969, the initiation and commercialization of World Wide Web from the 1990s, and the development and pervasive use of smartphone since 2007). Working as complementarities to each other, these GPTs are increasingly impacting the ways that goods and services are designed, produced, and delivered to consumers.

The financial service sector is no exception in that the BD·ML-driven innovations are spreading into its major segments of lending, funding, insurance, and payment. At the core of such innovations, there exist the AI algorithms that are capable of processing and utilizing vast amount of unstructured data (e.g., text, audio, video, and pictures) and of delivering a superior predictive power in explaining underlying data patterns compared to the conventional statistical methods. In the context of the financial markets, those BD·ML data analytics are already leading to welfare gains of various type, e.g., a more efficient intermediation process with lower transaction cost, a more accurate credit evaluation, an expanded financial inclusion for marginal consumers, and more automated internal and external processes for financial intermediaries. However, there is no free lunch in that those innovative technologies are also incurring welfare losses of diverse type, including the heightened vulnerability to cyber thefts and crimes (hacking, phishing, smishing, pharming, and so on) that are becoming more organized and sophisticated, as well as the rising incidences of excessive leverage and risk-taking by financial consumers thanks to those alternative financial services that offer easier and more convenient (sometimes fraudulent) ways of intermediating the financial products.

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[1] According to ChatGPT, generative AI is defined as, "a branch of artificial intelligence that generates new content (such as text, images, music, and other data types), often indistinguishable from human-created content, by learning from a vast amount of data."

[2] GPT refers to those innovative technologies that have abrupt, pervasive, and discrete effects on economic system (i.e., a game changer). The literature in this vein argues that GPT tends to combine with complementary technologies and to increase its social and economic impact in a discrete fashion. (Bresnahan and Trajtenberg (1995), Helpman and Trajtenberg (1998)) See Teece (2018) among others for this argument.

Given these on-going trends as a backdrop, the main objective of the current study is two-fold: first, deriving specific behavioral patterns to be tamed, both in demand-side and in supply-side of the financing markets, in the viewpoint of properly protecting financial consumers in the era of BD·ML innovations; and, second, elaborating a set of policy remedies to nudge them to improve each behavioral pattern identified. To that end, two particular optimization frameworks are specified, as an efficient means to elaborate and communicate those behavioral patterns that should be deemed as suboptimal: namely, (1) a two-period (working age vs. retirement) intertemporal utility maximization framework for financial consumers with the usual constraints and uncertainty factors faced by them; and, (2) a profit (or per-period NOI) maximization framework for financial intermediaries with a quality-adjusted production function as a constraint. (See Section 3 for details.) Out of this conceptual discussion, eight specific behavioral patterns are identified, as listed below:

(1). Over-consumption and under-saving (demand-side)

(2). Over-leverage and sub-optimal choice of loan product (demand-side)

(3). Excessive risk-taking and suboptimal choice of investment products (demand-side)

(4). Profit-making over fulfilling the fiduciary duty (supply-side)

(5). Moral hazard in product design and sale (supply-side)

(6). Inefficient risk management (supply-side)

(7). Suboptimal technology choice and utilization (supply-side)

(8). Inadequate responses to financial frauds & crimes (both sides)

As eloquently put it by Shiller (2012) (in his book entitled as "Finance and the Good Society"), the role of finance in a given country (at a particular time period) is to fulfill two core functions (which is characterized as 'the science of goal architect'): namely, developing demand-driven financial products to enable households, firms, and governments to achieve what they intend to do so; and, managing underlying financial risks of those products in an efficient fashion. It is fair to say that, for a long while, the financial regulations focused on the supply-side, i.e., how to ensure a financial safety and soundness of the intermediaries through the capital requirement and other means of oversight. However, the recent financial crisis ignited by the subprime mortgage debacle shifted the attention toward the demand-side, i.e., how to properly protect financial consumers from arcane financial products and abusive intermediation practices. To that end, a number of 'good' practices of financial consumer protection (FCP) have been suggested by different jurisdictions (e.g., the Dodd-Frank Act of

Wall Street Reform and Financial Consumer Protection in the U.S.) as well as by the multi-lateral international organizations (those rules and principles issued by the World Bank and OECD).[3] In essence, the overall goal of those FCP measures boils down to making sure two behavioral principles to be prevailed in the market place, i.e., sound and informed decisions by consumers in their personal financial planning and product choices, and a fair and ethical treatment of consumers by financial intermediaries and their employees despite the fact that their primary incentive is in profit-making.

The BD·ML driven innovations, as expected by many, are likely to be a game changer by deeply influencing the ways that the FCP measures are designed and implemented. As surveyed in the next section, the GenAI technologies are using the afore-mentioned prior GPTs as complementarities, and their applications in the financial service sector are likely to explode in coming years.[4] In particular, the advancement in the AI technology will accelerate its applications in two main directions. First, the GenAI's capability of collecting vast amount of knowledge available online, of converting them to an easy-to-understand summary, and of interacting with user through a prompt-response interface to arrive at a more tailored answer (all in a pretty much real time fashion) will enable a dramatic efficiency gain, both in the typical front-office functions (such as sales and marketing, and customer support) as well as in the middle- or back-office functions (like credit evaluation, product development, risk management, fraud detection, and regulatory compliance). As someone has put it, it will be like having an Aristotle-level tutor to everyone who is willing to utilize the service!

Second, applying an ML algorithm based data analytics (such as regression tree, random forest, and ensemble) can produce an enhanced predictive power compared to the traditional statistical models (e.g., the regression models of various types), as they rely on iterative estimations and sample separations to find the best functional form among the right-hand side (explanatory) variables in explain its target (explained) variable. As such, they can offer superior data analytics to enhance various functions of the intermediaries, e.g., a more accurate consumer segmentation, a more consumer-centric product development, a more data- and evidence-based risk management, and so on. One point that is worth noting is that, in order to

[3] For example, the World Bank (2012) proposes the 39 common good practices around four themes: (1) information provision (to financial consumers); (2) financial literacy and capability; (3) sales practices (by the intermediaries and their employees); and, (4) conflict resolution mechanism. And G20/OECD (2012) suggested the ten high-level principles of FCP, which was recently revised (as discussed by OECD (2022)) by adding two new principles and three cross-cutting themes (see Section 5 for more details).

[4] The survey in the next section will go over three waves of financial innovations that are happening since the inception of the internet, and will utilize the author's lecture notes along with some of the recent writings on the topic, including Cho (2023a) and (2023b), Cho (2021), Cho and Park (2021).

relate the improved predictive power to organizational performance, the intermediary has to simultaneously develop a multi-dimensional capability, including human dimension (i.e., personnel with analytical skills), physical dimension (i.e., IT infrastructure to collect and share BigData), and governance dimension (i.e., decision-making process to reflect the outcome of data analysis to actual business processes). (Akter et al. (2016), Wamba et al. (2017), among others).

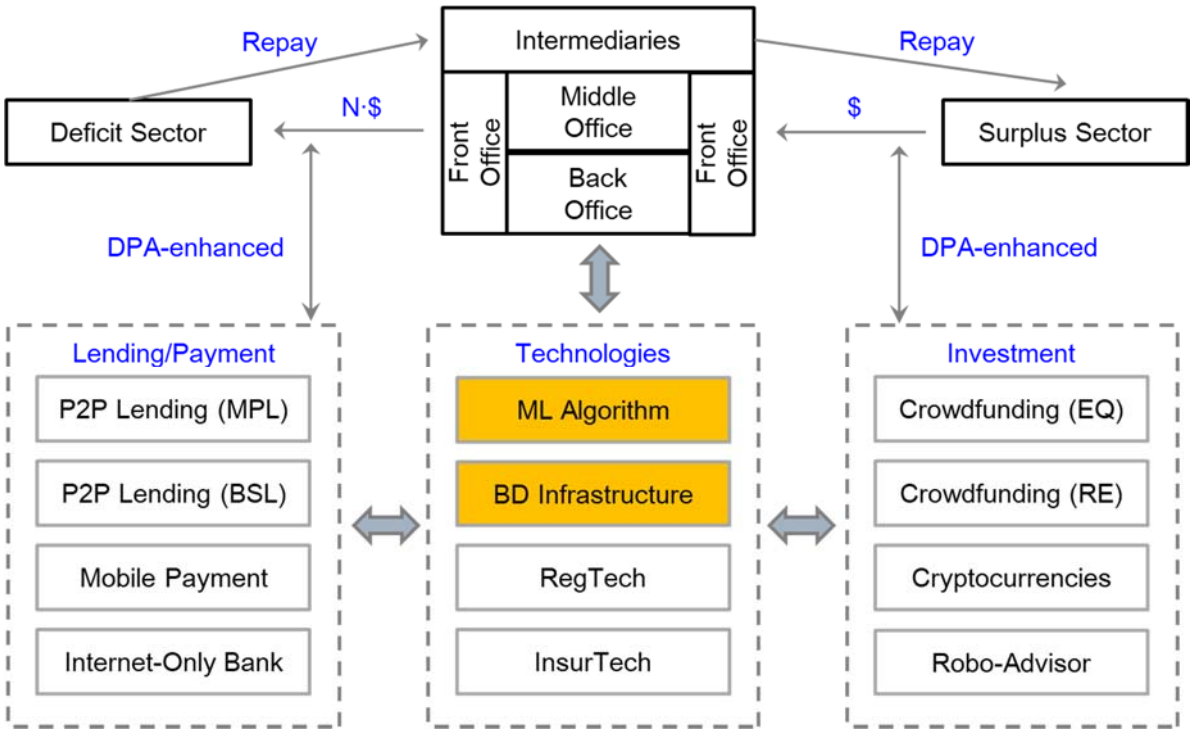
As a potential contribution, this paper offers a matrix that links three factors that are examined: namely, (1) those behavioral patterns identified, (2) real world cases of abusive or fraudulent intermediation practices, and (3) policy remedies relevant to each behavioral type. Hopefully, this matrix serves as a template for us to further think through what research agenda and policy instruments we as a global research community would contemplate in coming years to effectively deal with this regime-switching technology. To help promote our future collaboration, policy implications of the data and analyses contained in this paper in terms of financial education and counseling, business ethics training, prevention of incomplete sale, and market-wide competition are discussed.

The rest of the manuscript consists of the following five sections: scoping the concept of 'digital finance' by surveying three waves of the technology-driven (i.e., platform-driven, alternative data-driven, and AI-driven) financial innovations (Section 2); discussing the two optimization frameworks, to identify and elaborate the behavioral patterns to target in instituting welfare-enhancing FCP measures for each (Section 3); describing the real-world cases of financial frauds and financial crimes, by categorizing them as lending products (predatory or overly high-risk), investment products, and outright frauds or criminal activities) (Section 4); suggesting a matrix of the behavioral patterns, and real-world examples policy remedies for each (Section 5); and, summarizing and making concluding remarks (Section 6).

2. Scoping 'Digital Finance'

The ICT-enabled alternative financial services, often termed as 'digital finance' or FinTech (Financial Technology)[5], are broad and diverse in their scope. At the core of such services, however, there exist three underlying technological elements, as the author argues: online (internet or mobile) platform; alternative data; and, artificial intelligence (in particular, its recent version of the data-trainable algorithm called as machine learning). In Figure I, those tech-driven alternative services are labeled as the 'DPA (Data·Platform·AI) enhanced' services. With this as a backdrop, this section surveys three waves of the DPA-driven services in the financial markets by focusing on their welfare implications – the first wave of platform based business processes, the second wave of alternative data based changes, and the third wave of AI-driven financial services. While the first two have a relatively longer history, the third is still in its early stage. But its impact is expected to accelerate in coming years given the rapid advancement of the Gen-AI technologies.

Figure 1. Scoping 'Digital Finance': Key Components and Linkages



[5] Various definitions of FinTech are advanced in the literature: namely, an application of technology within the financial industry (Barberis (2014)); a new financial industry that applies technology to improve financial activities (Schueffel (2016)); an economic industry composed of companies that use technology to make financial services more efficient (Cizinska et al. (2016)); a cross-disciplinary subject that combines finance, technology management, and innovation management (Leong and Sung (2018))

Throughout this study, the intermediary is simply defined as a for-profit business entity that matches two groups of financial consumers (household, not business or institutional, users of the services) – those with liquidity surplus and those with liquidity deficit – by offering investment, lending, and insurance products along with related services (e.g., payment and settlement services). The basics of the intermediation process is depicted in Figure 1.

The 1st-wave of online platform driven financial innovations

The inception of the internet from the early 1990s was truly a milestone event that dramatically changed the way that economic system operated, the phenomenon often termed as "new economy" (as elaborated by Agrawal et al. (2017)). In essence, this new technology not only connects economic agents to form various online networks, but also lowers the price of doing certain activities, e.g., communication, data sharing and search. In the viewpoint of typical financial intermediation, the commercialization of the internet deeply influenced the front-office functions (e.g., client management and service delivery) via development of various B2B and B2C systems, as well as the middle- and back-office functions (e.g., risk management, transaction support, regulatory compliance, and other operational supports) through development of diverse online systems for internal communication and data sharing. This platform-based financial intermediation was further accelerated with the introduction of the smartphone from around 2007.

The technology also brought about the alternative forms of service provider in both sides of financial intermediation: that is, in the borrowing side (for those with liquidity deficit), P2P (Peer-to-Peer) lending of various types (e.g., Market Place Lending, and Balance Sheet Lending); and, in the investment side (for those with liquidity surplus), equity-crowdfunding for various asset classes (e.g., for real or financial asset investment projects). Unlike the traditional intermediaries, these platform-based service providers attempt to directly link a large number of borrowers and that of investors without a traditional financial institution involved. ZOPA (Zone Of Possible Agreement), one of the earliest platform lender in UK launched in 2005, is a good example, which provides online services of processing loan applications, of making underwriting (or accept-reject) decisions, and of posting desirable lending rates to be charged (reference rates plus risk spreads) to match loan applications with willing investors.[6]

[6] Some of the renowned examples of Crowdfunding and P2P lending servicers include Prosper (US, 2005), ZOPA (UK, 2005), Lending Club (US, 2006), iZhongchou (China, 2014, Alibaba), QQ Gongyi (China, 2014, Tencent). In general, P2P lending refers to an on-line lending method that makes loans to both household and business borrowers (a subset of crowdfunding); Market place lending (MPL): An on-line investment method that enables investors to purchase lending products; Direct (or balance sheet) lending vs. indirect lending (or MPL). On the other hand, Crowdfunding represents an on-line funding method that raises capital from a large

As elaborated by a number of studies, these platform-based alternative services tend to be more efficient than the traditional branch-based financial services, with a lower transaction cost along with a faster and more convenient service delivery. (IMF (2017), Buchak et al. (2017), Fuster et al. (2018), Frost et al. (2019), Jagtiani and Lemieux (2019), OECD (2019), FSB (2019)) As a case in point, Fuster et al. (2018), who utilizes a large loan-level data set, shows that the FinTech mortgage lenders in the U.S. - those online service providers who adopt a complete online processing of loan application, credit evaluation, and funding - reduce the transaction costs by 20 percent or more (compared to the traditional mortgage lending process), lower the ex post (or post-origination) delinquency rate, and respond to changes in housing demand and monetary policy in a more elastic fashion. As such, the platform-based services can pose a 'catfish effect' to the existing intermediaries, i.e., forcing them to be more efficient in their internal and external processes as well (as elaborated by Philipone (2016)). However, there are certain social costs that come along with this efficiency gain, which will be discussed later in this section.

The inception of smartphone popularized another form of alternative financial intermediation, i.e., the mobile phone based payment and settlement services (e.g., ApplePay, AliPay, SamsungPay, M-Pesa along with many other similar products adopted worldwide). The advancement of these service providers posed a competition to the traditional means of settlement (those with cash and credit cards); And, in the developing world, it also worked as a means of extending financial inclusion to unbanked or underbanked population, with M-Pesa in Kenya being a good example (Jack and Suri (2014), Beck et al. (2018)).[7] In addition, the mobile payment services are now working as an inlet for collecting and utilizing consumer data in a large quantity (by BigTechs in particular), which are used for various analytical purposes such as consumer segmentation, customer-tailored product development, and data-driven risk management practices (CitiGroup (2018)).

In the realm of these platform-based financial services, one can categorize three main types of service provider: (1) SmallTechs (i.e., start-ups or SMEs); (2) BigTechs and their affiliates (e.g., those servicers who are subsidiaries of Google, Apple, Amazon, Alibaba, Tencent, and others); and, (3) existing FIs who offer the platform-based services. The recent trend observed, however, indicates that the competition is now being converged to the one between the latter two, with the first group (SmallTechs) losing ground. For example, ZOPA, who began its operation as a SmallTech, acquired the full banking license in 2020, and converted itself to a traditional bank in UK. In Korea as well, although there are several hundred

number of unidentified investors, both for investment (e.g., consumer & SME loans) and for non-investment (e.g., rewards/donations).

[7] For more details on the financial inclusion effects of the platform-based intermediation, see Beck et al. (2018), Lu et al. (2021), Banna and Alam (2021), Zhong and Jiang (2021).

FinTech firms that are operating right now, the three 'internet-only' banks affiliated with the BigTechs (KakaoBank, K-Bank, and TossBank) are the dominant players in the sector in terms of asset and employment bases.

The 2nd-wave of alternative data driven financial innovations

The next wave of financial innovations involves with the utilization of alternative (usually non-financial) data, whose main impact is in reducing information asymmetry between business counterparties. For a long while in the finance literature, the intermediation process is characterized by the phenomenon of credit rationing, i.e., one form of market failure caused by the asymmetry between transaction counterparts in terms of the other party's (e.g., loan applicants') credit worthiness. (Stiglitz and Weiss (1981), de Meza and Webb (1987), and Waller and Lewarne (1994)) To deal with this issue, the intermediaries implement underwriting criteria, based on which an ex post (post-origination) likelihood of credit event (e.g., default or delinquency) caused by a particular loan applicant is assessed based on ex ante (before origination) data on his or her behavior (e.g., past credit history, and other 'hard variables' such as income, wealth, credit card utilization, and so on). However, thanks to the online platforms, alternative consumer data (on 'soft variables' such as digital footprints, online shopping patterns, and so on) are now being collected and utilized in the evaluation of creditworthiness, and a number of studies empirically demonstrates that the accuracy of the credit evaluation model gets enhanced when combining those soft variables with the conventional credit risk indicators.

Specifically, the extent of improvement in the predictive power of the Probability of Default (PD) model (as a key component of consumer credit scoring system, CSS) is reported by a series of the soft variables, as summarized in Appendix 1. (Iyer et al. (2016), Puri et al. (2017), Berg et al. (2020), and Kim et al. (2023)) The usual model-comparison statistic employed by these studies is AUC (Area Under Curve),[8] and the direction of the AUC improvement with those alternative data as reported by these studies is fairly uniform, i.e., all of them reporting a positive and fairly sizable improvement in AUC when combining both the conventional and non-conventional credit risk indicators.

To illustrate, Kim et al. (2023) reports a substantial enhancement of the AUC statistic in the case of 'thin filers' in Korea if three types of alternative data– online shopping data, telecommunication service data, and mobile payment data - are added to the traditional credit

[8] AUC is a convenient measure used for differentiating high-risk borrowers from low-risk ones, and works in a similar fashion as Gini coefficient (= 2*AUC–1). Its value ranges between 50% (a purely random prediction) and 100% (a perfect prediction); In general, if it exceeds 60%, the prediction accuracy is adequate under a scarce data availability, and 70% represents a target to be achieved with data enhancement.

scoring model (called as the Credit Bureau – CB - Score). That is, the study reports that AUC for thin filers (in the study sample) improves by 9%p from 67.8% to 76.8%, where that for thick filers is only 2.8%p improvement from 71.9% to 74.7% (see Appendix 1). The result implies that the use of alternative data can work as a mechanism to extent financial inclusion for thin filers to fulfill their borrowing needs. Equally important is the fact that the alternative data driven CSS exhibits a relatively low correlation with the traditional CSS. As shown in Table 1, for thin filers, the same CB Score range of 700~849 includes a diverse group of consumers in terms of the Mobile Payment (MP) Scores as observed from their average delinquency rates (ranging between 1.8% with MP Scores 1 through 3 and 19.1% with MP Scores 7 through 10).

Table 1. Alternative vs. Traditional Credit Scores in Korea

Categories			Mobile payment data based credit score							
			Delinquency rate				Percent			
			1~3 Grade	4~6 Grade	7~10 Grade	total	1~3 Grade	4~6 Grade	7~10 Grade	total
CB Score	Thin Filers	≥850	1.20%	1.70%	11.20%	6.60%	1.60%	2.40%	5.10%	9.10%
		700~849	1.80%	5.00%	19.10%	13.10%	8.70%	13.40%	39.50%	61.60%
		≤700	11.50%	15.70%	32.90%	29.50%	1.00%	3.90%	24.40%	29.20%
		total	2.50%	6.50%	23.00%	16.80%	11.30%	19.70%	69.00%	100.00%
	All Consumers	≥850	0.50%	0.80%	3.70%	1.50%	6.80%	8.10%	5.50%	20.40%
		700~849	5.50%	7.50%	16.40%	11.80%	8.90%	15.50%	29.00%	53.30%
		≤700	21.30%	24.80%	45.50%	38.50%	2.30%	5.20%	18.70%	26.30%
		total	5.30%	8.20%	23.50%	15.20%	18.00%	28.80%	53.20%	100.00%

Source: Kim et al. (2023)

Another data-driven innovation to be examined in this study is the market for cryptocurrencies (or crypto-assets for investment to be more exact). Taking Bitcoin as an example, its price movement demonstrates three dramatic boom-busts during the last ten years or so, probably the most volatile asset price dynamics ever recorded historically.[9] The growth of this asset is in a sense surprising given the fact that how the coin is generated and distributed among the network participants (called as 'nodes') essentially relies on a puzzle-solving, as sketched by Nakamoto (2008).[10] Nonetheless, the markets for Bitcoin and other crypto-assets

[9] Cho (2023) documents that, between March 2020 to April 2021, the Bitcoin price increased 696 percent in total (in real price), followed by a 41 percent drop in the subsequent three months; and, between July and November 2021 it boomed again with a steep growth of 73.9 percent, again followed by a decline of 70.7 percent as of November 2022.

[10] In particular, the process of mining, the process of validating new transactions and of rewarding the first successful one with the coin, utilizes a hash function called as 'SHA256' with 'SHA' standing for Security Hash Algorithm. And the miners are supposed to find a solution that satisfies the quiz based on the function, hopefully

are now huge and growing; In Korea only, there are roughly seven million investors, 35 percent of the total population, who are mostly in their 20·30·40s. Furthermore, many of them are levered-investors who rely on borrowing, making them more vulnerable to the downturn of the market.

Another important attribute to note about the Korean crypto-asset market is the fact that it consists of two main groups – (small) household investors and the private exchanges (most of whom are not validated by the government) – with not much involvement by institutional investors. In contrast, the US primary (issuance) market is dominated by Venture Capitals (VC), while institutional investors play an increasing role in the secondary (trading) market (Coinbase transaction volume ~ 64% institutional investors & 36% retail investors). In addition, the US security supervisor (SEC) approved the cryptocurrency-based Exchange-Traded Fund (C-ETF) in January 2024, upgrading the asset by encompassing it within the realm of regulatory oversight. Going forward, how to properly protect consumers in this sector should be a relevant policy issue to be contemplated.

Nonetheless, the underlying data technology to crypto-asset transaction (i.e., Distributed Ledger Technology, DLT, or blockchain) is deemed as a potentially important innovation in the viewpoint of financial intermediation. That is, often termed as 'DeFi' (Decentralized Finance), some pundits argue that DLT offers a different, and potentially welfare-enhancing, architecture where record keeping is completely decentralized, access to the service is anonymous and unrestricted, and the system enables trading diverse and new financial assets (e.g., stable-coins, smart-contracts, NFT – Non-Fungible Token, and so on). (Makarov and Schoar (2022)) However, given the recent incidences of fraud and abuse observed from the sector (e.g., the Terra-Luna debacle, and the FTX's inside trading of its own coin and the criminal sentences to its executives), it remains to be seen what would be net social welfare outcome from the DeFi-like alternative intermediation model.

The 3rd-wave of AI-driven financial innovations

As mentioned earlier, we are currently witnessing another wave of tech-driven innovations caused by the GenAI systems such as ChatGPT. In fact, this third wave is an outcome of a series of continued break-throughs in the AI algorithms that are capable of self-improvement through a BigData-based training,[11] which led to a dramatic enhancement in

faster than others.

[11] DeMauro et al. (2018) defines BigData as the information asset with five main characteristics - Volume (a large magnitude with multiple terabytes and petabytes), Velocity (the speed at which data are generated, analyzed, and acted upon in virtually same timing), Variety (various types of structured, semi-structured, and unstructured data), Analytics (available methods to process and analyze the data with the three Vs), and Value

several human-like capabilities (as summarized in Table 3): namely, (1) face or object recognition (enabled by the neural net algorithms trained with ImageNet and other internet-crawled large data sets); (2) gaming (enabled by similar AI systems, AlphaGo and AlphaZero, trained with the past game records along with its own simulations)[12]; and, (3) language recognition (by the GenAI systems such as ChatGPT and BERT, trained by the vast amounts of the documents downloaded from the internet).

Table 2. The Recent BD·ML-Driven Innovations

Enabling function	Elements of BDML	Applications
Face•Object Recognition	• From around 2012, R&D and investment↑ (BigTech); GPU use↑ • BD: Use of alternative data↑; Development of "ImageNet" • ML: Human neural net (86b nurons & their network); Deep Learning↑	• Driverless car • X-ray reading, cancer detection, R&D in medical•health sector • SmartX (SmartFarm, SmartFactory …..)
Gaming	• AI based online gaming (e.g., go, chess, curling) • BD: Past play records • ML: Deep Learning + Simulation, (DeepMind Technology)	• AlphaGo (2016), AlphaZero (2017) (for chess, go, shogi; capability of "self-play") • CurlingBot (2018)
Language Recognition (LLM)	• Emergence of LLM (post-2018) • BD: Texts of different languages (GPT3 ~ 500b words from www) • ML: Transformer Architecture (2018), Generative Pre-trained Transformer (GPT) (2020.6)	• BERT (Bidirectional Encoder Representations from Transformers) (Google) • ChatGPT (GPT-3 & GPT-4 by OpenAI); GPT-3 ~ 175b "parameters"
Academic Research, and R&D (Exploratory Science)	• ML based data analyses (for R&D) • BD: R&D targeting BigData (e.g., "All of US" in the US) • ML: Decision tree based data analytics	• Both social & natural science (e.g., "nowcasting") • Analytics: Regression tree, random forest, LASSO, ensemble, bagging ….

Source: the author

(extracted information or insight that can create economic and social value).

[12] As to gaming, in Korea and China, it was 2016 when AlphaGo, the neural net based AI system developed DeepMind (a Google's affiliate), beat the global top go players to invoke a highly strong interest on what an AI system can do, which led to related R&D and policy initiatives.For example, an article by New York Time later described that as 'the China's Sputnik moment' in that the country embarked an ambitious plan to be a dominant country in AI research and application by 2030. (Agrawal et al. (2017))

In the financial markets, the AI-enabled business systems have already been in place, with Robo-Advisor (RA) and RegTech (Regulatory Technology) being good examples. RA is an on-line financial advisory service for asset management with no or minimum human involvement[13], and it offers a more efficient process of the investment consultancy. That is, its development usually requires a high initial fixed cost, but, once being developed and being operational, marginal cost in serving one additional customer is virtually zero. As such, it is transforming the investment consultation service from the one that serves a small number of high endowed individuals to the one that offers the service to a large number of consumers with small or moderate wealth, i.e., 'democratizing' the service. The outcomes of this transformation, as documented in the literature, include a reduced advisory fee, a lower (or no) minimum account balance, among others (compared to human-based advisory service). (Lee (2021)) Nonetheless, there are several regulatory requirements that an RA system is supposed to fulfill: that is, its operator should fulfill the fiduciary duty, i.e., the legal and ethical obligation for financial intermediaries to act in the best interests of their clients and to put the interests of clients above their own; the recommendations should be suitable and appropriate to the users (consumers); and, the underlying algorithm should reflect the generally-accepted financial theories (such as the Modern Portfolio Theory, MPT, and Capital Asset Pricing Model, CAPM).

RegTech, on the other hand, is a BD·ML-driven service whose main task involves with providing an efficient (usually automated) internal process for regulatory compliance, detection of illegal or fraudulent transactions (e.g., Anti-Money Laundering, AML, and Anti-Terrorist Funding, ATF), and other business processes, by utilizing various structured and unstructured data along with a ML algorithm. The market for RegTech surged between 2014 to 2018, when large amounts of fine were levied to several global banks for their illegal transactions in the sanctioned countries (e.g., $8.9b to BNP Paribas, and $1.9b to HSBC).[14] In a more recent years, however, the RegTech service is being evolved into the one that offers a more comprehensive and enterprise-wide risk management tool for financial intermediaries.

Given these existing applications of AI in the financial service sector, the recent advancement of GenAI is expected to accelerate the BD·ML innovations in two main directions. First, its capabilities of collecting vast amount of information and knowledge, of converting them to an easy-to-understand summary, and of interacting with user through a prompt-response mechanism to more tailored answer (all in a pretty much real time fashion) will enable a dramatic efficiency gain in some of the intermediaries' functions. For example, the typical

[13] Typical steps performed by RA: (1) Assessing risk appetite of client; (2) Categorizing investable assets (or an opportunity set); (3) Determining matching portfolio(s); (4) Executing the ordering; (5) Rebalancing the portfolio (see Appendix 2). The system should comply with several principles, e.g., suitability principle, fiduciary duty, and avoidance of incomplete sale.

[14] Early examples of RegTech include Ayasdi (2008, US), RedOwl Analytics (2011, US), Elliptic (2013, UK), Compliance Advantage (2014, UK), Saude (2014, UK).

front-office functions such as sales and marketing, and customer support, as well as the middle- or back-office functions like credit evaluation, product development, risk management, fraud detection, and regulatory compliance are all potential targets of such efficiency gain through instituting a ChatGPT-like GenAI service. (OECD (2021)). As someone has put it, it will like having an Aristotle-level tutor to everyone who is willing to utilize such service.

Second, applying an BD·ML-based data analytics (such as regression tree, random forest, and ensemble) can produce an enhanced predictive power compared to the traditional statistical models (e.g., the regression models of various type). (Breiman (2001), Varian (2014), and Mullainathan and Spiess (2017)) The former, essentially an inductive analysis to find underlying data patterns (rather than a deductive analysis to test a hypothesis), relies on iterative estimations and sample separations to find the best functional form of the right-hand side variables (explanatory, or x, variables) in explaining the left-hand-side variable (explained, or y, variable). (That is, finding the smallest prediction error, MSE, in the function, $\text{Loss} = \text{Bias}(\hat{\beta}) + \text{MSE}(\hat{\varepsilon}'\hat{\varepsilon})$, without much consideration of the first term, Bias.) With this regard, Varian (2014) provides an interesting (relevant) example, in which he shows how an ML algorithm based data analysis (the conditional inference tree) is utilized to explain the survival probability among the Titanic passengers (facing the sinking of the ship), and how some of the complex interactions among x variables are found (women in the first or second classes of passenger room, and boys under nine years old with a sibling being the most likely cohorts who survived). (See Appendix 2 for the result of this analysis from Varian (2014).) The implication is that, when one faces a simple y variable to explain (e.g., whether or not a borrower was delinquent in his loan obligation) but a myriad of possible explanatory variables along with interactions among them (all possible factors that can help explain why someone was delinquent), and when testing a particular hypothesis is not a main analytical objective, then a BD·ML-based data analysis is likely to produce a better predictive power.

Two related points are worth noting. First, even though a BD·ML-driven data analysis yields a more accurate outcome, communicating that externally to consumers (as well as internally to co-workers) is another issue that requires a further thought. Second, in order to link such an enhanced predictive power driven by a BD·ML system to organizational performance, the intermediary has to simultaneously develop three dimensions of capability (often termed as BDAC, or BigData Analytics Capability): that is, human dimension (i.e., personnel w/ analytical skills); physical dimension (i.e., IT infrastructure to collect and share BigData); and, governance dimension (i.e., decision-making process to reflect the outcome of data analysis to actual business processes). (Akter et al. (2016), Wamba et al. (2017), among others).

Rising social costs (involved with all three waves of innovations)

Those three waves of innovations discussed also inflict social costs of different kind. For one thing, illegal financial transactions (e.g., terrorist funding, money laundering, "darknet" based criminal activities) as well as financial frauds (e.g., identity theft, voice or messenger phishing, and pharming) are already large in size (as shown in Table 3) and increasing. For example, the voice phishing cases reported in Korea are over 30,000 per year since 2020, with the high shares of them being not only among old-age consumers (over 60s), but among younger cohorts (in their 30s) as well as among female consumers in their 50s. Another worrisome side effect of the digital finance is the fact that online gambling is on the rise, particularly among youths. (Park (2024)) In Section 4, a number of real world cases of illegal or fraudulent financial transactions will be discussed, to help come up with a more comprehensive regime of consumer protection measures.

Table 3. The Amounts of Global Financial Crimes and Frauds

	Illegal Financing		Financial Fraud	
	Amount	Percent	Amount	Percent
North & South America	$1,100	34.9%	$151	31.1%
Asia & Pacific	$1,100	34.9%	$221	45.6%
Europe, ME, & Africa	$951	30.2%	$113	23.3%
Total	$3,151	100.0%	$485	100.0%

Source: Nasdaq Verafin 2024 Global Financial Crime Report

As to the personal consumption-saving decision, while consumers are enjoying a faster, lower-cost, and more convenient financial intermediation, some of them end up with incurring more debt and spending right now at the cost of saving for future (or for retirement) due to the easy lending and money transfer systems. (Panos and Wilson (2020), Ahn and Nam (2022), Yue et al. (2022)) Some of the new and creative settlement methods (e.g., BNPL, Buy Now Pay Later) contribute to such trend of the over-leverage and over-consumption. In the investment side, the easy online or mobile execution methods generate a herd behavior among financial consumers, pushing them to have a high-frequency trading and an excessive risk-taking by putting their wealth on the alternative assets such as cryptocurrencies with an extreme price volatility. (Barber et al. (2022)) And some of those markets are vulnerable to fraudulent intermediation practices. Taking the crypto-asset market in Korea as an example, there was a significant number of delisted coins (e.g., 74 new coin listings but 78 delisted coins in January to June 2022), and also a number of bribery and embezzlement cases reported.

Finally, while hacking and cyber thefts of personal data represent another area of concern in the viewpoint of consumer protection, an unwanted (and usually non-agreed) way of using consumer data by government or private entities (e.g., BigTechs) is the issue raised by

several scholars. For example, phrasing as the phenomenon as "surveillance capitalism," Zuboff (2015) and (2020) warn a social cost of the rising market power of BigTechs as they collect and utilize the consumer data of a large quantity to increase their business revenue, not necessarily with consumers' agreement. If this current trend continues, as she argues, BigTechs will enjoy very large and highly asymmetric market powers such that the principle of 'invisible hand,' a core assumption for capitalism, would no longer work, and their profit would greatly increase at the cost of consumers' surplus. What consumer issues we as a global research community have to worry about is also in-scope of our policy debate.

3. Optimization Frameworks

This section aims to elaborate how two transaction parties in financial markets – consumers and intermediaries – make their decisions within their respective (and simplified) optimization frameworks, and, further, what policy implications one can draw from those optimization processes in the context of FCP. These frameworks will serve as a basis, as the author hopes, for sharpening our policy discussion on what behavioral patterns to be tamed (in both sides), what constraints and uncertainty factors to be considered, and what effective and realistic policy measures to be implemented for the purpose of coming up with a welfare-enhancing FCP policy regime.

3.1. Consumers' Optimization Problem

A representative financial consumer maximizes a two-period intertemporal utility function subject to a budget constraint, in order to smooth marginal utilities of consumption in both periods divided between working age and retirement age. Equations (1) and (2) show the setup, which follows the model put forth by Lusardi et al. (2017). Two choice variables are the second period consumption, a, which represents the saving in the first period, s, multiplied by an expected return factor on saving, R (hence, a = R·s). R being one of the choice variables implies that the consumer makes a deliberate decision on financial products with varying risk-return profiles, both for borrowing and for investing.

$$(1).\ \max_{a,R} u(c) + \beta u(a)$$

$$(2).\ \text{s.t.}\ \ \mathrm{y} - \mathrm{c} - \mathrm{a}/\mathrm{R} = 0$$

where c and β represent the consumption in the first period and a discount factor (between the two periods), respectively. And it is assumed that the consumer earns labor income, y, only in the first period.

As demonstrated by Lusardi et al. (2017), the optimal consumption for the second period as a ratio to income (a^*/y) increases with y, but decreases with β and R. And, further, by solving a dynamic constrained utility maximization problem through a Bellman equation, the authors show that, the more financially-literate (as indexed by three education levels – less than high school, high school, and college), the better (or more welfare-enhancing) allocation of financial resource over the two periods is achieved; And wealth inequality increases across the consumer groups, with 30~40% of the inequality being accounted for by the financial knowledge.

Given this setup, three key decisions to be made in the demand-side are listed as:

- Consumption-saving decision (between working age vs. retirement): How much to consume now (c) vs. future (a, hence R·s)? As a related issue, what impact would a pension system in a given country have on that decision?

- Product choice decision, for investment: Where to put the saving to maximize a risk-adjusted return on s (if s > 0, i.e., the liquidity-surplus consumers), among a possible set of alternative assets (e.g., stock, bond, real estate, derivatives, and crypto-assets)?

- Product choice decision, for borrowing: Through what product(s) to borrow to finance the current consumption, c (if s < 0, by liquidity-deficit consumers[15]), among a possible set of loan products (differentiated by lending rates and other loan characteristics)?

One important argument advanced in the literature is that financial literacy (FL) matters in making all the above decisions. Being defined as consumer's knowledge of and ability to use fundamental financial concepts in their economic decision-making, those with a high level of FL tend to own the loan products with more favorable conditions (Disney and Gathergood, 2011; Gathergood and Weber, 2017; Lusadi and Tufano, 2015; Agarwal and Yao, 2017), to have better outcomes from investment portfolios (Calvet et al., 2009; Agnew and Szykman, 2005; Bianchi, 2018), and to be better prepared for retirement (Lusardi and Mitchell, 2008). In consequence, as the argument goes, they can enhance their financial wellbeing, i.e., the state of an individual's financial situation in which they feel secure, satisfied, and confident about their present and future financial circumstances. (CFPB, 2022) In Korea as well, a number of studies document similar results in that the level of FL shows a positive and statistically-significant impact on saving, investment, consumption, and preparation for retirement (Choi and Cho (2011), Na and Choi (2013), Lee and Jung (2013), and Yang (2018)). Furthermore, with a better understanding on financial markets and institutions, those with a high level of FL are also likely to be able to discern financial frauds better. (Anderson (2016). Andreou and Philip (2018), Engels et al. (2020), and Li et al. (2021))

In a real world setting, financial consumers face a series of uncertainties that make it difficult to make the above decisions in an optimal (welfare-maximizing) fashion. Four such uncertainty factors are sketched below – two from the setup in the above (the income, y, and the expected return, R) and two additional conditions (the borrowing constraint, and the life expectancy). In particular, a consumer group (indexed by i) at time t has to deal with the following as the additional conditions in their maximization process:

$$(3).\ y_{i,t} = \mu(\Phi_{i,t}) + \varepsilon_{y,i,t}$$

[15] In a theoretical sense, the liquidity deficit consumer (i.e., those with s < 0) is not exactly in scope of the model laid out. For simplicity, I will assume that that group of consumers will make a decision between choosing suboptimal current consumption vs. achieving that through borrowing.

$$(4).\ R_{i,t} = r_t^f + \mathrm{RP}(\theta_{i,t}, \Phi_{i,t}) + \varepsilon_{R,i,t}$$

$$(5).\ L_{i,t} \leq L_{i,t}^{max}(U_{i,t})\ (iff\ s < 0)$$

$$(6).\ m_{i,t}^e = E_{i,t}[\tilde{T}]\ (\tilde{T} \leq \bar{T})$$

As to the income (equation (3)), one has to deal with its uncertainty during the working age, whose intertemporal process can be divided into two components – (1) a serially-correlated part, $\mu(\Phi_{i,t})$, which is influenced by a broadly-defined human capital ($\Phi_{i,t}$ that reflects such factors as education level, career experience, and degree of financial literacy), and a stochastic part, $\varepsilon_{y,i,t}$. The expected return on saving (equation (4)), R, on the other hand, consists of three elements – (1) a risk-free rate, r_{t+1}^f; (2) a risk premium to compensate extent of investment risk borne by certain asset class(es), $\mathrm{RP}(\theta_{i,t}, \Phi_{i,t})$, which also reflects the human capital (assuming it is correlated with the level of savviness in choosing alternative assets) as well as extent of risk-aversion involved with a particular consumer group; and, (3) a stochastic term, $\varepsilon_{R,i,t}$. Measurement of RP should incorporate its usual determinants, i.e., mean-variance of return to holding a particular asset, correlation across different asset classes, along with other market- and product-driven risks (e.g., economy-wide systematic risks as well as product- or intermediary-driven idiosyncratic risks).

The borrowing constraint (equation (5)) limits type and amount of leverage for those with liquidity deficit to finance their current consumption, c, for both durable and non-durable goods and services. In a simplistic fashion, it is specified as the maximum loan amount that consumer i at time t can obtain, $L_{i,t}^{max}(U_{i,t})$, which is determined by a set of underwriting criteria (in particular, caps on LTV, DTI, and consumer credit score). Those lending conditions also vary over time, as shown by the cyclical lending patterns by certain intermediaries. Finally, the life expectancy is another uncertainty factor for individual consumer to deal with, which is simply shown as the maximum age expected at time t, $E_t[\tilde{T}]$.[16]

Heterogeneity among financial consumers is another important factor to be considered in analyzing demand-side decisions. As demonstrated in the FL literature, they can be differentiated with respect to the level of financial knowledge and ability (e.g., the education levels as employed by Lusardi and Mitchell (2023)). In addition, consumers are different in terms of how much risk averse they are (which affects the choice of R, as discussed in the above), what lifecycle stages they are in, and how much endowment they have (i.e., y and s in

[16] This follows Lusardi et al. (2017), which assumes that consumer starts working at 25 (i.e., t=0 at 25) and lives until 100 (t=T at 100), which should be less than the assumed maximum ($\tilde{T} \leq \bar{T}$) (or 100 years). And the mortality risk is applied in both periods (as shown by the probability of survival at each age from 25 to 100).

equation (2)). All these factors should be considered in assessing consumer behavior and decision as to how optimal they are.

Finally, there is a burgeoning volume of studies in the realm of the behavioral finance that indicate that financial consumers are far from being rational and deliberate in making their consumption and product-choice decisions. Instead, they tend to think automatically (i.e., considering what automatically comes to their mind rather than deliberately assessing a broad set of relevant factors), to be present-time biased (i.e., overweighting the present time, or shifting good experiences, e.g., consumption, toward the present and bad experiences, e.g., saving, toward the future), and to be influenced by the way that financial products and tools are presented to them (i.e., framing effects). (Kahneman (2003), Evans (2008), and the World Development Report (2015)) The key implication to take out of this line of research is that it is necessary to institute an effective nudge to offer a paternalistic guide to financial consumers to help them make a more sound and informed decisions.

3.2. Intermediaries' Optimization Problem

A representative financial intermediary maximizes net operating income (NOI) per period (equation (7)), subject to a quality-adjusted production function (equation (8)). Two choice variables in the process are the level production factors (labor and capital) used, κ_t, and a production-related technology, δ_t. NOI, in turn, consists of two components – the total quantity of service provided, Q_t, and the excess return from each dollar of intermediation service provided, EY_t (as specified in equation (9)):

$$(7).\ \max_{\kappa_t, \delta_t}\ Q_t \cdot EY_t$$

$$(8).\ \text{s.t.}\ \ Q_t = \mathrm{A}(\delta_t) \cdot \kappa_t^{\gamma}$$

$$(9).\ EY_t = r_t^c - r_t^f - RP_t(\delta_t) - G\&A_t(\delta_t)$$

The production function (equation (8)) contains two elements - the quality component that is influenced by the technology chosen, $\mathrm{A}(\delta_t)$, and the amount of production factors used, κ_t. δ_t can be interpreted as the DPA (Data·Platform·AI) technologies adopted at time t that govern internal and external business processes (e.g., B2B and B2C systems for client services through, data-driven automated internal processes for fraud detection and regulatory compliance, and BD·ML-driven risk measurement and management practices). The excess yield (EY in equation (9)) is shown as the difference between the (average) interest rate charged, r_t^c, minus three cost items – risk-free rate (as a cost of capital), r_t^f, risk spread to compensate the amount of risk taken in the intermediation process, RP_t, and general and administrative costs, $G\&A_t$.[17]

As competition in the market place intensifies, EY for individual intermediary declines (theoretically, it goes to zero in a perfectly competitive market). However, financial markets are generally viewed as inefficient (informationally at least), and, as such, the level of EY is non-zero and is dependent upon how well an intermediary identifies and targets source of inefficiency in offering its service. In that context, the intermediary can employ two alternative strategies to maximize its objective function (i.e., $NOI_t = Q_t \cdot EY_t$).

The first strategy is to maximize the business volume, i.e., Q_t. Under this, the intermediary can apply a DPA technology to efficiently categorize consumers in terms of their preferences, based on which it can develop and offer better-targeted (or more incentive compatible) financial products to retain or expand customers. In the context of the BD·ML technology, how well it can do depends on accumulated data and institutional knowledge, as

[17] See Cho (2008) for a similar specification of EY in the context of the residential mortgage finance business.

some of the theoretical papers on the topic of data economy argue.[18] To illustrate, Farboodi and Veldkemp (2021) models a firm's data-driven technology choice as a recursive process over time in which it attempts to converge to the optimal technology,[19] and shows that the larger the accumulated and usable data, the smaller the dispersion (or the more accurate) in the process of that search.

The second strategy is to minimize the cost, G&A in equation (9), by utilizing the BD·ML technologies to institute more efficient, usually more automated, internal and external processes. Here again, accumulated data and institutional knowledge should play an important role. For example, the intermediary can offer a mobile platform based service to its customers, a robo-advisor based investment consultation, an alternative data based credit evaluation, an automated internal process for regulatory compliance as well as for fraud detection, and so on. One particular issue to note in this context is a possibility of intentionally inflated some G&A items by the intermediary, as a way to increase its operational revenue (i.e., a market failure caused by moral hazard on the part of the intermediary). One such example (which will be discussed in the later section) is a hidden cost as a part of intermediation fee that depends on frequency of trading in managing an investment portfolio).

Under both strategies, how underlying financial risks are measured and managed (as reflected by RP) represents a key determinant (as it influences EY and NOI) to the success of the strategy taken. It is often casually stated that financial risk should be managed 'efficiently,' but the efficiency in this context generally means a fulfillment of two principles: namely, RP charged should be enough to cover cost of risk-taking (the principle of cost recovery); and, it should also ensure a sustainability of the intermediation service over both normal and stress economic scenarios in a forward-looking sense (the principle of sustainability).

At a given point in time, actual measurement of RP involves with a forward-looking projection (for time t+k) on expected amount of financial loss evaluated at current time (time t), as such, its will also entail a stochastic components:

$$(10). \quad RP_{j,t} = E_t\left[Loss_{j,t+m}\right] + \varepsilon_{RP,j,t}$$

[18] Here again, GenAI can allow for customer segmentation at the individual level, allowing brokerage firms and other investment advisors enhance their robo-advice with differentiated recommendations produced in a fast, efficient and customised manner, and delivered in a human-like conversational manner tailored to each client. (OECD, 2021)

[19] In particular, the optimal technology is specified as $\alpha_{j,t} + \varepsilon_{\alpha,j,t}$, which entails two elements – the persistent component, $\alpha_{j,t}$, and the transient component, $\varepsilon_{\alpha,j,t}$ that are not separately observable; And the technology choice is shown as $\delta_{j,t} = \alpha_{j,t} + \varepsilon_{\alpha,j,t} + \nu_{\delta,j,t}$. Hence, the process of finding an optimal technology boils down to sequentially minimizing the two stochastic terms ($\varepsilon_{\alpha,j,t}$ and $\nu_{\delta,j,t}$) by utilizing available data and analytics.

In reality, three classes of financial risk represent a key concern of the intermediary – the credit (or business counterparty) risk, and the interest rate risk (both upside and downside), and the liquidity risk. As the first one is more relevant to financial consumers, this study focuses on that. Its actual measurement usually involves with a two-step process: first, the borrower and product driven (i.e., idiosyncratic) risks factors are assessed based mostly on past data, which is often summarized as a credit score; and, second, those differentiated risk levels of the counterparties are projected to future scenarios of key economic variables (e.g., through a Monte Carlo simulation) to form a distribution of the estimates of credit events to occur. In terms of theoretical backdrop to this process, Merton (1974) offers an option-theoretic default model, termed as 'the distance-to-default framework' (i.e., if and when collateral or asset value goes below outstanding loan amount, borrower is incentivized to exercise a put option by giving up and transferring the asset to the lender).[20] In a real world financial intermediation, the heuristic measures from a credit scoring system, focusing mostly on the first step, are utilized, and, as discussed in Section 2, a BD·ML-driven technology can help enhance the model fit as well as the efficiency in measuring and managing underlying credit risk (e.g., a more accurate PD model, a "nowcasting" based projection of economic variables, and so on).

Given the above discussion, the key supply-side decisions are listed as follows:

- Product design and sale decision: What repayment schedules (in case of lending products), and what risk-return profiles (in case of investment products) to institute, to intermediate them to financial consumers? What levels of complexity, transparency, and explanability to be considered at the time of selling the products to consumers? What type of robo-advisor service to provide, and how to update and validate the system if it is offered?

- Risk measurement and management decision: What BD·ML technologies to adopt in efficiently measuring and managing borrowers' credit risk (i.e., RP)? What mechanisms to put in place to that end, i.e., risk-avoidance (via underwriting), risk-pricing (via charging RP), and risk-transfer (via risk-sharing)? How to incrementally expand financial inclusion for marginal consumer groups (e.g., thin filers) through a more efficient risk management practice?

- Process automation decision: What DPA technologies to utilize for automating internal and external business processes, for data collection and sharing, regulatory compliance, fraud detection, and so on?

Two more dimensions of complexity should be considered in the supply-side. First, financial intermediation is in general heavily regulated, and the intermediary should comply

[20] The reduced-form model as another theoretical construct for measuring the credit risk. (Saunders and Allen (2009)

with two regimes of financial regulation – the prudential regulations (to ensure safety and soundness of its operation), and the business conduct regulations (to ensure fair and ethical treatment of financial consumers). The second one, the main focus of the current study, entails some specific regulatory requirements, such as prevention of incomplete sale, efficient conflict resolution mechanism, and prevention of financial fraud and financial crime. Second, the intermediaries are also heterogeneous, due to which different types can employ different business strategies or can face different regulatory regimes. In this study, three categories of intermediary will be considered (same ones discussed in Section 2): SmallTechs (startups and SMEs who are traditionally not financial service providers); BigTechs (those large, often global, IT firms who offer various financial services); and, existing FIs (traditional intermediaries such as banks and non-bank FIs).

3.3. Market Outcomes (Behavioral Patterns)

Given the dynamic and stochastic factors involved, deriving the general equilibrium conditions (and performing comparative static analyses) out of the optimization frameworks discussed would be a highly complicated, likely to yield intractable, outcomes (and, more importantly, that would be beyond the author's analytical capability). Approach taken in this section is to identify a set of anticipated market outcomes in terms of specific behavioral patterns to be tamed in both demand- and supply-side, which can be termed as 'suboptimal market outcomes' that should be a target in designing a welfare-enhancing FCP policy regime (which will be discussed in Section 5). Specially, the following eight behavioral patterns will be elaborated and used for subsequent discussion.

- Over-consumption and under-saving (demand-side)
- Over-leverage and sub-optimal choice of loan product (demand-side)
- Excessive risk-taking and suboptimal choice of investment products (demand-side)
- Profit-making over fulfilling the fiduciary duty (supply-side)
- Moral hazard in product design and sale (supply-side)
- Inefficient risk management (supply-side)
- Suboptimal technology choice (supply-side)
- Exposure to frauds and financial crimes (both sides)

(1) Over-consumption and under-saving (demand-side)

One behavioral pattern of financial consumers discussed is the present-time bias, i.e., the tendency of consume-now-save-later, which can result in over-consumption in current time period but under-saving for future by many. Given this, one question to pose is, through what nudging mechanism(s) can one help them make a more rational long-term personal planning on the consumption-saving decision? As the FL literature argues, a well-designed and well-targeted financial education program, differentiated for those in different lifecycle stages and endowment levels would be helpful. However, such program should have a clear objective and target, e.g., improving this particular behavioral pattern and effectively nudging consumers to be able to change their behavior toward establishing and executing an optimal long-term planning. Such program will have to cover relevant financial concepts to this end (e.g., time value of money, compounding, financial risk and reward, financial markets and institutions, pension system, and so on), but, more importantly, should entail a pedagogical mechanism to induce behavioral change to make their decisions more rational and welfare-enhancing. As a research issue, the effectiveness of such program, particularly for the second part of its objective (i.e., stimulating the behavioral change) should also be assessed in a sound empirical framework (e.g., a randomized controlled test).[21]

(2) Over-leverage and sub-optimal choice of loan products (demand-side)

While the digitalized financial services deliver a number of benefits to consumers, those means of easy-lending and easy-payment also inflict a social cost in the form of over-leverage (hence, over-consumption) for some consumers. This is a complex issue because the debt is used not only for more consumption but also for more investment and, hence, can lead to a welfare loss for those levered investors if and when asset prices (e.g., for stock, real estate, and cryptocurrencies) experience a downturn. To make things more complex, expanding financial inclusion for marginal borrowers through the new and alternative intermediaries is often viewed as positive and welfare-enhancing for consumers. Given all these, what would be a right device to help consumers avoid the negative outcome of the digital finance, and will financial education offer such device to help consumers make a more rational decision on how much (and what type of) leverage to utilize? Here again, a well-designed and well-targeted financial education program could be useful. But a more effective mean would be an in-time, independent (to the intermediaries), and interactive counseling and advice service for

[21] The Financial Literacy Map (FLM) in Korea: Objective ~ To help develop contents of FE by assessing current states and designing policy directions; Based on the similar FL capability measurement frameworks (OECD INFE, US, UK, JP, among others); Six financial topics of interest: (1) Household financial management; (2) Asset management; (3) Credit management; (4) Risk management; (5) Use of financial services; (6) Lifetime financial planning; Five life stages: (1) Primary school; (2) Middle & high school; (3) College; (4) Adult; (5) Retired; Separate FLMs for special groups (e.g., disadvantaged, multi-culture households, refugees (from NK), credit-impaired)

consumers at the time of decision-making. One possibility to be considered to that end is to utilize a ChatGPT-like system as a consumers' AI agent for that purpose. Personally, I have not heard a real world case in this regard, and, if one considers actually developing such system, there would be a number of issues to think through (e.g., who should be a sponsor, what data and AI algorithm can be developed and utilized, how consumers can access to the system, and so on).

(3) Excessive risk-taking and suboptimal choice of investment products (demand-side)

A strong asset price boom usually works as a stimulus in forming a herd behavior among investors (those with liquidity surplus), by raising their forward-looking expectation on the return to holding a particular asset (i.e., R). There are ample examples over time for such consumer behavior, including the housing price booms in the U.S. and some other countries before the global financial crisis, and the explosive price upturns of Bitcoin and other cryptocurrencies globally in the recent years. In addition, during an asset market boom, frequency of fraudulent financial intermediation (e.g., a Ponzi investment scheme) tends to increase as well to attract the investors. Question is, how to nudge those consumers with liquidity surplus to move away from an excessive risk-taking and to make a more rational decision on how much, and on what products, to invest (as an alternative to safer assets such as bank deposit or stocks of large established firms)? One thing that should be clearly communicated to financial consumers is that, first, fundamentally they are responsible for outcome of their investment decisions, and, second, (as some pundits put it) they have to realize that it is very hard to make money. Here again, the financial education programs with a clear targeting and objective (of taming this particular behavior of investors to make a more rational investment decision) would be useful. Nonetheless, there appear to some loose ends as to how effectively to do so, I argue, and it should be the task for the global research community like IAFICO to come with constructive solutions to them. As a part of such effort, what technology solutions one would utilize to that end (e.g., a robo-advisor based counseling system, a consumer-centric on-device AI-agent, and so on) should also be a relevant issue to be investigated.

(4) Profit-making over fulfilling the fiduciary duty (supply-side)

Financial intermediation is designed to pursue two inherently competing goals – profit-making for them (as described in the above) and fulfilling the fiduciary duty for their clients. Enforcement of the fiduciary duty in general relies on various means, including regulatory oversight, licensing and registration, disclosure requirements, client complaints and arbitration, and even civil lawsuits. A question to pose is, are these mechanisms sufficient in making the intermediaries to actually put the consumers' interest on the top, and, if not, what additional remedial measures to be designed? After the recent financial crisis, the importance of business ethics is emphasized, and the training programs in that regard for financial professionals of different levels (employees for customer services, managers, and executives)

are implemented in the U.S., UK, and other countries (e.g., the UK CBI's - Chartered Bank Institute - two-level ethics courses of the basic concepts of business ethics and their business applications). That would be a necessary, but probably not a sufficient, remedial action to follow, and the research community along with the financial service industry and policy circle will have to cooperate to come up with more realistic and effective ways to induce the intermediaries to follow the principle. One argument advanced, as author came across from the media, is that finance professionals should have a mandatory oath similar to the Hippocratic Oath sworn by medical doctors under the premise that money is as important as health for many, a point to digest in designing a whole schema of FCP policies.[22] As shown in the footnote below, some items of the Hippocratic Oath appear to be fairly directly applicable to the financial service sector.

(5) Moral hazard in product design and sale (supply-side)

More often than not, financial products (for both lending and investment) are designed to maximize the return to the intermediaries at the cost of consumers' welfare. The predatory lending practices in the subprime mortgage market and the listing of fraudulent coins in the crypto-asset market represent good examples of such behavior. Some products also entail a hidden cost as a part of the contract (e.g., some of the variable annuity life insurance products caught and fined by the regulators, which encompass inadequate and excessive brokerage fees). Question is what to do about it, both before and after such product is sold. Preventing 'incomplete sale' is essentially a policy direction to protect consumers from such products, for which information provision (on the product sold), offering a cooling-off period, establishing a conflict resolution mechanism, and regulatory oversight (in terms of consumer complaints, ombudsman, and internal processes of relevancy) are all geared to prevent trading of such products. However, given all the biases and suboptimal decisions (in both demand- and supply-side) discussed in that above, those measures may not be sufficient in protecting from such products: that is, the consumers are present-time biased, prone to the herd behavior, and heterogeneous with respect to financial savvy and risk-aversion; the intermediaries are essentially maximizing their profits; and, there are different degrees and types of regulatory oversight in different financial service sectors (e.g., the listed security markets vs. the un- or loosely-regulated crypto-asset markets). It is also the research community's role to assess how

[22] The typical elements of the Hippocratic Oath are as follow, with those seemingly applicable to the financial service sector being bold-faced: **(1) Commitment to the patient's (consumer's) well-being and confidentiality**; (2) A promise to do no harm (primum non nocere); **(3) A pledge to practice medicine (financial) ethically and with integrity**; (4) Respect for patients' autonomy and dignity; **(5) A commitment to lifelong learning and the advancement of medical (financial) knowledge**; (6) A vow to not engage in euthanasia or abortion, though modern interpretations may vary; **(7) A pledge to work collaboratively with colleagues for the betterment of patients (consumers); (8) A commitment to uphold the highest standards of professionalism and accountability.**

effective those usual FCP measures are in protecting consumers from those products designed and sold that increase the profit at the cost of consumers' financial losses, and what alternatives to be considered to target this particular supply-side behavioral pattern.

(6) Inefficient risk management (supply-side)

The profit maximization framework in the above represents a short-term view, in that it does not reflect a long-term consequence of risk-taking to the intermediary. As witnessed frequently, financial institutions sell high-risk products to increase their business volume, hence raising their per-period (or annual) revenue, but financial losses caused by the sale of those products can result in years to come. As an alternative, one can employ a framework in which the intermediary maximizes the value of its operation, and in that way, one can reflect not only the per-period cashflow but also the long-term consequence of risk-taking and capital investment done in a given time period. In the viewpoint of financial consumers, a welfare loss can be inflicted from this short-term business strategy, caused essentially by an inefficient risk management practice, usually being realized through the pro-cyclical operation by the intermediaries (i.e., under-shooting business risk and, hence, lowering RP during an asset market boom, but over-shooting the risk, and abruptly raising RP, during a bust). This behavioral pattern is mainly a target of the prudential regulation (e.g., the Basle III risk-based capital requirements), but has an important implications to FCP as well.

Managing financial risk is inherently an incomplete science, in that it is essentially an attempt to project a risk event that would happen in future, based data collected on past behavior of business counterparties (e.g., financial consumers). Nonetheless, there are generally-accepted finance theories and the empirical models that are well-established for the two key financial risks – the credit risk and the interest rate risks, and the intermediaries are expected to reflect them in their risk measurement and management practices. In particular, by collecting data (both conventional and non-conventional) and applying appropriate models, they make their practices more evidence-based, in all three modes of risk management - underwriting, pricing, and risk-sharing (with third party). In case that a particular product has a long history of performance, it will be more plausible to make the practices more risk-based by collecting and utilizing the performance data. The main issue to be considered in the context of FCP is how to convey and communicate the product-driven financial risk – in terms of both its extent and type – to customers. In that vein, a risk-rating system for financial product can be considered, from which a summary measure of embedded risk is given and explained to consumers in a plain and understandable language (in fact, BaFin in Germany requires the intermediaries in the jurisdiction to do so). In addition, the intermediaries should also be required to employ a sound internal monitoring system of systematic (or market-wide) risk factors, which usually involves with a simulation of possible future scenarios of key economic variables and a set of early-warning indicators. To this end, one can consider instituting a BD·ML-based analytics that can utilize both conventional and non-conventional data.

(7) Suboptimal technology choice (supply-side)

The intermediaries can enhance the efficiency of their internal and external business processes by institution appropriate DPA technologies for front-, middle-, and back-office functions. However, doing so involves a capital expenditure (often quite large in amount) as well as a number of tradeoffs to consider. For example, developing an online B2C system to automate interaction with consumers would incur a significant initial cost but a large efficiency gain for both intermediaries and consumers as marginal cost of serving one more customer will be virtually zero (although a per-period maintenance cost should be factored in). Also, those internal KYC processes to automatically detect illegal transactions (e.g., money laundering, and terrorist funding) will also benefit from the investment on the DPA technologies. The question is, how to incentivize the intermediaries to make a welfare-enhancing decision on this issue for both them and for their clients? The decision would be more difficult for existing FIs given that they already have their legacy technologies and systems, posing a higher internal friction to deal with. One such vehicle would be a more competition in the market place, which is often termed as the 'catfish' effect posed by BigTechs and other alternative service providers. The former also have an edge in general in terms of collecting and utilizing consumer data. In a regulatory point of view, it should be emphasized and communicated (to all intermediaries) that having a proper investment on DPA technologies can deliver a long-term cost saving for them as well as a more efficient and convenient service delivery to their customers, and that developing multi-dimensional capabilities is important to realize such benefits in an organizational level (i.e., having BDAC in the personnel, infrastructure, and governance dimensions).

(8) Inadequate responses to financial frauds and criminal transactions (both sides)

As financial services become more DPA-based, frequencies of financial frauds (e.g., theft of private data, voice phishing, and a ponzi investment scheme) and of illegal transactions also increase, as reported by a number of studies. The next section will document some of the real-world cases observed from Korea and other countries. Protecting consumers from those illegal activities requires appropriate measures from both demand- and supply-side of financial markets. Nonetheless, properly dealing with those activities goes beyond the financial service sector, and is in fact a society-level task for which the financial service sector and the criminal investigation authority should join the force.

4. Abusive and Fraudulent Cases

4.1. Predatory or high-risk lending products

In general, lending products are less risky and less complicated than investment and insurance products, due in large part to the contractual agreement between consumers and intermediaries (or investors) on loan term, repayment schedule, and other product details. Nonetheless, there were incidences of serious welfare loss on the part of consumers in this sector, to which the online platform based alternative intermediaries contributed. As one example, over three thousands P2P lending platforms (out of about 5,000) in China became either closed or inoperable between 2014~17 as the supervision authorities tighten their oversight on the sector. The incidence inflicted a big financial loss by many who participated to the platform based lending and investment.[23]

As discussed in Section 2, the online platform-driven financial intermediation generally delivers a more efficient and convenient process for consumers in originating loan products. One such example was the Automatic Underwriting System (AUS) that was popularized in the home mortgage origination and securitization industry in the U.S. from the mid- to late-1990s (e.g., Desktop Underwriter, DU, by Fannie Mae, and a number of similar online B2B and B2C systems adopted by other market intermediaries in the sector). AUS revolutionized the mortgage origination and securitization process by dramatically reducing the processing time for loan applications (in many cases, from about a month to a few minutes).[24] However, the system was also used as a tool for mass-producing the subprime and Alt-A mortgage contracts during the early- to mid-2000s, the epicenter of the global financial crisis followed.

In terms of loan attributes, some of the subprime mortgage contracts (e.g., 2-28 or 3-27 Option ARM contracts) entailed quite arcane and high-risk repayment characteristics, which were hard-to-comprehend by financial consumers at the time of loan origination: to illustrate, a big payment shock after 2~3 years after the artificially-designed low-payment period; a negative amortization of principal (increasing the effective LTV) due to no- or partial-payment of mortgage interest in the initial 2~3 years; and, the extension or refinancing risk at the expiration of the low-payment period (which was exacerbate during the downturn when lenders constrain the underwriting criteria and refuse to refinance existing loan contracts).[25] The practice of some subprime lenders was also predatory in that they sold the loans to those who

[23] See Citi-GPS (2018) for more details.

[24] See Cho (2008) for more details as to how AUS was developed and utilized in the residential mortgage fiancé sector in the U.S.

[25] See Gorton (2008) and Cho (2009) for details on loan characteristics of the subprime mortgage contracts along with the embedded risks underlying them.

were capable to repay not financially-savvy (seniors in many cases), with a primary purpose of having them default on their mortgage obligations (sooner rather than later) so as to liquidate the properties in a booming housing market. However, it should be stressed that financial consumers were also responsible (at least partially) for such a rapid growth of the subprime and Alt-A contracts, because many of them were incentivized to take those loans to increase the expected return to holding home equity, a debt maximization behavior driven by the herding to housing investment. But it is worth noting that there are other contributing factors to the subprime mortgage debacle in the U.S., e.g., the overly-generous underwriting criteria during the boom, and the non-recourse provision for non-performing borrowers in a number of states, and so on.[26]

In a broader sense, easy lending can push certain consumers over-leverage and over-consumption, leaving them a sub-optimal level of saving for their future and retirement. On this point, the recent studies report the gap between short-term vs. long-term consequences of the P2P lending for the consumers with liquidity-deficit. That is, using a large credit bureau data set on the borrowers who use the MPL platforms, Chava and Paradkar (2018) shows that the borrowers use the funds from the platforms mainly to consolidate their credit card debts, and accordingly their card balances decline by 47% on the average right after the funding relative to the previous quarter, their credit card utilization ratios also decrease, and, in consequence, their credit standings assessed in terms of CSS also improves. However, the study documents that that the MPL-borrowers tend to incur additional credit card debt from their existing intermediaries, resulting in a higher aggregate indebtedness three quarters after the funding and a significant increase in credit card defaults subsequently. DiMaggio and Yao (2018) reports a similar result in that, while the FinTech borrowers' credit outcomes improve right after receiving the fund, they are significantly more likely to be delinquent and exhibit higher indebtedness after several months.

4.2. Predatory or high-risk investment products

In an emerging-market countries' point of view, the financial service sector generally grows in parallel with an expansion of economic system, creating a wider set of alternative assets to invest for consumers. Along with this process, however, overly high-risk or predatory investment products are sold, to which both formal intermediaries and unlicensed (often illegal) entities participate. The DPA-driven innovations in the financial markets (as surveyed in

[26] In that juncture, it is difficult to over-emphasize the importance of proper documentation and its validation as a part of credit evaluation: that is, as shown in the case of the subprime mortgage crisis, the Alt-A mortgages (those mortgage contracts with no or low documentation that are known with various acronyms, e.g., NINA for No Income (documentation) No Asset, SISA for Stated Income and Stated Asset, and NINJA for No Income No Job and Asset) worked as the major source of credit losses in the U.S. mortgage finance industry. (Cho (2009))

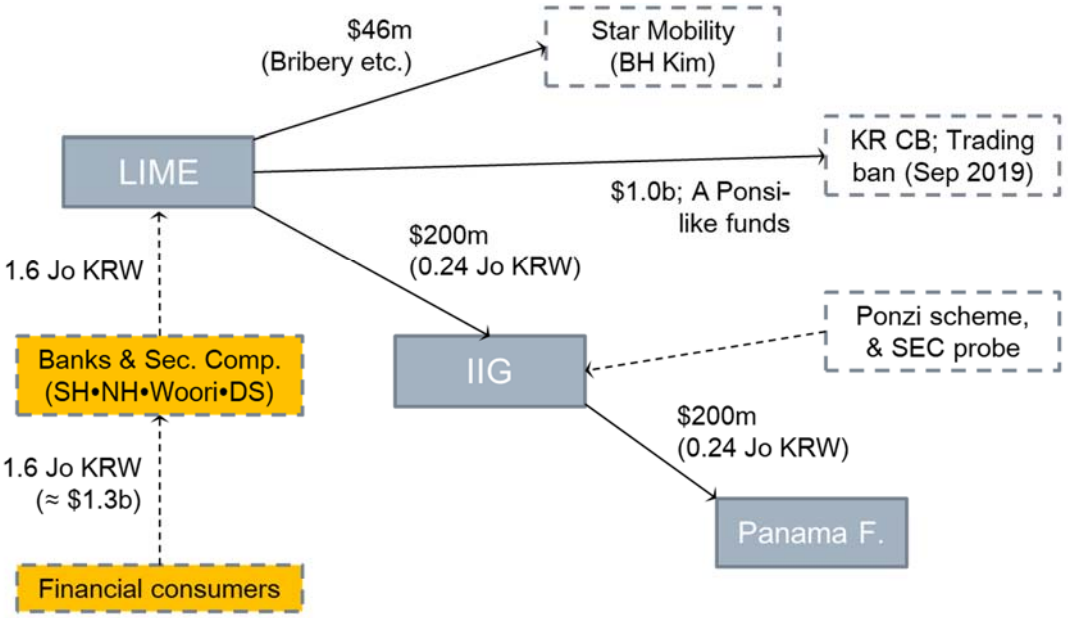
Section 2) make it easier for such intermediaries to develop and sell those high-risk and fraudulent products in the market place.

In particular, a number of the scandalous cases of the private equity funds (PEFs) was recently reported and being investigated in Korea. One famous case that drew a lot of public attention was the PEF organized by the firm named the Lime Asset Management (LAM), which mobilized a huge amount of money for a Ponzi investment scheme.[27] LAM was founded in 2015 and recorded a phenomenal growth until 2019, with its total asset under management (AUM) reaching 6 trillion KRW (about $4.6 billion USD). The way that the company mobilized the fund was through the established and well-known financial intermediaries in Korea - three major commercial banks and one security dealer, who contacted their customers and helped open thousands of investment accounts with LAM (4,035 in total). As shown in Figure 2 below, the collected fund is allocated to the three main investment channels (according to the media reports): (1) 173 PEFs created and managed by LAM (about $1 billion USD as of July 2019); (2) one offshore fund in Panama that was mediated by one U.S. firm named International Investment Group (IIG) ($200 million USD); and, one investment project called as "Star Mobility," a personally owned fund by the de factor owner of LAM, Mr. Kim ($46m USD in total). A surprising aspect of this case is the fact that the owner, Mr. Kim, had no experience in the financial service sector before LAM and used to run a local transportation business. In the late 2019, there came the news reports on the LAM's illegal money transactions, which led to the fund runs and eventually the bankruptcy of the company. Its U.S. business partner, IIG, also became a subject of investigation by the U.S. regulator (SEC), and was banned in trading later on. How to allocate the total financial losses incurred out of this case (between the intermediaries involved and the consumers who put their money) is still being debated through lawsuits and regulatory arbitration.[28]

Figure 2. Sources and Uses of the Fund Managed by LAM in Korea

[27] Taking its root from the Great Depression era, an operator of a Ponsi-scheme promises a certain level of return to a group of investors, fulfills the promise with the money collected from next group, and continues this mode of operation until it busts.

[28] A similar Ponzi scheme based investment project that was recently reported in the Korean press is the Ado International case. For this, however, no formal intermediary was involved, and the one without a license of mobilizing a fund from general public organized the scheme and raised total amount of $338 million USD from a large number of consumers. The money was put into dubious investment projects, and the funds got defaulted, and the executives of the company were prosecuted.
(https://news.kbs.co.kr/news/pc/view/view.do?ncd=7973332&ref=A)



IIG (International Investment Group); https://www.regcompliancewatch.com/iig-co-founder-charged-with-string-of-frauds/ ; "SEC investigation & plea bargain by an employee (characterized as a $60m ponzi-like scheme)

Source: the author

Another case of the investment product to note is the variable annuity life insurance (VALI) contracts. VALI is a type of annuity that provides periodic payments to consumers for a specified period or for the annuitant's lifetime (hence, suitable to seniors and retirees), with the added feature of variable returns based on the performance of selected investments.[29] Recently, some abusive cases related to the VALI products are reported, as summarized in the table below. According to the summary, several common issues that cut across those five cases described: that is, misleading information (providing false or misleading information about the benefits, costs, and features of variable annuities); unsuitable sales (recommending variable annuities that are not appropriate for the client's financial situation or investment goals); churning (excessive trading of variable annuities to generate commissions, often detrimental to the client); and, lack of supervision (inadequate oversight and supervision of brokers and agents selling variable annuities).

[29] The VALI products involves lots of contract details, in terms of the accumulation of investment, asset classes to select (e.g., stocks, bonds, money market instruments, among others), payment of the return, tax treatment, death benefit, and so on.

Table 4. The fraudulent or abusive cases of the VALI products

Intermediary	Country	Event Year	Description
Lina Tanaka and William Worth	United States	2009	Lina Tanaka, an insurance agent, and William Worth, a former insurance broker, were involved in a scheme where they sold variable annuities to elderly investors and then churned their accounts to generate high commissions. Churning refers to the excessive buying and selling of securities to generate commissions at the client's expense. They targeted senior citizens, convincing them to switch annuities frequently, which incurred high surrender charges and fees, severely depleting their investments.
MetLife	United States	2016	The Financial Industry Regulatory Authority (FINRA) fined MetLife $25 million for misleading customers about the costs and benefits of variable annuities. MetLife made misrepresentations and omissions about replacement variable annuity transactions, leading customers to believe that new annuities were more advantageous when, in reality, they often carried higher costs and less favorable features. This resulted in customers incurring significant fees and charges.
Raymond James Financial	United States	2014	FINRA fined Raymond James Financial $8.25 million for failing to adequately supervise the sales of variable annuities. The company was found to have inadequate systems and procedures in place to ensure that the variable annuity sales were suitable for their clients. This lack of oversight led to instances where customers were sold annuities that did not meet their financial needs or investment objectives.
AXA Equitable Life Insurance Company	United States	2015	AXA Equitable was fined $20 million by FINRA for making misstatements and omissions regarding the fees and potential benefits of variable annuities. They misled investors about the costs of transferring their existing investments into AXA's variable annuities and the associated benefits, which caused financial harm to many investors who trusted their recommendations.
Waddell & Reed	United States	2005	The National Association of Securities Dealers (NASD), now part of FINRA, fined Waddell & Reed $5 million and ordered restitution of $11 million for failing to supervise the sale of variable annuities. The company allowed brokers to recommend unsuitable annuity exchanges that generated high commissions but resulted in significant financial losses for clients due to surrender charges and other fees.

Data source: ChatGPT 4.o; Revised by the author

Finally, there are ample cases of abusive intermediation in the crypto-asset sector. As an overall issue, unlike its original intent of creating a decentralized and low-cost transaction process with no middle man, the actual process is filled with a diverse group of intermediaries (e.g., exchanges, digital wallets, payment companies, and miners), ending up incurring fairly high transaction costs.[30] And some of the intermediaries are reportedly involved with

[30] For more details, refer Cambridge Center for Alternative Finance (CCAF) (2017).

fraudulent business practices: that is, Chun (2018) documented that the Initial Coin Offering (ICO), initially designed as a means of funding for crypto-related start-ups (e.g., infrastructure and app developers, network operators), in many cases employed a Ponzi scheme to mobilize and using investors' fund illegally (e.g., money laundering, and tax evasion), with 81% of ICOs in the sample being assessed as fraudulent.[31]

Another globally-renowned case of fraudulent intermediation of crypto-asset was the failure of FTX in November 2022, one of the three largest cryptocurrency exchanges in the world. In particular, there were the criminal charges against its executives on the illegal uses of investors' money and the inside trading of its own coin (FTX Coin) between the company and its affiliate (the Alameda Research).[32] It is amazing to see that this young start-up run by executives who are in their 20s could build such a huge asset base through leverage (the total liability of $50 billion as reported by the media) with a so little equity (estimated to be about $500m, inferred from its 20% equity sale), which yields a leverage ratio (LR) of over 100 (in comparison, the LR of Lehman Brothers when it failed in 2008 was a little over 30). Yet, according to the media report, the company instituted a primitive level of internal control (the accounting done by QuickBook), and relied on the celebrity marketing by hiring sports and movie stars to attract investors to their exchange.

In Korea as well, the market for crypto-asset is a high-risk one, not just because of the extreme price volatility but because of the fraudulent practices by some intermediaries. As mentioned in Section 2, the delisting from the exchange is rather frequent, and some of them are a subject of criminal investigation. For example, the coin named PuriEver (PURE) was ceased in trading in April 2023, as its operator was found to provide a wrong information to consumers (on its major investors, the assessment report, and so on); The CEO of one exchange holding company (the BitSum Holdings) was investigated in May 2023, for taking a large sum of briberies (about $3.8 million USD) from the multiple issuers of 'Kimchi coins' (the ones traded in Korea only); A coin-listing broker is charged for embezzlement by giving briberies (to the executives of the exchanges such as CoinOne) as well as taking a large sum of money from the coin issuers between 2020~23; Last but not least, the major coin exchanges in Korea – BitSum, CoinOne, and GoPax – were invested in 2023 and found to having involved with

[31] Bitcoin and "darknets": Rise of "darknets" such as "Silk Road"; About 13,000 "Darknets," used for drug dealing, contracted murder, and other criminal activities; Foley et al. (2019), "Sex, Drugs, and Bitcoin": Most of transactions are financed through CCs; 20~30% of all CC uses are classified as such; "Silk Road": One of the 13,000 "Darknets" (used for drug dealing, contracted murder, and other criminal activities) (Foley et al. (2019))

[32] In October 2023, the court found guilty on seven counts, and sentenced 110 years in prison, for the FTX' CEO, Sam Bankman-Fried (31-yrs old), See "the Collapse Of FTX: Insiders Tell All," https://www.youtube.com/watch?v=XqwGt69pDXQ.

the fake transactions of huge amounts with their own money to inflate the market price of Terra-Luna, the infamous case of the fraudulent stable coin traded world-wide.

4.3. Outright frauds or criminal activities

Frequency of cyber thefts of personal data and financial crimes with the stolen data is on the rise in the recent years. Widely-reported types of crime in that regard include hacking (particularly those targeting financial intermediaries and crypto-asset exchanges), pharming (stealing data in PC by implanting a malignant code), smishing (implanting a code in e-mail or SNS message to do the same), and voice or messenger phishing (attacking consumers by fraudsters through phone calls or written messages to trick individuals into providing sensitive financial information or performing unauthorized transactions). As to the last type, the reported cases are so many that several movies on the topic are recently released in Korea and the U.S.[33] In those movies as well as in the real-world cases, the fraudsters who operate the schemes are large, well-organized (connecting their operational points in multiple countries), and highly specialized in targeting and trapping consumers. And the methods they employ are also very diverse (see Appendix for the top-ten most frequently-used voice phishing types). A scary thing is that a consumer can face a serious risk of such crime by simply losing his or her mobile phone.[34]

Some of the fraudsters appear to be quite tech-savvy, as recently reported. For example, it is shown that some of the voice phishing operators utilize a GenAI system to create more tailored scenarios for individual consumers for a more 'efficient' attack their vulnerabilities: as reported in news media, the organization called as Canadian Kingpin12 developed a specialized GenAI systems in 2023, called as "WormGPT," and sold its service to the voice phishing operators with a mere $75 monthly subscription fee. (Seo (2024)) Also, deepfake (deep learning plus 'fake'), a GenAI technique to generate a false image or video, is being used by some crime operators. For example, one employee of a large corporation in Hong Kong received a deepfake-generated video in which the company's CFO ordered him to transfer money, and the person actually followed the order and transferred $26 million USD in total. (Seo (2024))

With regard to hacking, the crypto-asset exchanges are shown to be particularly vulnerable, with many reported cases in the recent years in Korea and other countries. One

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[33] Those movies include 'Voice,' 'Citizen Deok-Hee' in Korea, and 'BeeKeeper' in the U.S.

[34] KakaoPay case (via a handphone loss) ~ https://www.sedaily.com/NewsView/260SRE0QVH; Coupang and Toss payment cases are https://biz.chosun.com/site/data/html_dir/2021/03/11/2021031102762.html?utm_source=naver&utm_medium=original&utm_campaign=biz.

famous hacking reported was the FTX case: that is, within 24 hours from its bankruptcy filing in November 2022, the total amount of $390 million worth crypto-assets was lost due to the hacking. One concern raised as to the new technology is the likelihood that hacking crypto-assets and the exchanges would become a lot more possible and easier once the quantum computing is used because breaking into the cryptographies used will become more feasible with the technology. (the World Economic Forum (2020))

Another social issue to be concerned is the rising cases of youth gambling, many of which done through an illegal platform. In fact, the online gaming and gambling represent the sectors that receive the largest benefits from the digital transformation: as one example, there is a steep increase of the online casinos in which PayPal and other mobile payment systems are used. (Park (2024)) Related to this issue, the volume of online gambling grows 12% per annum globally in the recent years with the total amount of $70 billion in 2021, which is expected to reach $250 billion in 2030; It is generally the case that youths are easily influenced by the online gambling ads through SNS and other means, and that those who are addicted are likely to involve with other criminal activities (thefts, prostitution, among others). (Packin (2023), Park (2024) Like in the case of voice phishing, the operators of illegal gambling sites are also run by those large and organized criminals. For example, as recently reported in the Korean news media, one online gambling site with the main server in China intermediate the total amount of $4.6 billion gambling money during 2014~22, out of which reaped a $50 million profit. (NewsPim (2022)) Hence, what's at stake is how to combat those organized crimes, which usually rely on international money laundering scheme through underground financial system, in order to protect consumers from the types of frauds discussed in the above.[35]

[35] Refer the video clip below for the international drug-trafficking ('fentanyl' in particular) and the money laundering scheme run by the underground banking system: "Chinese brokers launder hundreds of millions for global crime groups | FT Film"
https://www.youtube.com/watch?v=EjGIp7kdS6E&list=PLrhpR40o4n5wZ1TVyXx-46hKf66uRbADV

5. Policy Remedies

After the subprime mortgage debacle, various reform measures on the financial service sector were instituted, including the new risk-based capital regulations (under the Basle III regulatory regime), and the Dodd-Frank Act of 2010 (for Wall Street Reform and Financial Consumer Protection). In addition, as a set of good practices of FCP are suggested by the multi-lateral international organizations: that is, G20/OECD (2012) and its revised version in OECD (2022); and, the World Band (2012). In particular, the World Bank (2012) proposes the 39 common good practices around four themes: (1) information provision (to financial consumers); (2) financial literacy and capability; (3) sales practices (by the intermediaries and their employees); and, (4) conflict resolution mechanism. On the other hand, G20/OECD (2012) promulgates 10 high-level principles on FCP, which is revised (as in OECD (2022)) by adding two new principles along with three cross-cutting themes.[36]

Table 6 below offers a three-dimensional matrix that links the behavioral patterns discussed with two additional dimensions - the real world cases of abusive or fraudulent intermediation practices, and the policy remedies to improve each pattern identified. Hopefully, the table can serve as a template with which one can identify future research agenda and policy instruments measures. Implications of the policy remedies suggested, in terms of financial education and counseling, business ethics training, prevention of incomplete sale, and market-wide competition, are summarized in the next section.

Table 6. Behavioral patterns to be tamed and policy remedies

Behavior	Examples	Policy Remedies
(1). Over-consumption & under-saving (demand-side)	• Present time bias (i.e., too much consumption now but under-saving for future by many consumers) • Un- or under-prepared retirement (asset-based vs. pension-based retirement funding in different countries)	• Well-targeted financial education (FE) programs with a clear objective, tailored to remedy this particular behavioral pattern for different consumer groups (differentiated by lifecycle stages, endowment levels, and other factors) • Empirical assessment of the effectiveness of such programs in a sound measurement framework (e.g., an RCT-based analysis)

[36] Those ten high-level principles promulgated by G20/OECD (2012) include: (1) legal, regulatory, supervisory framework; (2) role, powers, and capabilities of oversight bodies; (3) equitable and fair treatment of consumers; (4) disclosure and trancyparency; (5) financial education and awareness; (6) responsible business conduct of financial services providers and authorized agents; (7) protection of consumer assets against fraud and misuse; (8) protection of consumer data and privacy; (9) complaints handling and redress; and, (10) competition. OECD (2022), the revised one, adds two new principles - access and inclusion, and quality financial products, and also institutes three cross-cutting themes that are relevant to all principles - digitalization, sustainable finance, and financial well-being.

(2). Over-leverage & unsound product choice (demand-side)	• Easy borrowing & easy payment under the platform-based lending (e.g., the P2P lending that led to over utilization of credit cards) • Over-leverage caused by predatory lending products (e.g., the subprime mortgage contracts such as 2-28 or 3-27 Option ARM contracts)	• FE programs with the same features as the above, targeted to influence the ability to choose adequate lending products (key attributes of widely-used loan products in a given country to be covered) • In-time, independent, and interactive counseling or advice programs (a GenAI-based interactive system to be considered); A number of issues to be considered (e.g., who should sponsor, and what type of access to provide for consumers?) • Sound and incremental expansion of financial inclusion for marginal borrowers
(3). Excessive risk-taking & unsound product choice (demand-side)	• Herd behavior caused by a strong and sustained asset price upturn (e.g., the recent crypto-asset price surge, and the house price upturns before GFC) • Fraudulent intermediation of investment products (e.g., the LAM case in Korea, and the FTX, Terra-Luna, and the fraudulent ICO cases)	• FE programs with the same features, targeted to influence the ability to choose adequate investment products; Those programs should elaborate why "it is very hard to make money!" • A GenAI-based investment consultation system (e.g., a robo-advisor operated by an independent entity) • Information sharing (i.e., collecting and disseminating real-world cases on outcomes of the herd investment behavior and the fraudulent intermediaries)
(4). Profit-making over the fiduciary duty (supply-side)	• Putting the intermediaries' interests (i.e., profit-making) at the cost of financial consumers (e.g., the predatory lenders in the subprime & Alt-A mortgage lending, and the fraudulent intermediation of the crypto-assets)	• Business ethics training programs, targeting different levels of employees in the financial service sector (e.g., front-office employees who deal with consumers, middle-managers, and executives) (e.g., the UK CBI's two level training program) • A mandatory oath, similar to the Hippocratic Oath by medical doctors (under the premise that, "money is as important as health for many")
(5). Moral hazard in product design and sale (supply-side)	• Developing and selling predatory or fraudulent financial products (e.g., the delisted crypto-currencies in Korea, the hidden costs in some of the variable maturity life insurance (VALI) products, and the Ponzi-like investment products	• Regulatory requirements to prevent 'incomplete sale' (by providing appropriate information in an appropriate format, by offering a cooling-off period, by establishing an efficient and affordable conflict resolution mechanism, among others) • Regulatory oversight of the intermediaries, (via ombudsman, monitoring of consumer complaints, overseeing internal processes)
(6). Inefficient risk management practices (supply-side)	• Volume maximization strategy, to increase current profit at the cost of long-term financial loss (e.g., the subprime mortgage lenders and securitizers) • Cyclical risk measurement and management practices (e.g., overly-lenient underwriting criteria,	• Prudential regulations (e.g., the Basle III RBC requirements), to institute a long-term view in the intermediaries' operation (to help prevent the pro-cyclical risk management practices) • Sound risk measurement and management practices by the intermediaries (following the accepted finance theories and empirical models in assessing the systematic and idiosyncratic risk factors);

	underestimated risk spreads - RP, and unclear risk-sharing arrangements among intermediaries during the boom, and vice versa)	A BD·ML-based analytics to be considered • Risk-rating of financial products to be conveyed to consumers (done by intermediary, validated by regulator, and released to consumers in a plain language; the BaFin case as an example)
(7). Suboptimal technology choice & utilization (supply-side)	• Under-utilization of, and under-investment on, the DPA technologies for front-office functions (e.g., under-utilizing online B2C systems for client interface) • Under-utilization of the DPA technologies for middle- or back-office functions (e.g., the automated AML & ATF processes, the BD·ML-driven risk measurement and management practices	• Market competition among SmallTechs, BigTechs, and existing FIs (i.e., the catfish effects imposed to each other); Making a leveled playing field in terms of data, market infrastructure, and other dimensions of competition (among the intermediary types) • Regulatory sandbox to promote innovations among financial intermediaries (hence, to enhance a welfare gain in a societal level) • Equipping intermediaries with the BDAC (in all three dimensions of personnel, infrastructure, and governance); How to incentivize them to do so?
(8). Inadequate responses to financial frauds & crimes (both sides)	• Organized financial crimes seriously affecting consumers' welfare (e.g., voice or messenger phishing, pharming, smishing, and hacking) • Other cases of welfare loss caused by the digital finance (e.g., rising youth gambling, 'darknets,' and the tech-savvy fraudsters such as WormGPT)	• Mechanism to coordinate the combat against the large (often multi-national) crime organizations that are behind the financial frauds (between financial market participants - regulators, intermediaries, and consumers - and crime investigation authorities in a country) • The SAR (Suspected Activity Report) by requirement by CFPB • Information dissemination on the actual cases of financial frauds occurred in different countries, and on policy remedies employed (both preventive and re-active policy measures)

Source: the author

6. Summary and Conclusion

There are several specific FCP measures to which the prior discussion (in Sections 2 through 5) can offer some implications. Fist, financial education (FE) and counseling to help the consumers to be more sound and informed in their decisions appear to be the one that will be deeply influenced by the advancement of BD·ML driven innovations. As stated in Table 6, the FE programs can be designed to develop the capability for the consumers, rather than to convey the knowledge (often in a supply-oriented fashion), such that they establish a more optimal long-term financial planning, utilize the leverage in a more welfare-enhancing way, and choose a safer investment alternative. In order to do that, the programs should have a clear objective in terms of what behavioral pattern to tame (e.g., among the three in the demand-side discussed in the table), what consumer cohort to target (differentiated by lifecycle stages, endowment levels, and other factors), and how to assess their effectiveness in a sound measurement framework (e.g., an RCT-based analysis). In terms of the contents, those programs should contain not only relevant financial concepts but also nudging mechanisms to induce the consumers to choose adequate products both for borrowing and for investment, as well as some common-sense principles that consumers should carve in their minds, such as "too much leverage is dangerous and can ruin one's long-term financial safety," and "it is very hard to make money." Collection and dissemination (as a part of the FE programs) on real-world cases of abusive and fraudulent intermediation practices that actually happened in different countries would be a good strategy to be considered, in designing a well-targeted and effective FE program for a particular consumer cohort.[37]

In the era of the BD·ML driven innovations, an in-time, independent (from the intermediaries), and interactive advisory mechanism aided by a GenAI system would dramatically increase the effectiveness of consumer counseling at the time of product choice (both for borrowing and for investment). As discussed earlier, such system can access vast amount of knowledge relevant to a particular product, and can interact with the consumers to offer product-related information in a more understandable fashion to them. It appears that the technology to develop such system tailored to FCP is there; Question is who's going to pay, for development, maintenance, and subscription (by consumers and by intermediaries), and how the access is offered, and so on. A number of such issues will have to be thought through if one seriously consider providing the service in that nature.

In the supply-side, the key FCP agenda is how to ensure a fair and ethical treatment

[37] Appendix 5 provides a comparison of the recent policy initiatives adopted in three countries as a reference (i.e., UK, the United States, and Korea).

of consumers by the intermediaries (and their employees) with several desirable behavioral patterns as elaborated in the above, i.e., by putting consumers' interest on the top (i.e., sticking to the fiduciary duty principle), by designing and selling products without an intent of moral hazard, by measuring and managing underlying risks in an efficient way, and by adopting and implementing the BD·ML technology solutions in an optimal fashion. In terms of the policy remedies, such measures as business ethics training (targeting different levels of employees in the financial service sector), various means to prevent incomplete sale, and ex post (or post-contract) measures of conflict resolution are suggested in the matrix. In addition, a mandatory oath of a standard format, similar to the Hippocratic Oath by medical doctors, can also be considered, under the premise that, "money is as important as health for many." Here again, testing how effective those measures are in achieving the stated goals appear to be a future research issue. One related point to make is that, despite all these issues, a sound and incremental expansion of financial inclusion for marginal consumers (in both borrowing and investment sides) should also be considered as an important policy direction as so-doing will also enhance welfare of certain consumer cohorts.

In terms of the risk management, one of the two core functions of finance, the prudential regulations (e.g., the Basle III RBC requirements) represent a first line of defense to induce the intermediaries to institute a long-term view in their operation and to implement a more optimal risk management practice (e.g., a counter-cyclical, rather than a pro-cyclical, intermediation practice). To that end, a BD·ML-based analytics can be considered in measuring effects of the systematic risk factors (via a nowcasting) as well as idiosyncratic factors (via a credit-scoring method), and in reflecting outputs of data analyses in actual risk management decisions (i.e., underwriting, pricing, and risk-sharing). One suggestion made in Table 6, in the context of information provision to financial consumers, is a risk-rating of financial product, which can be done by intermediary, validated by regulator, and released to consumers in a plain-language summary. Underlying logic is, consumers are rated in terms of their creditworthiness, given that why not doing the same for financial products? In fact, there is an example of such practice in the case of BaFin, the German regulatory agency. (Elsen (2021))

As an industry-wide issue, competition can lead to a more efficient operation on the part of the intermediaries, which can result in a reduction in unnecessary intermediation cost (i.e., lowering G&A in equation (9)). Entering the market by those alternative service providers, in particular by BigTechs, can exert a catfish effect to make the existing intermediaries (banks, non-bank FIs, and security dealers) by pushing them to be more efficient in their operations. However, as surveyed in Section 2, the increased market power by BigTechs, not only in in terms of the data and AI related technologies but also in terms of the capability to steer consumers toward their products and services, is a policy challenge to be tackled. The essence

of this debate appears to be in balancing two directions of social welfare enhancement - a fair completion by creating a leveled playing field (among the three types of the intermediaries) and innovations in financial services (through the BD·ML and other technologies).

Finally, how to protect consumers from the financial frauds and financial crimes should receive a fair amount of attention from research community and policy circles. As discussed in Section 4, those frauds and crimes are backed by the large (often multi-national) crime organizations, and, hence, an effective combat against those crimes goes beyond the financial service sector. Instead, a coordination mechanism (possibly multi-national in nature) should be developed through a cooperation between financial market participants - regulators, intermediaries, and consumers - and crime investigation authorities in a country. On the part of the intermediaries, they can automate their internal processes by utilizing a BD·ML technology to efficiently detect and prevent the fraudulent transactions. In addition, the regulators can implement a reporting routine on such transactions as well (e.g., the SAR - Suspected Activity Report - requirement by CFPB in the U.S.). And there should be a training in the demand-side, to make the consumers more cautious and savvy in responding to the crimes, for which information dissemination on actual cases of financial frauds occurred in different countries and on appropriate responses to those cases would be fruitful.

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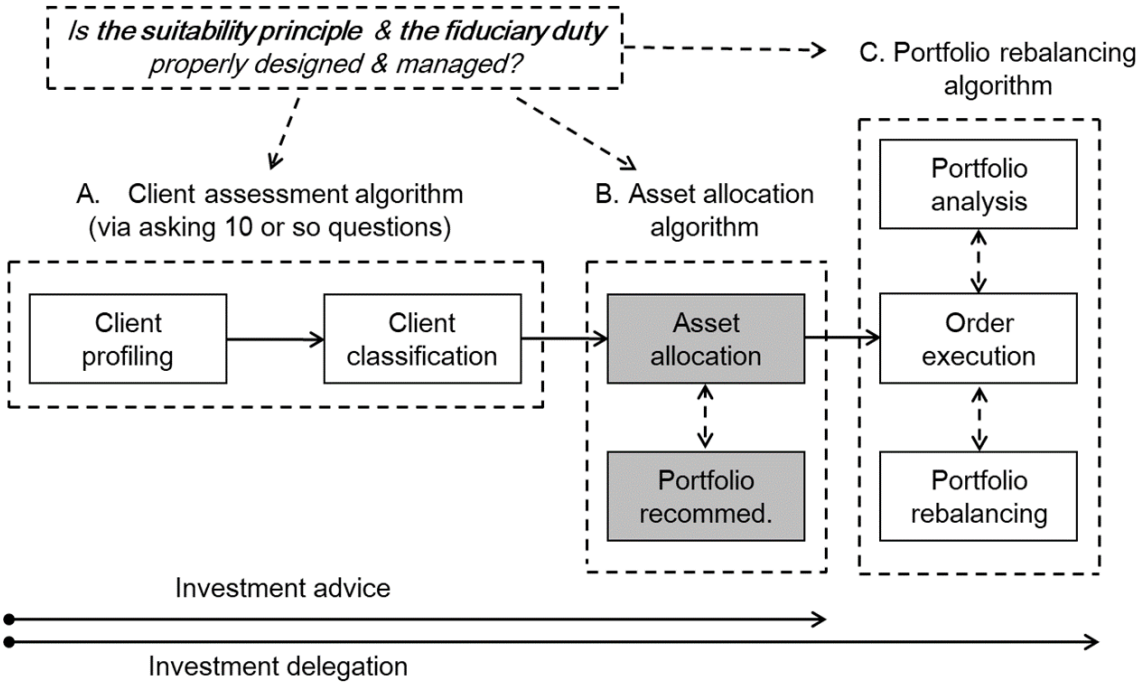
Appendices

Appendix 1. Improvement of Prediction Accuracy via Alternative Data (ΔAUC)

Reference	Alternative data or score	AUC, CCS[a] only	AUC, combined	ΔAUC
Kim, Shin, Park, and Cho (2023); "Thin filers"	Mobile payment, telecom service, & online shopping data	67.8%	76.8%	9.0%
Kim, Shin, Park, and Cho (2023); "Thick filers"	Same as the above	71.9%	74.7%	2.8%
Berg, Burg, Gombović, and Puri (2020)	Digital footprint variables (combined with CB score)	68.3%	73.6%	5.3%
Berg, Puri, and Rocholl (2017)	Bank internal rating (combined with CB score)	66.6%	75.4%	8.8%
Puri, Rocholl, and Steffen (2017)	Bank internal rating (combined with CB score)	66.5%	78.4%	11.9%
Iyer, Khwaja, Luttmer, and Shue (2016)	Interest rates (combined with CB score)	62.5%	68.2%	5.7%
Iyer, Khwaja, Luttmer, and Shue (2016)	All available financial and coded information	62.5%	71.4%	8.9%

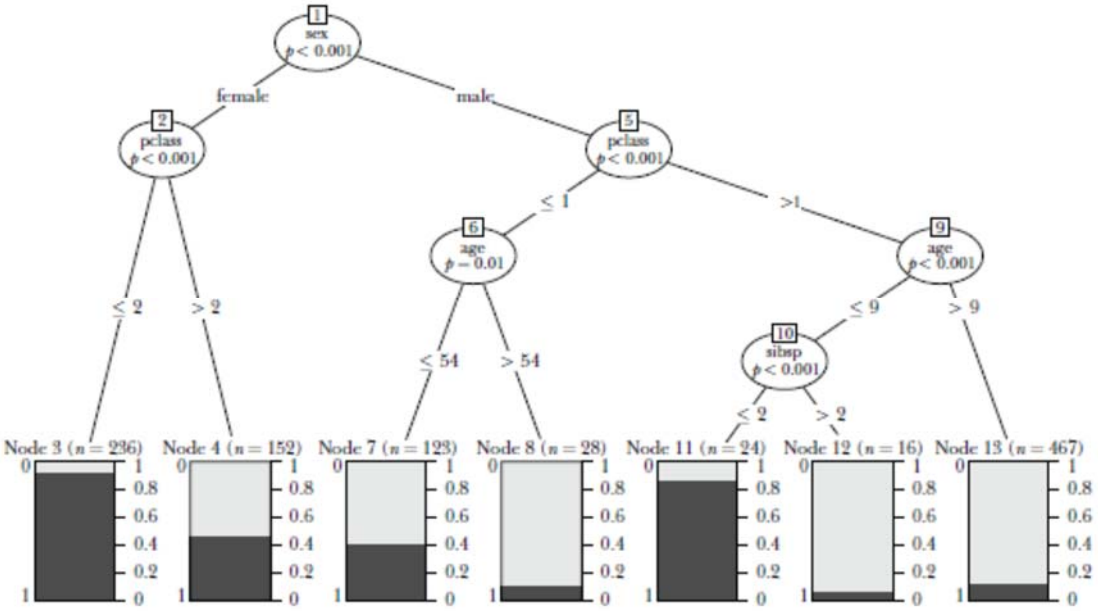
Sources: Berg et al. (2020), and the author

Appendix 2. The Typical Analytical Process of Robo-Advisor



Source: The author

Appendix 3. The ML-based analysis of the survival probability of the Titanic passengers



Source: Varian (2014)

Appendix 4. Top 10 most-frequent types of voice phishing

Impersonation of Financial Institutions	Fraudsters pose as representatives of legitimate financial institutions, such as banks, investment firms, or credit card companies, and attempt to obtain personal or account information by claiming there is an issue with the victim's account
Fake Investment Opportunities	Scammers offer fake investment opportunities with promises of high returns, urging victims to transfer funds or disclose sensitive financial information over the phone
Loan Scams	Fraudsters offer fake loans or debt relief services, requesting upfront payments or personal financial information as part of the application process
Tax Scams	Scammers impersonate tax authorities, such as the IRS in the United States, and threaten victims with legal action or arrest for purported unpaid taxes. They may request immediate payment or personal information to resolve the issue
Lottery or Prize Scams	Fraudsters inform victims that they have won a lottery or prize, but must pay taxes or fees upfront to claim their winnings. They may request payment via wire transfer or provide instructions for purchasing prepaid cards.
Tech Support Scams	Scammers impersonate technical support personnel from well-known technology companies and claim that the victim's computer or device has been compromised. They may request remote access to the victim's device or payment for fraudulent services.
Charity Scams	Fraudsters solicit donations for fake charities or disaster relief efforts, preying on victims' generosity during times of crisis. They may use high-pressure tactics to convince victims to make immediate donations over the phone.
Employment Scams	Scammers offer fake job opportunities with promises of high pay or flexible work arrangements, but require victims to provide personal or financial information as part of the application process.
Romance Scams	Fraudsters develop relationships with victims through online dating platforms and then request financial assistance under false pretenses, such as medical emergencies or travel expenses.
Voice Biometric Spoofing	: Advanced voice phishing techniques involve using voice manipulation software or recordings to impersonate individuals, including financial institution employees or trusted contacts, in order to deceive victims into disclosing sensitive information or authorizing fraudulent transactions.

Source: ChatGPT 4.o

Appendix 5. The policy initiatives on financial literacy (UK, US, and Korea)

	United Kingdom	United States	Korea
Institutionalization	• Legislation: Re-org of FSA (to FCA &) • Key agencies: FCA (main FCP agency); MaPS (Money & Pension Services), a control tower for FL by providing info & advisory services • Emphasizing FE in school, home, & community	• Legislation: The Financial Literacy & Education Improvement Act (2003), & the national strategies (2006, 2011, & 2016) • Key agencies: CFPB (FL & FE policies); The Financial Literacy & Education Commission (FLEC)	• Legislation: The FCP Act (2021) • Key agencies: FSC (national strategy); FSS (Bureau of FCP, & E-education Center); The FE Council (enhanced to a legal body in 2021)
Notable Policies	• The Financial Capability Strategy for the UK (2015) • The UK Strategy for Financial Wellbeing 2020-2030 (2020) ➔ Raise FL by enhancing confidence & empowerment	• Council for FE (developing curriculums & others) • The Financial Industry Regulatory Authority (FINRA), various FL tests for adult • Loan modification (HAMP, & Flex)	• Financial Literacy Map (a matrix of 6 topics by 6 life stages) • Loan modification (by the Credit Counseling and Recovery Service)