# A Study on the Mechanisms and Risk Challenges of Fintech-Driven Financial Business Innovation

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**Abstract.** Our research mainly focuses on the mechanism of traditional financial business innovation under the influence of Fintech and the new risk challenges posed by Fintech. Next, we focus on how to build a Fintech risk model based on a combination weighting approach. Our research discusses in detail the mechanism of financial business innovation from three aspects: how Fintech stabilizes financial markets, how it promotes financial equity, and how it promotes the development of financial inclusion. As for the risk challenges brought by Fintech, we analyze five aspects: technology risk, algorithm risk, industry transformation risk, speculative risk, and regulatory challenges. Finally, we summarize the Fintech risk assessment system based on the above analysis. Based on the summarized Fintech risk indicators, we constructed a Fintech risk model based on a combination weighting approach. This assignment model is based on the minimum discriminative information principle, which integrates fuzzy hierarchical analysis and the entropy method. We hope to analyze Fintech risk quantitatively through this model. And based on the relative size of the weights, we determine which risk is the highest and which risk is the lowest among the risk challenges posed by Fintech.

**Keywords:** Fintech · financial innovation · digital technology · Fintech risk

## 1 Introduction

Fintech is the innovation of high-tech financial products based on the influence of technological innovation, which is driven by relevant technologies, such as blockchain, big data and artificial intelligence, to transform intelligent finance and digital finance. Fintech is a synthesis of Finance and Technology, but the substance is not simply a combination of finance and technology. There is no unified standard for Fintech at home and abroad, mainly because of the different backgrounds of central bank regulators and other central organizations in each country. In our work, we define Fintech as the activities of


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reforming and innovating traditional financial business under the supervision of financial regulators, driven by emerging technologies and involving market players such as traditional financial institutions and emerging financial sectors. In turn, the application of these emerging technologies and the innovation of traditional financial business by Fintech can bring about new risks. Therefore, we focus on analyzing the mechanism of Fintech-driven financial business innovation and constructing a Fintech risk model to quantify the new risks.

Our research contains two significant aspects: first, the factors of Fintech on financial business innovation, and second, the negative impacts of Fintech. In terms of the positive impacts of Fintech, Qiu and Liu [1] explores the positive impacts and specific mechanisms of Fintech on financial stability and development from a theoretical level and suggests that Fintech technology can help improve resource allocation efficiency by expanding the boundaries of financial resource allocation; Durai et al. [2] discusses digital finance and its impact on financial inclusion, concluding that digital finance makes it easier for customers to control their personal finances, make quick financial decisions, and enhance their ability to pay and receive their accounts, i.e., digital finance contributes significantly to financial inclusion. Risman et al. [3] argue that digital finance positively impacts financial stability by increasing the ability of banks to provide financing. In terms of the risks posed by Fintech, Zhang [4] finds that Fintech poses new regulatory challenges in terms of legal, technological, and information blindness by analyzing the relevant risk derivation mechanisms; Goo and Heo [5] suggest that regulatory sandboxes play an essential role in increasing risk capital flows into the Fintech risk ecosystem by eliminating regulatory uncertainty through comparative analysis and regression analysis of nine pioneering countries that have adopted regulatory sandboxes. They suggest regulatory sandboxes play an essential role in increasing risk capital flows into the Fintech risk ecosystem by removing regulatory uncertainty.

Most of the relevant literature studies [2–4] are limited to the positive impact of Fintech on financial business innovation, and relatively few consider the negative impacts of Fintech. Even the relevant articles on the new risk challenges brought by Fintech are mainly limited to the regulatory field and rarely consider other risk factors, such as its technological risks. Therefore, in Sect 2, our research first summarizes the mechanism of financial technology innovation in the financial market. In Sect 3, we then focus on analyzing the risk challenges posed by Fintech and use them to construct a Fintech risk assessment system. Finally, in Sect 4, we construct a Fintech risk assessment model based on a combination weighting approach. This model can measure the level of risk factors by the relative size of the weights.

## 2 Innovative Mechanisms of Fintech on Financial Markets

### 2.1 Stabilize the Financial Market

Financial efficiency plays a vital role in the value basis for the stability of financial markets, and financial stability is reached when the efficiency of financial allocation reaches the Pareto optimal state [2]. The application of Fintech has dramatically improved the efficiency of financial operations, and its superiority of new technologies in efficiency

is demonstrated in all aspects of financial operations. We next explore how Fintech can optimize the efficiency of financial resource allocation.

At the micro level, the importance of financial resource allocation efficiency is reflected in the optimal local state when the marginal rate of substitution of investors and the marginal rate of substitution of financiers are equal. When the efficiency of financial resource allocation is optimal, the financial market is stable. At the macro level, it is reflected in the Pareto optimal allocation of resources of each link and unit involved in the financial market [2]. In this equilibrium state, the financial market continues to develop steadily. However, there are many uncontrollable factors in the real financial market, so there is a need to proactively adopt new technologies to deploy financial resources and efficiently allocate financial resources under the realistic conditions of limited financial resources. The new technologies brought by Fintech significantly improve production efficiency. Moreover, the new advantages brought by Fintech improve the supply capacity of financial products, shifting the supply curve of financial resources outward, thus widening the boundaries of financial resource allocation. Fintech has also injected new vitality into significantly improving financial resource allocation efficiency.

### 2.2 Promote Financial Equity

Fintech promotes financial equity in two main ways: firstly, Fintech helps to promote the transparency of financial markets and solve the problems related to the opacity and information asymmetry of transactions within the financial markets; secondly, Fintech helps to promote the development of the financial regulatory field and promote the development of financial equity from outside the financial markets.

The first issue is market transparency, which is essential for maintaining financial fairness and stability. Various aspects, such as information on both supply and demand sides of financial product transactions, financial products, and financial market regulation, determine financial market transparency. In the actual financial market, due to shallow thrusts and complex objective factors, there are problems related to information asymmetry between the two sides of financial product transactions. This leads to opaque financial markets and even triggers a run on financial products, eventually leading to financial crises. The blockchain and other related technologies brought by Fintech have the advantages of natural transparency, traceability, and non-comparability because of the characteristics of a distributed ledger. The industry aggregation effect of these new Fintech-related technologies can create a transparent and symmetrical information trading place for the financial market and promote equitable financial development.

Then comes the issue of financial regulation. Financial regulation is complex, involving various aspects of the financial market, which requires regulators to consider multiple parties to protect the interests of both sides of the transaction under the premise of reducing the risks involved in the transaction in order to solve the problem of opacity and information asymmetry between the two sides of financial transactions [6]. The application of financial technology, including big data, blockchain, cloud computing, and other technologies, has dramatically improved the original regulatory dilemma and helped to upgrade the digital transformation of financial regulation.

### 2.3 Promote Inclusive Financial Development

Another significant new change in financial technology in the financial market is that the application of advanced science and technology has dramatically accelerated the development of inclusive finance and broadened the boundaries of the customer groups of traditional inclusive finance. In the traditional financial market, there are many long-tail customers, including small and micro enterprises and many rural customers. The individual capital scale of these groups is small, but the total amount is enormous. For traditional commercial banks, long-tail customers belong to a category of groups that are challenging to please. However, the application of financial technology provides digital transformation and upgrading for commercial banks in terms of time and cost, reduces service costs, improves service efficiency, and provides feasibility for financial inclusion.

Fintech accelerates the development of financial inclusion by establishing an inclusive financial platform, accelerating the integration of financial technology and MSME industries, and accelerating the development of inclusive finance by reducing service costs and eliminating information asymmetry with the help of advanced technology. Specifically, Fintech can first expand the user base at a low cost with the help of advanced technology, which means that the marginal cost of customer acquisition is meager, and the marginal incremental gain of users is eventually obtained. Thus the digitally upgraded commercial banks can make financial services move down; then, the new Fintech technology can accelerate the industrial aggregation effect; compared with traditional finance, Fintech is more convenient to the real economy and promotes industrial aggregation. Finally, the application of new technologies in the financial sector can significantly promote the development of productivity and reduce the cost of financial services in all aspects. At the same time, artificial intelligence technology and big data cloud computing technology also facilitate commercial banks' low-cost, accurate marketing, provide personalized services and eliminate information asymmetry.

## 3 Risk Challenges Brought by Fintech

Fintech is a double-edged sword, and while it injects new vitality into traditional finance and changes the traditional business model, there are also many risks. The advanced features of Fintech also make it more difficult to detect and control the new risks it brings. Fintech risks are not only limited to the technical level but also bring new risks with its new algorithms and new pressure for supervision. We summarize Fintech risks in three areas: technology risks, algorithm risks, and regulatory challenges.

### 3.1 Technical Risk

Technology risk [7] has a rich connotation, involving deficiencies in the new technologies used in Fintech and including network risk, data risk, etc. Technical risk mainly refers to the risk of computer systems related to financial technology. The computer network risks reflect the hardest hit areas, including TCP/IP protocol vulnerabilities, poor critical security, fundamental management problems, etc. Human factors are another major

cause of computer system risks, especially in personnel management and outsourced technical staff risk control. Network risk mainly refers to the risks associated with financial data that may be suffered in an insecure Internet environment. As the Internet that transmits financial-related data is an insecure channel, there are classical means that endanger network security, such as penetration attacks, eavesdropping, replay attacks, malicious codes, phishing software, etc., causing relevant data leakage or tampering, which eventually leads to significant losses. Data risk mainly includes database risk and noise risk. Database risk is mainly due to hackers attacking the database where financial information is stored and leaking data through dragging and crashing the database; noise risk is due to a large amount of Fintech data and the butterfly effect of noise data and other disturbing factors on the whole financial market through the Internet [7].

### 3.2 Algorithm Risk

Algorithm risk is because Fintech has led to technology gradually replacing people's central position in the financial sector, and algorithms have started to take the lead. In this process, due to the endogenous problem of algorithms, a series of algorithm-related risks have arisen, including algorithm discrimination, algorithm kidnapping, and algorithm convergence. One of the most critical problems is the algorithm discrimination problem [7]. In the era of financial technology, the original intention of applying advanced technology to solve practical problems is to use advanced algorithms to eliminate information asymmetry, facilitate access to financial services and guarantee financial equity. However, due to the selectivity of the algorithm itself in the face of data, it has created a new discrimination problem, which instead re-impacts financial fairness. For example, in building customer portraits, artificial intelligence technology is needed to analyze customers' assets, risk resistance, investment preferences, and other data with the help of algorithms. However, due to the limitation of data dimensions or the lack of data to eliminate bias, the customer portraits built by algorithms become "extensions of social structural discrimination." The most graphic example is that the algorithm considers whether the customer is unemployed or not when constructing the customer profile. For the unemployed, the algorithm will prefer not to provide credit and other financial services to these people, thus further worsening the situation of the unemployed.

### 3.3 Industry Transformation Risk

Financial technology accelerates the transformation and upgrading of the financial industry, which prompted commercial banks and other related financial institutions to comply with the wave of the digital transformation era. However, in the transformation and upgrading of financial institutions, the risks of applying new technologies in the financial field, the problems of services in new application scenarios, and the lack of control in the era of financial technology are numerous.

For example, the accelerated industrial transformation and upgrading, coupled with cyclical economic fluctuations, have led to the accelerated exposure of non-performing assets in the banking industry in the Fintech era, resulting in frequent loan recovery difficulties for banks, which in turn may lead to severe consequences, including cash-out crises. The banking industry and other financial businesses, such as the securities

industry and insurance industry, are also facing increased risks in financial business operations due to technical problems, risk control problems, and competition escalation brought about by the Fintech era. In short, the risk of industry transformation brought about by Fintech has intensified, and financial institutions are in great difficulty.

### 3.4 Speculative Risk

Speculative nature is an inherent characteristic of capital markets, coupled with the fact that Chinese capital markets are highly speculative, not only in terms of higher market win rates in the stock market than in Western countries but also because of high stock trading rates. This has led to increased speculative risk in capital markets driven by Fintech.

The speculative nature of the capital market itself will lead to irrational investment behavior of investors, coupled with the lack of relevant financial knowledge, especially for individual investors, which will intensify financial risks. In addition, in the era of financial technology, the problem of information asymmetry between individual investors and institutional investors is becoming more and more serious, which will lead to individual investors blindly following the trend and harming their interests; it will also lead to institutional investors using insider information to make illegal acts such as arbitrage and illegal operations.

### 3.5 Regulatory Challenges

The complex characteristics of Fintech bring further challenges to the regulation. In Fintech regulation, there are mainly imperfect legal systems and problems that cannot be followed, backward regulatory technology and technical shortcomings, backward regulatory mechanisms, and the traditional "one-many-head" regulatory system that cannot keep pace with Fintech. First, no clear laws and regulations have been promulgated in financial science and technology, and regulators need to have the necessary legal basis. Because of the backward legislation, many behaviors can not be regulated and ruled by ordinary enterprises and individuals. However, some lawless elements exploit the legal loopholes of the opportunity, thus causing several financial crimes. Then is the problem of regulatory technology. New technologies are constantly emerging, inevitably causing regulation to fail to keep up with the pace of technology. For example, the application of artificial intelligence technology in the field of supervision is still in the stage of development and testing, with fewer mature products. In addition, due to the application of financial technology, regulatory focus has long changed, and financial technology has gradually become the hardest hit, putting forward new requirements for the quality of practitioners. Finally, the problem of the regulatory system, the traditional financial regulatory system under the central leadership of the implementation of regulation in the field, while in the era of Fintech, technology to accelerate industrial integration, the financial industry cross-mixed development trend, the backward system there are many regulatory blind spots, it is challenging to complete the cross-industry cross-regional regulatory tracking [6].

# 4 Fintech Risk Model

The fintech risk mentioned in Sect 4 is only a qualitative concept; therefore, to measure fintech risk quantitatively, we construct a combined weighting model of fintech risk indicators based on the principle of minimum discriminative information [8]. In this model, combination weighting includes two parts, i.e., subjective weights are determined by fuzzy hierarchical analysis [9]; objective weights are determined by the entropy value method [10]. The reason for considering the integrated weighting approach is that, as an emerging field, FinTech involves two major fields, finance and technology, and different people hold different views on the risks of FinTech, so it is necessary to rely on authoritative experts to score FinTech risk indicators. However, it is not enough to just consider the subjective empowerment of fuzzy hierarchical analysis. Fintech is a new field, and experts in the field are limited by inadequate knowledge of finance or computers, or because the risks associated with the rapid pace of innovation in fintech technology are constantly changing. Therefore, we consider the objective empowerment of entropy method on the subjective empowerment of fuzzy hierarchical analysis method.

## 4.1 Fuzzy Hierarchical Analysis

We construct a fintech risk assessment system based on the fintech risks analyzed in Sect 4. This system includes two levels of risk indicators, as shown in Table 1.

Next, the fuzzy complementary judgment matrix is constructed by comparing the importance of each indicator in the indicator layer under the same criterion layer (i.e., the five main indicators mentioned above). We use Satty's hierarchical analysis method, where 1–9 scale is to determine the relative importance of the two indicators, depicted by Table 2.

**Table 1.** Fintech Risk Assessment System

| Evaluation target (target level) | Main indicators (guideline level) | Secondary indicators (indicator layer) |
|---|---|---|
| Fintech Risks | Technology Risk | New technology risk, cyber risk,data risk |
| | Algorithm Risk | Algorithm discrimination risk, algorithm kidnapping risk, algorithm convergence risk |
| | Industry transformation risk | Management risk, operational risk, market competition risk |
| | Market Risk | Interest rate risk, exchange rate risk, price change risk |
| | Regulatory Risk | Risk of legal deficiency, risk of backward regulatory technology, risk of backward regulatory system |

**Table 2.** Hierarchical analysis 1–9 scale table

| Scale $a_{ij}$ | Meaning |
|---|---|
| 1 | Element i and element j are equally important |
| 3 | Element i is slightly more important than element j |
| 5 | Element i is significantly more important than element j |
| 7 | Element i is very important than element j |
| 9 | Element i is extremely more important than element j |
| 2,4,6,8 | Intermediate value of two adjacent judgments |
| reciprocal | Indicates that the former is less important than the latter |

The judgment matrix is expressed as (1),

$$B = \begin{bmatrix} b_{11} & \cdots & b_{1m} \\ \vdots & \ddots & \vdots \\ b_{m1} & \cdots & b_{mm} \end{bmatrix}_{m \times m} \tag{1}$$

where $b_{ij}$ is a decimal number between 0.1 and 0.9, indicating that the indicator term $a_i$ compared to the $a_j$ the importance of the indicator item, and the larger the value, the $a_j$ the more important.

Secondly, we put the matrix $B_f = \left(f_{ij}\right)_{n \times n}$ to calculate the weight values of each indicator. $B_f = \left(f_{ij}\right)_{n \times n}$ is expressed as (2).

$$f_{ij} = \frac{b_i - b_j}{2m} + 0.5 \tag{2}$$

Under the same criterion level of $i$, the subjective weight value of the second level indicator $\omega_{zi}$ is expressed as (3),

$$\omega_{zi} = \frac{1}{m} - \frac{1}{2\alpha} + \frac{1}{m\alpha} \sum_{j=1}^{m} f_{ij} \tag{3}$$

where $\alpha$ is the parameter that satisfies $\alpha \geq m - 1/2$, the magnitude of $\alpha$ is inversely proportional to the variance of the weights.

### 4.2 Entropy Value Method

We leverage the entropy method [10] for our objective assignment, and its specific steps are as follows.

First, we need to construct the rating data matrix: with $m$ a rating item and $n$ rating indicators, then the original indicator matrix is expressed as (4).

$$Z = \begin{bmatrix} z_{11} & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{m1} & \cdots & z_{mn} \end{bmatrix}_{m \times n} \tag{4}$$

Then, we normalize the metrics as (5).

$$P_{ij} = \frac{z_{ij}}{\sum_{i=1}^{m} z_{ij}} \tag{5}$$

Next, we calculate the entropy value of the index $e_j$ and the degree of redundancy $h_j$ as (6) and (7).

$$e_j = -k \times \sum_{i=1}^{m} P_{ij} \ln\left(P_{ij}\right) \tag{6}$$

where $k > 0$, the constant $k$ is related to the total number of indicators $n$ is related to the total number of indicators, and generally takes the value of $k = \frac{1}{\ln n}$.

$$h_j = 1 - e_j \tag{7}$$

where the greater the redundancy of the $j$, the greater the evaluation effect of the index on the scheme.

Finally, we calculate the subjective weight value of the second level indicator $\omega_{ki}$ as (8).

$$\omega_{ki} = \frac{h_j}{\sum_{j=1}^{n} h_j} (j = 1, 2, \cdots, n) \tag{8}$$

### 4.3 Integrated Empowerment Method

We use the principle of minimum discriminative information [11] to perform the integrated assignment as follows. First, the objective function is set based on the principle of minimum discriminatory information. The objective function is expressed as (9)

$$\begin{cases} minF(\omega) = \sum_{i=1}^{m} \left(\omega_i ln \frac{\omega_i}{\omega_{zi}} + \omega_i ln \frac{\omega_i}{\omega_{ki}}\right) \\ s.t. \sum_{i=1}^{m} \omega_i = 1, \omega_i \geq 0, i = 1, 2, \cdots, m \end{cases} \tag{9}$$

Second, we need to solve the objective function based on the Lagrangian function. We assume that the Lagrange function is expressed as (10).

$$L = \sum_{i=1}^{m} \left(\omega_i ln \frac{\omega_i}{\omega_{zi}} + \omega_i ln \frac{\omega_i}{\omega_{ki}}\right) + \lambda \left(\sum_{i=1}^{m} \omega_i - 1\right) \tag{10}$$

Then we calculate formula (11).

$$\begin{cases} \frac{\partial L}{\partial \omega_i} = 2ln\omega_i + 2 - ln\omega_i\omega_i + \lambda = 0, i = 1, 2, \cdots, m \\ \frac{\partial L}{\partial \lambda} = \sum_{i=1}^{m} \omega_i - 1 = 0 \end{cases} \tag{11}$$

Thus, we can finally obtain the combined weights as (12).

$$\omega_i = \frac{\sqrt{\omega_{zi}\omega_{ki}}}{\sum_{j=1}^{m}\sqrt{\omega_{zi}\omega_{ki}}} \tag{12}$$

The combined weights imply that we can obtain the relative size of the weights of each fintech risk indicator in the quasi-measurement and indicator layers considering subjective and objective assignments. We can determine which risk is the highest and which is the lowest among the risk challenges posed by Fintech based on the relative size of the weights. In the subsequent work, we can also calculate the size of Fintech risks among individual firms or among individual countries by applying TOPSIS algorithm based on the weight size of each indicator obtained from the combined weighting.

## 5 Conclusions

In our research, we explore the impact of Fintech on financial business innovation and the financial market from positive and negative impacts. And we present a new Fintech risk model in the final section of the article. In terms of the positive impact of Fintech, we focus on the factors that influence FinTech on financial markets. In terms of risk challenges brought by Fintech, we summarize and sort out the technology risks, algorithm risks, industry transformation risks, market risks, and new challenges to regulation posed by Fintech.

In the Fintech risk model construction section, we construct a combined weighting model of Fintech risk indicators in order to quantitatively measure Fintech risk. In this model, combination weighting includes two parts, i.e., subjective weights are determined by fuzzy hierarchical analysis; objective weights are determined by entropy value method. In the subsequent work, we can obtain the weight size of Fintech risk indicators based on combined weighting model to measure the degree of Fintech risk for each firm or each country.

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