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Risk Prediction for Internet Financial Enterprises by Deep Learning Algorithm and Sustainable Development of Business Transformation

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ABSTRACT

It is necessary to find new ideas of business transformation of traditional financial enterprises under the background of internet finance. Based on DL (deep learning) algorithm, the BPNN (back propagation neural network) model and vector autoregression model are used to analyze the business conflict of commercial banks among traditional financial enterprises under internet finance. The business integration point of the two is found through the impulse response analysis of the impact of the internet financial business on the traditional financial industry. Then, the DL algorithm based on BPNN is used to obtain the optimal solution of business integration, to promote the transformation of traditional financial services under the background of internet finance. The results show that there is a close correlation between internet finance and traditional financial business. The initial conflicts between the two are serious, but as time passes, they have a trend of mutual integration.

KEYWORDS

Back Propagation Neural Network, Business Transformation, Deep Learning, Internet Finance

INTRODUCTION

With the development of network communication technology, internet finance began to rise, greatly impacting the traditional financial industry. The main body of traditional finance is commercial banks, which play an important role in the national economy (Sun & Varatharajan, 2021; Wang et al., 2021a). In the modern market economy, commercial banks, as participants in the financial market, play a leading role in the development of the entire financial market and connect society and economic activities. The main financial services of commercial banks include deposits, loans, and customer services. China has actively participated in the continuous expansion of economic globalization with constant adjustments to the business strategy to seek development. Also, appropriate competition is encouraged in the financial industry, which continuously intensifies commercial competition among banks (Cui et al., 2021; Pei & Li, 2021). In the competitive environment, all commercial banks are committed to providing financial services for the management activities of various departments and enterprises of the national economy with diversified financial products and services to make finance more stable and promote the rapid development of the national economy.

Internet finance is a new economic model that combines the traditional economy and the internet. It has many advantages over the traditional internet in many aspects, despite some new shortcomings.

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The advantages of internet finance greatly impact traditional financial markets. In the traditional economy, there are many cost factors, such as operation cost, financial cost, information risk cost, and time cost. These costs greatly limit the development of the traditional financial industry, so many financial institutions conduct research to improve cost savings. Meanwhile, internet companies use the advantages of technologies and platforms to enter the existing financial industry, providing commercial and financial products based on the internet to the market, which promotes the development of the traditional financial industry (Brown et al., 2011; Sun et al., 2021). On the one hand, the combination of the internet and finance provides technical support for the creation and development of internet finance. On the other hand, it innovates the existing financial field by providing the possibility for internet companies to enter the financial field and promotes the innovation of internet financial modeling and financing. Common internet financial instruments include artificial intelligence, big data, cloud computing, search engines, and social media (Qi et al., 2020). Xie et al. (2016) built a new type of supply chain financial platform to solve the problem of mistrust among participants in the supply chain caused by information asymmetry. A more comprehensive analysis of internet finance and banking business is conducted here.

The business relationship between internet finance and commercial banks in traditional financial enterprises is analyzed using the BPNN (back propagation neural network) and VAR (vector autoregression). The BPNN based on the DL algorithm finds the correlation and conflict point between the development scale of internet finance and the business of traditional commercial banking and integrates internet finance and traditional bank businesses. It provides new ideas and methods for traditional financial enterprises to avoid business conflicts and develop business integration under the background of internet finance. The traditional financial industry, especially banks, had a monopoly before the emergence of internet finance with a relatively stable state in the industry. Traditional financial enterprises commonly have a relatively extensive way to gain profits due to intra-industry mutual competition. Today, the emerging internet finance with the advantages of convenience, efficiency, and product diversification has had a great impact on the traditional financial industry, which reduces the overall profits of the traditional financial industry. Therefore, in the face of the strong impact of internet finance, commercial banks must improve their old business model, make breakthroughs, and innovate to successfully integrate themselves into the development of financial markets. The research significance lies in using the DL algorithm to analyze the impact of internet finance on the traditional financial industry to find the conflicts and integration points between the two types of businesses. A feasible reference is provided for the transformation and reform of commercial banks to improve the business level and service quality of the entire traditional financial industry. The advantage of the research method is that it finds a more effective business combination of internet finance and traditional commercial banks.

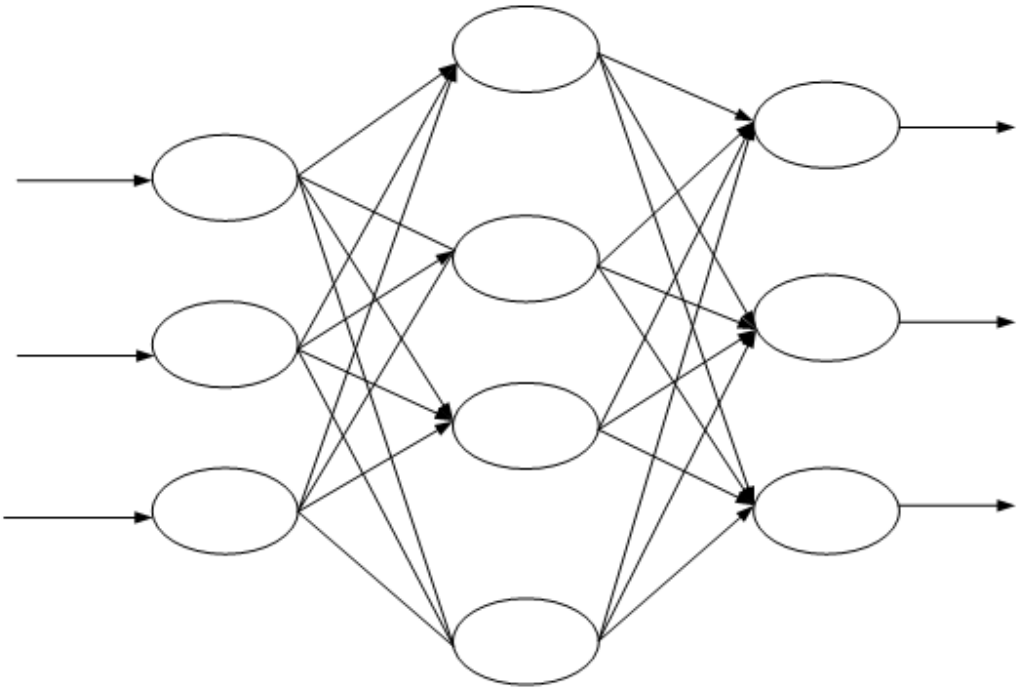
THEORY AND METHOD

Introduction of the DL Algorithm

The DL theory is used as a technical basis, so the DL algorithm and model are introduced in this section. The business integration model combining internet finance and traditional commercial banks draws lessons from the recognition of multi-objective data fusion by multiple sensors (Du et al., 2020). In the integration system, the information is often partially missing from the source of each sensor, with many blurred information data. Reasoning and calculation of such uncertain data are required to fuse these data and information. Neural networks have powerful functions including fault tolerance, self-learning, self-organizing, and self-adaption, which can help researchers quickly find the required optimal solution (Xu et al., 2020). Neural networks can simulate complex nonlinear mapping through unique nonlinear characteristics. Therefore, all neurons can perform large-scale tasks and calculate large-scale data without external synchronous signals at the same time. The most

famous neural network target recognition algorithm is the BP algorithm neural network based on adaptive signal processing (Sun & Chen, 2020). The classification criteria are determined based on the sample similarity allowed in the current system. The specific learning algorithm in the neural network is used to obtain knowledge to meet the needs of data integration from multiple sensor sources. Therefore, the neural network is adopted in the structure of an information fusion target recognition system based on multiple sensors to simulate information merging from multiple sensors (Keskin et al., 2010; Zhang et al., 2021). According to different feedback forms, neural network models can be divided into forward networks and feedback networks. The BPNN is a typical forward feedback neural network. The general forward feedback neural network structure is shown in Figure 1.

Figure 1. Structure of the forward feedback neural network



The VAR model is a common econometric model proposed by Christopher Sims in 1980. This model uses the multi-equation simultaneous form to regress the lagged variables by all the current variables in the model to estimate the dynamic relationship of all endogenous variables. It is a generalization of the regression model and has been widely used in various fields of analysis. It is often used to analyze the composition of different types of random interference items in economics to illustrate the impact of various economic shocks on economic variables (Liu et al., 2021a). Due to the influence of time factors, the research of equations and data fitting can make up for the lack of interpretation of economic significance. Assuming that there are independent variables in the mathematical model to be studied, the general mathematical expression of the VAR model is shown as Equation (1).

$$M_t = a + B_1 m_{t-1} + B_2 m_{t-2} + ... + B_p m_{t-p} + c_t$$

In Equation (1), a represents the constant vector, while B is the n-order matrix, and c_t denotes the error vector of the matrix.

Theoretical Definition and Analysis of Internet Finance

Different scholars have different interpretations of the definition of internet finance. In foreign-related research fields, some scholars believe that internet finance is the third new financial model. They argue that it is different from the indirect financing of commercial banks and the direct financing of the capital market in theoretical concepts and practical applications. Other scholars pointed out that in the traditional financial market, information asymmetry is not caused by the imperfection of the economic market, which is actually a manifestation of competitive advantage (Chen et al., 2020). Financial institutions and financial intermediaries innovate in financial products and provide financial services. In terms of financial business and financing means, whether in direct or indirect financing, the application of internet technology has fundamentally reduced the asymmetry of information. From these new perspectives, and with the growth and integration of the internet in various fields of financial activities in a sustainable way, the phenomenon of information asymmetry in traditional financial companies will become less and less. Innovative financial platforms are emerging, such as online banks, online trading, and online lending. The integration of internet technology with financial institutions is rising with its continuous development, so many objective restrictions in the traditional financial industry have been widened, like the restrictions brought by regional factors. In addition, many enterprises combine internet finance with the competitive advantage of physical stores to improve their core competitiveness by grasping financial information and rational use of new technologies (Bin et al., 2018; Bogaerts et al., 2020). Compared with foreign research, domestic research on the definition of Internet finance is basically the same. Domestic scholars think that internet finance is a new financial model different from the indirect financing of commercial banks or the direct financing of the capital market. Compared with foreign research, the domestic application research of internet finance mainly focuses on electronic finance and internet lending. However, due to the imperfect management mechanism of domestic network lending platforms, financial problems emerge endlessly, so internet lending is strictly regulated. It still needs considerable accumulation and massive adjustment and improvement to reach the development of internet finance in China.

There is a big controversy about the advantages and disadvantages of internet finance in commercial banks in the current research. Some scholars believe that the integration of internet technology and finance has promoted the emergence of new businesses in the financial industry and made a revolutionary breakthrough in the traditional financial industry. Moreover, the internet provides many new technologies to improve the operational efficiency of the financial industry, reduce operating costs, and improve the overall level of the financial service industry. Contrarily, other scholars believe that the emergence of Internet finance has more disadvantages than advantages for the development of commercial banks in traditional finance. The main viewpoints of this type of scholar are reflected in the following aspects. First, although the development of Internet finance has brought rapid growth to e-commerce, the service and innovation in e-finance have struggled to keep pace with the rapidly growing e-commerce; e-financial services cannot match realistic demands (Liu et al., 2021b; Reiter et al., 2021; Wang et al., 2021b). Although electronic cash can partly compensate for the inadequacy of financial services, it is not long-term and stable due to the lack of sound national laws and policy provisions in this area. With the development of internet finance, a form of loans and investments has emerged based on social networks (Zhao et al., 2021; Tsai et al., 2021; Qiao et al., 2021). This lending platform transfers some lending businesses out of the bank's business scope, cutting the bank's operating profits to some extent. Finally, negative factors of internet financial business to the development of commercial banks are reflected in the emergence of new

forms of electronic payment, such as Alipay and Ant Credit Pay. Through online trading, currency flows directly without going through the bank. Correspondingly, the bank's customers and business are diverted, making the bank's performance further decline and indirectly leading to a large outflow of commercial bank deposits (He et al., 2020a; Khan & Yairi, 2018; Yu, 2020).

In summary, the emergence of internet finance has affected the market of traditional financial enterprises and brought new opportunities and challenges. Commercial banks are inevitably affected as one of the main bodies of traditional financial enterprises. Only by actively challenging business models and management ideas, grasping opportunities and seeking development can commercial banks stand firm in the fierce market competition. Xiang et al. (2020) examined the determinants of the use of FinTech finance by enterprises through the sampling survey, which suggested the benefits of FinTech for enterprises (Gaurav & Anil, 2021; He et al., 2020b; Liu et al., 2020; Song et al., 2020). The analysis of business integration points of internet finance and traditional commercial banks based on the DL algorithm discuss the financial conflict points and business integration and provide a new research idea and method for related studies. The algorithm is also applicable to the integration and analysis of other types of business competition relations.

Analysis of Conflicts and Integration Points between Internet Finance and Commercial Banking

Commercial banks need to analyze the direct conflict between internet finance and traditional financial business for immediate response and adjustment to the weak points to avoid risks under the impact of internet finance and successfully complete the business transformation. First, through the analysis of relevant literature and market research, the competition points and conflicts between internet finance and traditional commercial banks are summarized as in the following five aspects: 1) the competitive relationship between online lending and traditional lending business, 2) the third-party payment software shifts some deposit business of commercial banks, 3) changes in payment channels weaken the intermediary role of the financial business of banks, 4) internet finance has an impact on bank profitability, and 5) financial service requires a transformation in the context of internet finance. Based on the above five conflicts, the VAR model is adopted to analyze the correlation between internet finance and commercial banking (Lan et al., 2020; Le-Niculescu et al., 2009; Wang, 2020).

Data Source Description and Competitive Situation Analysis

According to the previous analysis, the impact of internet finance on the scale of deposits and loans of commercial banks in China is further summarized into income impact and business substitution impact. Obviously, income impact means the impact of internet finance on traditional commercial banks' profit. The impact of business substitution refers to the substitution and competition of internet finance for the original specific business of some banks. Business substitution impact is the focus of following analysis of internet finance on the deposit and loan business of commercial banks. Quarterly operating data of 15 listed banks in China from 2018 to 2020 are taken as samples, consisting of five state-owned commercial banks, seven joint-stock commercial banks, and three urban commercial banks. In detail, the five state-owned commercial banks are the Industrial and Commercial Bank of China, Bank of China, China Construction Bank, Agricultural Bank of China, and Postal Savings Bank of China. The seven joint-stock commercial banks include China Merchants Bank, Ping An Bank, Industrial Bank, and China Citic Bank. The remaining three urban commercial banks are the Bank of Nanjing, Bank of Beijing, and Bank of Ningbo. After the data classification, stationarity test, impulse response analysis, and variance tests are carried out to study the competition situation between internet finance and traditional commercial banks.

Analysis of the Business Integration of Internet Finance and Traditional Commercial Banks

According to analysis results of the competition situation of internet finance and traditional commercial banks, the BPNN model based on DL technology is constructed to simulate business integration. The business integration of internet finance and traditional commercial banks are conducted from four aspects, including capital, financial management, intermediary agent, and future development (Price & Allen, 1990). According to the integration results, suggestions and directions are put forward for the business transformation of commercial banks. The specific process of business integration is shown in Figure 2.

Figure 2. Process of business integration

First, it is necessary to select the appropriate information source to fuse different information. According to the obtained data, the experimental samples are collected and the data is pre-processed. Then, the BPNN model is adopted according to the data fusion demand. Moreover, the selected forward feedback neural network model is used to train and calculate the data (Bogusz et al., 2020; Mandalapu et al., 2021). Finally, the trained BPNN model is used to integrate the actual business of internet finance and traditional commercial banks.

ANALYSIS, RESULTS, AND DISCUSSION OF BUSINESS CONFLICTS AND INTEGRATION BETWEEN INTERNET FINANCE AND TRADITIONAL COMMERCIAL BANKS

Stationary Test of Data Sequence and Correlation Analysis Results of Business Conflicts

In the correlation analysis of business conflicts, the VCR model is adopted, so it is necessary to implement the stationary test on the data sequence before analysis. The test results are shown in Table 1.

The confidence level of the stationarity test of the data sequence is 5%. According to the test results, when the *p*-value exceeds 5%, it is regarded as non-stationary. The first-order difference of several variables is stationary sequences, including the proportion of income from financial management services of commercial banks, the return of total assets of commercial banks, income from an intermediary business, the financial scale of third-party net loan, the financial scale of net loan on Yu Ebao platform, and the financial scale of P2P (peer to peer lending) online lending platforms. Only the *p*-value of the first-order difference of interbank offered rate is greater than 0.05, which is non-stationary. The interbank offered rate is a kind of traditional financial business unrelated to internet finance, denoting the lending rate between traditional commercial banks. Therefore, it is in line with the normal logical relationship that the stationary test results of the correlation data sequence are non-stationary of the internet financial business of commercial banks.

After completing the stability test of the data sequence, according to Equation (1) of the VAR model, 2 is selected as the best lag period. The regression equations are among the financial scale of internet lending, return of total assets of commercial banks, the ratio of the loan balance to deposit balance, and the proportion of income from financial management services of commercial banks.

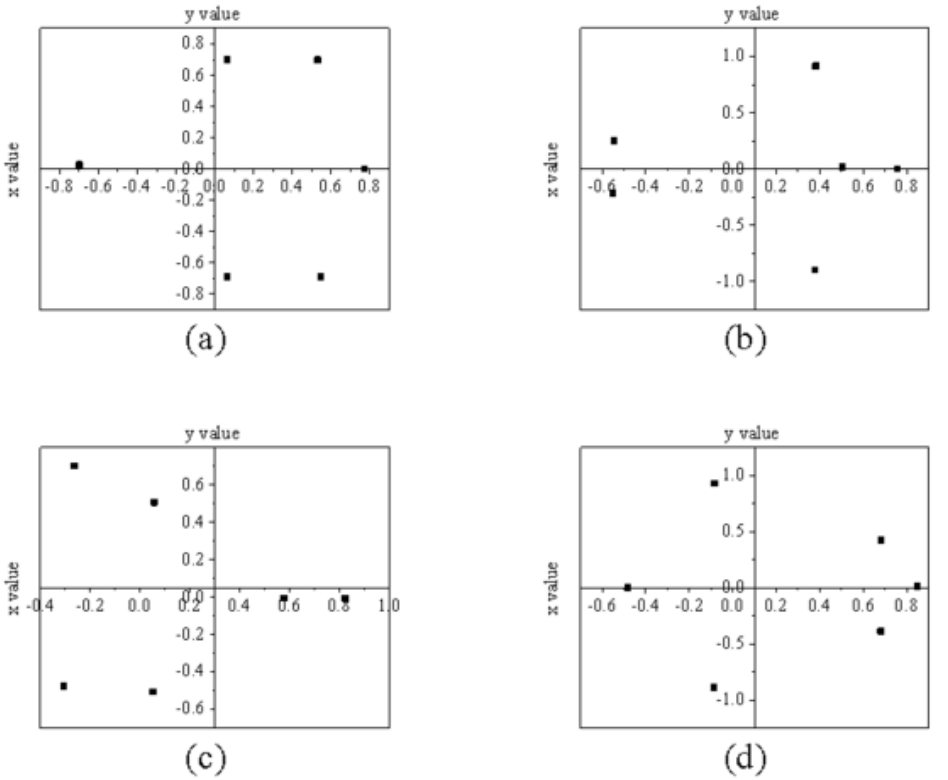
Table 1. Results of the stationary test of the data sequence

Variable	Test type	5% critical value	P value	Conclusion
Proportion of income from financial management services of commercial banks	(C, T, 1)	-1.963979	0.8929	Non-stationary
Returns on total assets of commercial banks	(C, T, 1)	-1.982344	0.3783	Non-stationary
Ratio of loan balance to deposit balance	(C, T, 1)	-1.982344	0.9732	Non-stationary
Income from intermediary business	(C, T, 1)	-1.995855	0.9689	Non-stationary
Interbank offered rate	(0, 0, 0)	-1.982344	0.5065	Non-stationary
Financial scale of third-party net loan	(C, 0, 3)	-1.982344	1.0000	Non-stationary
Financial scale of net loan on Yu Ebao platform	(C, 0, 3)	-1.982344	0.9997	Non-stationary
Financial scale of P2P online lending platforms	(C, 0, 3)	-1.982344	0.5992	Non-stationary
Proportion of income from financial management services of commercial banks C	(C, T, 0)	-4.450425	0.0055	Stationary
Return of total assets of commercial banks C	(C, T, 0)	-3.404311	0.0002	Stationary
Ratio of loan balance to deposit balance C	(C, T, 0)	-3.404311	0.0003	Stationary
Income from intermediary business C	(C, T, 0)	-3.404311	0.0001	Stationary
Interbank offered rate C	(0, 0, 0)	-3.818975	0.1527	Non-stationary
Financial scale of third-party net loan C	(C, 0, 3)	-3.269808	0.0007	Stationary
Financial scale of net loan on Yu Ebao platform C	(C, 0, 3)	-3.259808	0.0362	Stationary
Financial scale of P2P online lending platforms C	(C, 0, 3)	-3.320969	0.0106	Stationary

Note. C represents the first-order difference of the preceding content.

Then the characteristic root method is used to solve the equations. The solution results are shown in Figure 3.

Figure 3. Regression results of the VAR model



Note. (a), (b), (c), (d) represent the characteristic root results of four regression equations

Figure 3(a) is the characteristic root of the regression equation between the proportion of the financial business income of commercial banks and the financial scale of Internet lending. Figure 3(b) shows the characteristic root of the regression equation between the return of total assets of commercial banks and the financial scale of Internet lending. Figure 3 (c) represents the characteristic root of the regression equation between the ratio of the loan balance to deposit balance and the financial scale

Table 2. Results of the integrated of order 1

Hypothesized No.of CE(s)	Eigenvalue	Statistic	Critical value 0.05	Prob.**
None*	0.480356	140.0012	69.99925	0.0000
At most1*	0.254182	62.9843	47.78175	0.0010
At most2*	0.177571	30.36928	29.67542	0.0429

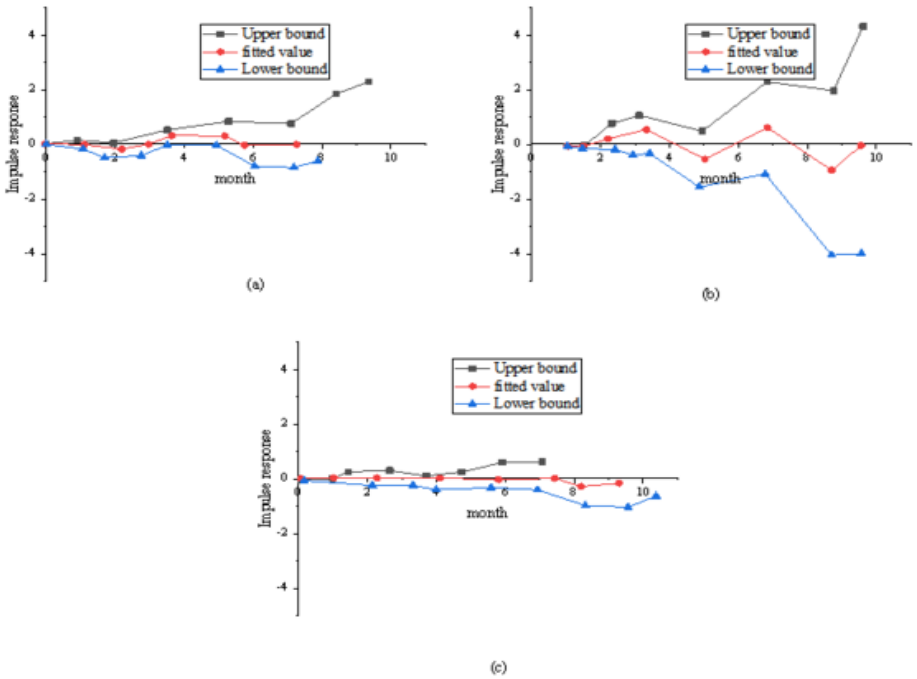
of internet lending. Figure 3(d) shows the characteristic root of the regression equation between the income from intermediary business and the financial scale of Internet lending. From Figure 3, the absolute values of all characteristic roots of the four regression equations are less than 1. According to the stability test index, when the absolute value of the characteristic root of the regression equation is less than 1, the data sequence of the regression equation can be judged to be stationary. After the stationarity test, the integration of order 1 is used to test the variables of the regression equation. Table 2 shows the test results of the integrated order 1.

In the cointegration test, it is first assumed that there is no cointegration relationship between variables. According to the cointegration test results in Table 2, the value of Prob is less than 0.05, indicating that the hypothesis is not valid. That is, there is a cointegration relationship between all variables. In conclusion, there is a long-term and stable equilibrium relationship among the financial scale of internet lending, the proportion of the financial business income of commercial banks, the return of total assets of commercial banks, the ratio of the loan balance to deposit balance, and income from the intermediary business.

It is necessary to further study the impact and influence of the financial scale of internet lending on traditional commercial banking. Therefore, the impulse response function is conducted between the financial scale of internet lending and the proportion of the financial business income of commercial banks, the return of total assets of commercial banks, the ratio of the loan balance to deposit balance, or the income from the intermediary business. Figure 4 shows the impulse response of the proportion of the financial business income of commercial banks to the financial scale of internet lending.

Note. (a) represents the impulse response of the variable to the third-party payment service, (b) represents the impulse response of the variable to P2P online lending platforms, and (c) denotes the impulse response of the variable to the Yu Ebao platform

Figure 4. Impulse response of the proportion of commercial banks' income to internet lending businesses



The impulse response function can be used to analyze the dynamic impact of the change in the financial scale of internet lending on commercial banking. Figure 4 shows that the impact of internet finance on the financial services of commercial banks has formed a wave of impulse responses. The three different financial scale changes of internet finance result in diverse impacts on commercial banking. First, the third-party payment service decreases the profit of commercial banks. Second, the expansion of the business scale of P2P lending platforms has brought a great impact on the profits of commercial banks, especially ranging from April to June and from July to September. In addition, the financial scale of the Yu Ebao platform also causes a small diversion of financial services of commercial banks. Figure 5 shows the impulse response of the return of total assets of commercial banks to the internet lending business.

Note. (a) represents the impulse response of the variable to the third-party payment service. (b) represents the impulse response of the variable to P2P online lending platforms. (c) denotes the impulse response of the variable to the Yu Ebao platform)

Figure 5. Impulse response of the return of total assets of commercial banks to internet lending businesses

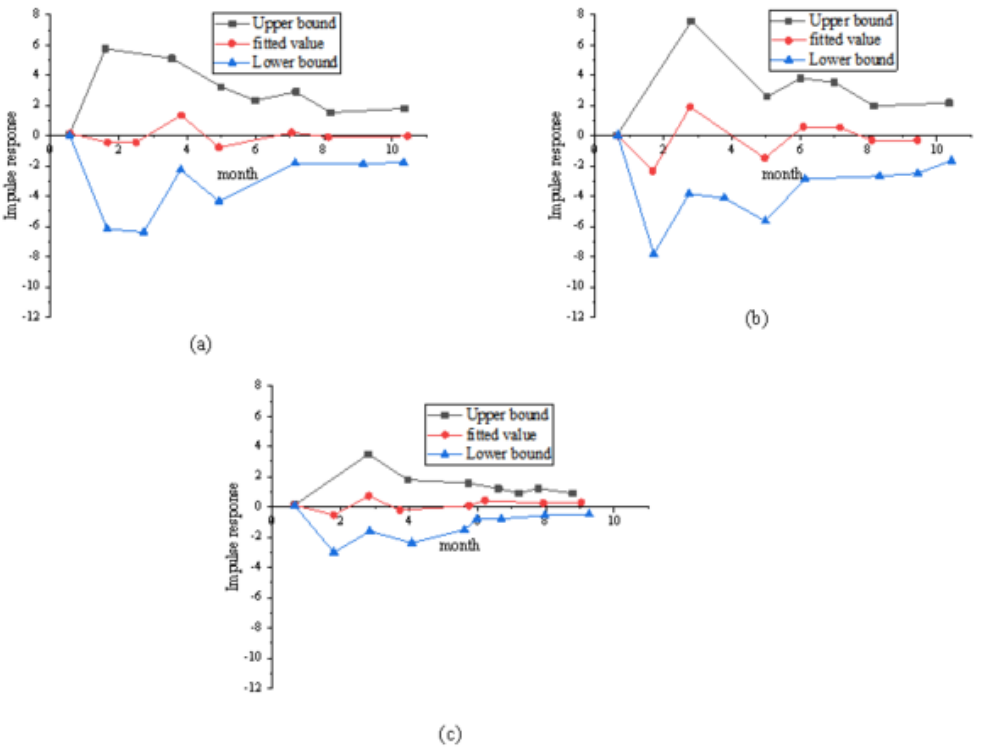


Figure 5 shows that the three services of the internet lending businesses have caused a very big impact on the return of total assets of commercial banks before June. The three kinds of impact show the same tendency. Among them, P2P lending platforms have the greatest impact, followed by the third-party payment service. The impulse response results of the ratio of the loan balance to deposit balance to the internet lending business are shown in Figure 6.

Note. (a) represents the impulse response of the variable to the third-party payment service, (b) represents the impulse response of the variable to P2P online lending platforms, and (c) denotes the impulse response of the variable to the Yu Ebao platform.

Figure 6. Impulse response of the ratio of loan balance to deposit balance to internet lending businesses

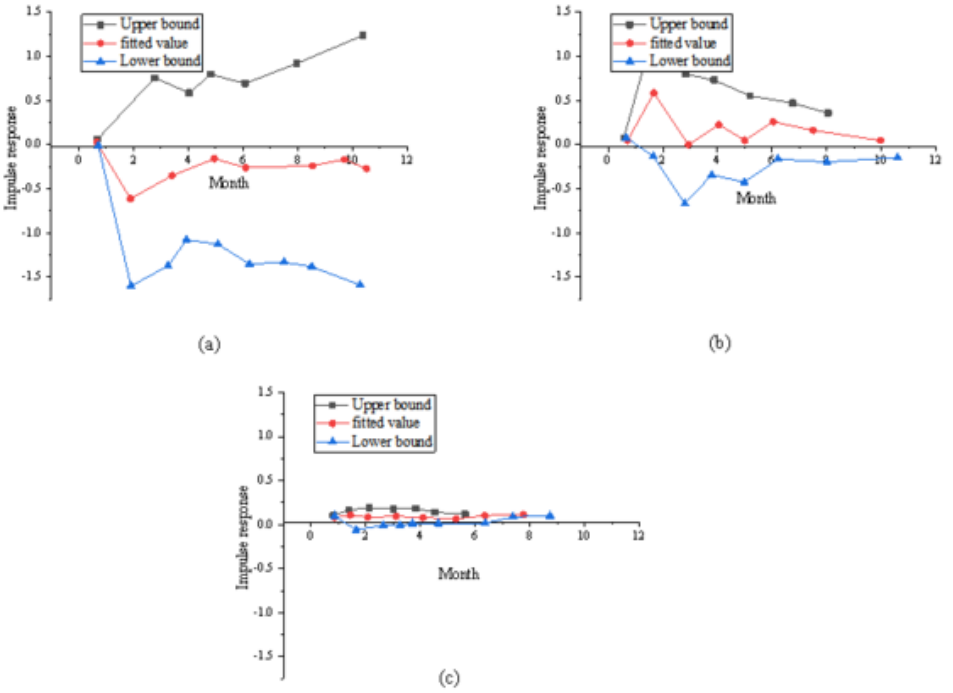
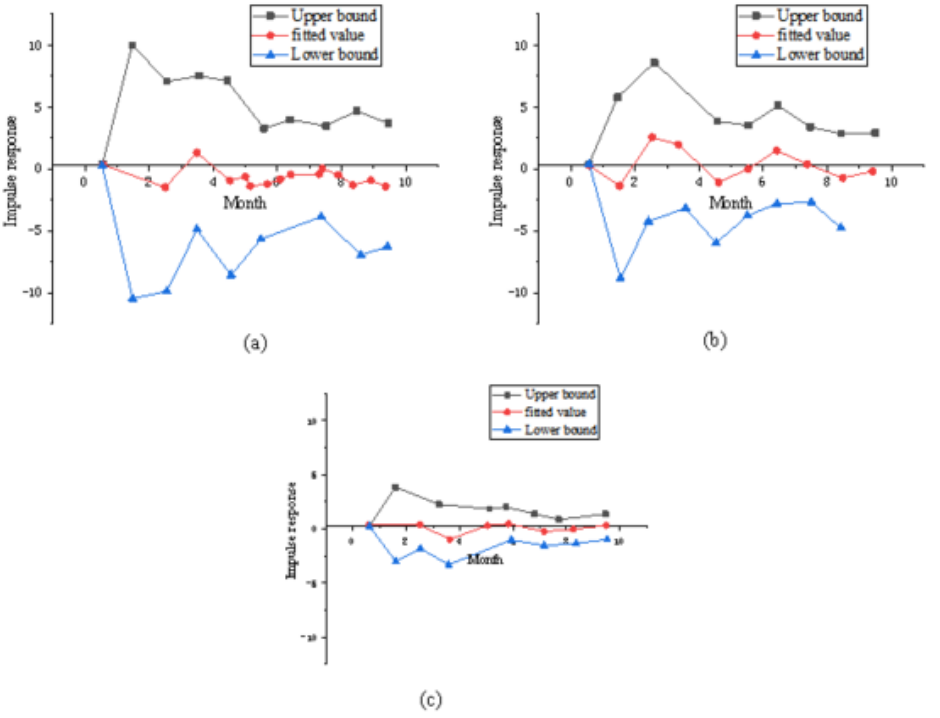


Figure 6 shows that the third-party payment service has the greatest impact on the ratio of the loan balance to deposit balance. Later, the impact tends to shrink with the development of internet payment and the adjustment of banks' businesses. Furthermore, although P2P online lending platforms have a greater impact on the ratio of the loan balance to deposit balance before April, this impact shows a decrease rather than an increase. Finally, the Yu Ebao platform has almost no impact on the ratio of the loan balance to deposit balance since it does not involve loans and deposits business. The impulse response results of the income from intermediary businesses to internet lending businesses are presented in Figure 7.

Figure 7. Impulse response of the income from intermediary businesses to internet lending businesses



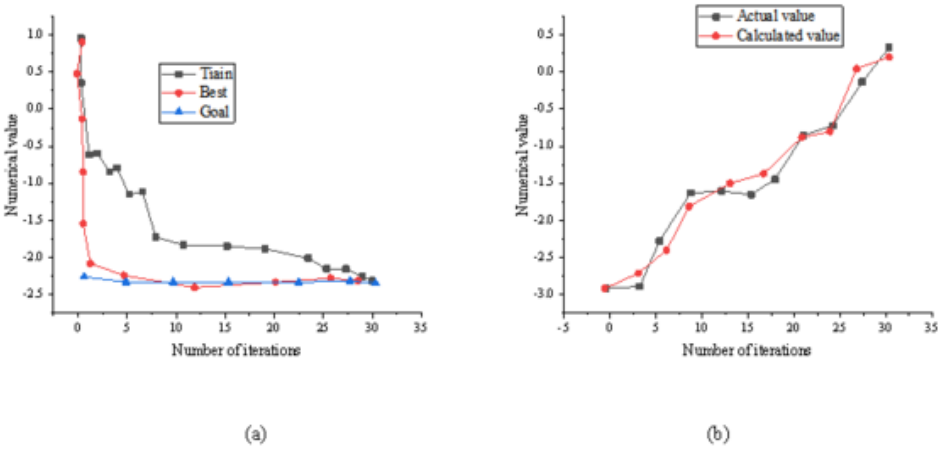
Note. (a) represents the impulse response of the variable to the third-party payment service, (b) represents the impulse response of the variable to P2P online lending platforms, and (c) denotes the impulse response of the variable to the Yu Ebao platform.

According to Figure 7, as the scale of the internet lending business continues to expand, the initial intermediary business of commercial banks has been greatly affected, and this effect lasted for a long time. However, as time passes, the intermediary business of internet finance and traditional commercial banks has gradually become integrated. In the short term, the expanding business scale of internet finance has had a huge impact and influence on the business of traditional commercial banks. However, over time, this influence has been gradually eliminated, and the two have shown a trend of integration. Therefore, in the future, internet finance and commercial banks will move toward mutual integration and common development. The research here involves business conflicts and changes in the situation between internet finance and traditional commercial banks in different periods of time, with the results presented in the form of pulses, which are more intuitive.

Integration Effect of the BPNN Model for Internet Finance and Traditional Commercial Banking

According to the results of the business correlation and conflict between internet finance and commercial banks, the integration simulation is conducted by the BPNN model based on the DL algorithm according to the business process are shown in Figure 2. The integration error calculation results are shown in Figure 8.

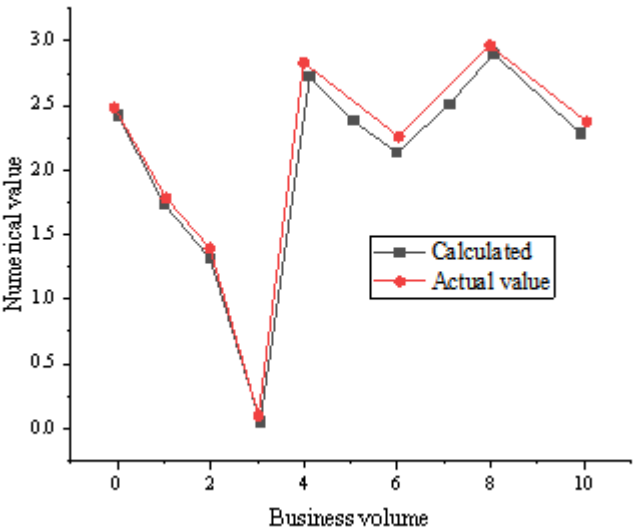
Figure 8. Results of regression training and error calculation of the BPNN model



Note. (a) represents the number of iterations in which the model converges to the optimal value and (b) represents the comparison of integration errors.

Figure 8 shows the BPNN model converges to the optimal value after 32 iterations in the regression training. The error of the model after integration is within 0.5%. Data of other banks are selected for further experiments to further verify the integration error of the model, and the verification results are shown in Figure 9.

Figure 9. Verification results of regression testing of the BPNN model



In Figure 9, the verification of the integration effect of the model shows that the trained model can accurately calculate the optimal solution in different banks' business information data. According to the fused data, the BPNN model estimates commercial information with an accuracy rate of more than 95%. The results show that the business integration model of internet finance and commercial banks based on BPNN can spontaneously learn effective information in the business of commercial banks and internet finance. Further, it can automatically find the optimal solution of the business integration point with high accuracy.

CONCLUSION

The DL algorithm is used to find the combination point and future development trend of internet finance and traditional commercial banking, starting from the business conflict between internet finance and commercial banks in traditional financial enterprises. Meanwhile, the DL algorithm integrates internet finance and traditional commercial banking based on the BPNN model. The results show that internet finance and traditional financial enterprises have diversified businesses, indicating that the conflict has a trend of integration with potential optimization. The business integration model of internet finance and commercial banking based on BPNN can spontaneously learn effective information in the business of commercial banks and internet finance. Moreover, it can automatically find the optimal solution of the business integration point of internet finance and traditional commercial banking through calculating and accurately judging their business information. The following suggestions are proposed for the business transformation of existing traditional financial enterprises based on the research results: 1) improve service strategies and increase attention to customer service, 2) proactively innovate in the search for more integration points between Internet finance and existing traditional financial business and undertaking new business, and 3, build an online financial platform. It is worth noting that future research could look for more integration points of internet finance and traditional financial business based on the above three suggestions.

COMPLIANCE WITH ETHICAL STANDARDS

This article does not contain any studies with human participants or animals performed by any of the authors.
Informed consent was obtained from all individual participants included in the study

AUTHOR CONTRIBUTIONS

Changlin Wang contributed to writing (original draft preparation, formal analysis, data curation), conceptualization, and methodology.Siting Liu contributed to writing (review and editing), visualization, and supervision. All authors have read and agreed to the published version of the manuscript.

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