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Impact of payment technology innovations on the traditional financial industry: A focus on China

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ABSTRACT

With the rapid advent of e-commerce in China, the technological innovation of third-party payment has experienced explosive growth. This important technological innovation, initiated by emerging Internet companies, is helping the traditional financial industry's payment business—represented by commercial banks—expand in both depth and breadth. Meanwhile, there is also a large degree of substitution, competition and crowding out among these banks in terms of the traditional financial industry's basic payment and settlement functions, potential customers, deposit and loan services and traditional intermediary business. This paper explores the impact (episodic and long-term steady-state) of the technological innovation of payment on commercial banks. It also considers the impact of technological innovation on industrial evolution to clarify whether technological innovation offsets the advantages of traditional industries or promotes industrial development. This study adopts the Vector Auto-Regression (VAR) impulse response model to analyze the impact of Internet Third-Party Payment (TPP) on the traditional financial industry from 2007 to 2014. The empirical results suggest that in China, third-party payments have had a significant positive correlation with the value creation capabilities of traditional financial industries, and that this relationship tends to remain in a steady state in the long term. Based on these findings, this paper confirms that the technological innovation of methods of payment in emerging economies, such as China, has promoted the development of the financial industry and accelerated the process of industrial evolution. We conclude the paper with feasible policy suggestions.

1. Introduction

New information technologies, especially the Internet, have changed modern commercial activities (Gu et al., 2016; Zhao et al., 2016). In recent two decades, e-commerce market grows rapidly with the growth of the Internet across the world (Wang et al., 2008). *E*-commerce has advantages, such as around-the-clock availability, speed of access, a wider selection of goods and services, accessibility, and international reach (Xiang and Jing, 2014). Recently, the Internet of Things (IoT) and cloud computing have been widely applied in supply chain, logistics, and transportation (Bi et al., 2014; Cai et al., 2014; Gorkhali and Xu, 2016; Fang et al., 2014; Jiang et al., 2014; Kim, 2017; Li et al., 2013; Liu et al., 2016, 2017; Whitmore et al., 2015; Xie et al., 2017; Xu, 2011; B. Xu et al., 2014; L. Xu et al., 2014; Yang et al., 2018; Yin et al., 2016). These technologies further boost the development of e-commerce. Particularly, mobile Internet makes it possible for consumers to do purchase at anytime from anywhere (Linck et al., 2006). However, the traditional payment methods are not fit for e-commerce. For example, buyers worry that product quality may not turn out as expected, whereas sellers worry that they may not receive payment after mailing out products. Credit risks between buyers and sellers, identity theft, fraudulent cards, and Internet fraud are the main obstacles to e-commerce (Cheng et al., 2017).

Known as non-financial institution payment services, Internet third-party payment (TPP) refers to payment services provided on a neutral payment platform by non-financial institutions; these services are connected to the bank payment and settlement systems of e-commerce companies and commercial banks. This platform enables online payment and settlement functions, including online transfers and bankcard receipts, etc. (People's Bank of China, 2010). TPP arose as a way to resolve problems of trust and financial transaction security between buyers and sellers (Cheng et al., 2017). It is able to effectively promote the convenience and applicability of traditional cash payments, money transfers, and bank card payments by utilizing innovative payment technology supported by the internet. First introduced in the U.S. in 1998, PayPal is a pioneer company committed to providing online

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payment services. Its third-party payment platform guarantees the transaction security of both buyers and sellers in e-commerce environments (Micu and Micu, 2016). In China, credit risk is a major obstacle in the development of e-commerce market (Yan and Chang, 2007). Accordingly, Alipay (also known by its Chinese name ZhiFuBao) was the first online payment intermediary introduced to China and is now China's most commonly used third-party online payment system. Tencent, a leading social networking service provider, has developed WeChat payment. Because of the lack of financial infrastructure for credit and debit cards in China, TPP becomes the main payment method among Chinese consumers (Cheng et al., 2017). The operating pattern, trading volume, and business scope of TPP have changed dramatically during the past decade. According to iResearch (2017), the Gross Merchandise Volume (GMV) of the TPP market amounted to RMB2.3 trillion (US$0.35 trillion) in 2011 and reached RMB24.1 trillion (US $3.65 trillion) in 2015. The rapid development of information technology and the Internet has changed the payment model of Chinese consumers. Also, the factors that influence payment technology innovation and the mechanisms by which technological innovation drives the evolution of the financial industry are becoming increasingly complex. Therefore, it is necessary to research the mechanism that exists between technological innovation and the evolution of the traditional financial industry from a new perspective.

This paper examines the following problems through theoretical analysis and empirical research: a) Is the influence of TPP technological innovation on the traditional financial industry positive or negative? b) What is the influence mechanism and its equilibrium state? c) What is the impact of TPP on the processes of industrial evolution, industry synergy and industry differentiation? This paper provides a reference for decision-making about payment technology innovation, industrial development and associated research in emerging economies.

2. Theoretical framework

Technological innovation is the fundamental driving force of industrial evolution. Schumpeter (1912) built the theory of innovation based on the combination of technology and economics. He proposed the concept of innovation to argue that technological change leads to unbalanced economic growth and unstable social development. He believed that innovation is the driving force behind economic development and promotes industrial change and economic structural changes. He borrowed biological terminology to refer to the process of constantly reforming the economic structure from the inside; that is, constantly destroying the old structure and creating a new one by means of industrial mutations. Later scholars expanded Schumpeter's theory of innovation to discuss the relationship between technological innovation and industrial evolution. In recent years, with the development of evolutionary economics, some scholars have begun to explore the process and mechanism of technological innovation that promotes industrial evolution from a dynamic perspective. Among them, the most representative research results are Abernathy and Utterback's (1978) industrial innovation dynamic process model—the A-U model. This model suggested that an enterprise's product innovation and technological innovation are correlated. The type and frequency of innovation depend on the industry's growth stage. In the early stages of industrial development, enterprises focus on product innovation. With the emergence of leading design, industries step into the transition phase, in which the focus of innovation turns to technology innovation. When an industry develops into a stable stage, the enterprise's innovation activities are concentrated on incremental product innovation and technology innovation. The A-U model reflects the distribution pattern of innovation in the process of industry development and provides an important clue to understanding the relationship between technology innovation and industrial evolution.

2.1. Payment technology innovation and industry evolution from the perspective of supply

Technology innovation from the supply side, especially financial technology innovation, comes from the spillover and development of technical knowledge (Kauffman et al., 2014). By generating new technologies or reorganizing existing technologies, enterprises can provide consumers with new applications in the financial industry (Tornatzky and Fleischer, 1990). Currie and Seltsikas (2001) argued that entrepreneurial efforts to create new technologies drive an organization's technological transformation and adoption. Technological innovation in the financial market has affected the value proposition provided by the enterprise to the customer. It is critical to understand the sources of technological innovation and take advantage of investment and market opportunities. Technological innovation benefits innovators and adopters and also benefits the overall market (Frame and White, 2004). The convenience brought about by technological innovation supports financial innovation from the demand side (Lerner and Tufano, 2011; Lyytinen and Rose, 2003). Is the supply perspective applicable to payment technology innovation? Why is the developing speed and popularity of third-party payment in China more significant than that of developed countries with a richer technology supply, such as the United States? It can be seen that the innovation of payment technology is more likely in developing economies like China because China's credit system is relatively weak, and consumers are more in need of third party agencies as a credit guarantee for payment. Payment technology innovation in emerging economies is likely to be driven by demand.

2.2. Payment technology innovation and industry evolution from the perspective of demand

In recent years, some scholars have realized the importance of demand for technology innovation and analyzed the relationship between technology innovation and industrial evolution from the aspects of demand space, demand heterogeneity, demand conditions and demand constraints. Adner and Levinthal (2001) expounded on the process of dynamic technological innovation from the perspective of demand space and explained the relationship between technology development and the demand environment by using the concept of heterogeneous thresholds. A heterogeneous threshold is the minimum standard that must be met by the technology or product when adopting a technology or purchasing a product. By conducting theoretical research, Sun and Zheng (2010) argued that the conclusion of the relationship between technological innovation and industrial evolution based on heterogeneous market demand (Adner and Levinthal, 2001) is basically consistent with the A-U model. The choice of consumers often depends on the level and preferences of individual needs. The resulting differentials in demand will affect the speed of enterprises' technological innovation, and thus affect the process of industrial evolution. Saviotti (2001) argued that the differentiation in consumer's perception of the product is an important factor in industrial evolution. Consumers will not form preferences for new products in a short period of time—not even for new products with high applicability. Only when the conditions are ripe, will consumers accept new products. In the case of an identical demand scale, if competition within a product category is more intense than cross-product competition, new and old products can coexist in the market and products will tend to diversify. The reason for this is that even if the performance of the new product is better than that of the old product, the product with poor performance will not be substituted because of the cognitive differentiation of customers. However, when the difference between the new and old products is too great for one to replace the other, the two products can coexist in the market. It can be inferred that consumer perception differentiation and product differentiation will weaken competition, and the benefit of weakening market competition is the increasing degree of product diversification. It is conceivable that if new products completely replace old products,

products with better applicability will eliminate other products on the market, resulting in a decline in product diversification and thus constraining economic development. Therefore, according to Saviotti (2001), consumers' perception differentiation in terms of demand facilitates the healthy and sustained development of industries by means of technology innovation. Windrum et al. (2009) have reached similar conclusions by studying consumer trade-offs and the development of environmentally friendly technologies.

2.3. Two paths of industrial evolution resulting from payment innovation

Arthur (1989) argued that technology innovation can bring economic benefits to companies and induce an incremental return mechanism. Technology plays a key role in the process of industrial evolution: in the process of technology and industry co-evolution, diversified behavior causes market competition. With the market selection mechanism, some technology is eliminated while some survives and gradually becomes dominant, resulting in industrial differentiation. Yet some technology promotes the coordinated development of industry due to industry cohesion, which leads to dependence in the overall industry's technological innovation path. Pavitt (1984) examined the relationship between technology innovation and industrial evolution by building an industry-dependent model based on technology innovation. The research shows that there are significant differences in technology innovation among various industries: some technology innovations lead to industrial differentiation while others promote industrial synergy. Antonelli (2003), however, took the IT industry as an example and found that the demand innovation of users is the motive for technology innovation. The innovation of demand leads to the differentiation of the original industrial system; that is, the recession of the old industry and the emergence of new industry, which leads to the continuous evolution of the industry.

Demand from small and medium enterprises (SMEs) for financial services has become more and more diversified in China. Conventional financial institutions may not satisfy theses needs (Lin and Li, 2001). Safarzyńska and Van den Bergh (2016) conducted research on macro-evolutionary modelling of technology, finance and energy interactions. Their work captured interactions between technological, financial and energy systems. The interactions between technological and financial systems demonstrated the positive influence of energy technology on financial stability. Nicita and Pagano (2016) made an extension of the organizational equilibria approach to the analysis of the institutional complementarities. Ma (2005) utilized the Nash Equilibrium to explore whether TPP companies and banks can reach a cooperation pattern. Specifically, he proposed that they choose to compete with each other, instead of collaborating, for profit maximization. Thanks to Internet technology and mobile Internet services, Internet TPP platforms provide more convenient money clearing services as compared to banks. TPP companies have become a multi-dimensional platform that provides services to both upstream and downstream firms. These TPP companies attract numerous target customers with lower charges and more flexible services. Therefore, Internet TPP platforms have generated challenges and threats to traditional banks in terms of loans and deposits, intermediate business, and internet banking. This has breached the initial agreement (banks serve big clients and TPP companies serve small customers) between banks and TPP companies (Bei, 2011).

2.4. Qualitative research on industrial evolution from the perspective of residual income

Profitability is one of the most commonly used methods to assess bank performance. Many studies have been conducted to compare the profitability of TPP and commercial banks (Bei, 2011; Deng, 2009; Ma, 2005). There are two categories of bank profitability: internal factors and external factors. The internal factors refer to determinants within the banks themselves. Research on internal factors includes size, capital, and risk management. Akhavein et al. (1997) and Smirlock (1985) found that bank size has a positive and significant influence on banks' profits. Additionally, large banks tend to raise capital less expensively, resulting in more profits (Bikker and Hu, 2002; Bourke, 1989; Short, 1979). However, Berger et al. (1987) argued that large banks cannot save much by increasing their size. With high credit risk, more loans will go unpaid and thus banks' profits will go down. Miller and Noulas (1997) stated that there is a negative relationship between credit risk and bank profit. On the other hand, external factors refer to banks' external environmental variables (Athanasoglou et al., 2005). External factors can be summarized as the macroeconomic environment, market concentration, industry size, and ownership status. Inflation may have a positive effect on profits only when the bank management adequately adjusts inflation expectations, as well as manages expenses in an efficient way (Perry, 1992; Revell, 1979). Bourke (1989) and Molyneux and Thorton (1992) argued that market concentration is positively related to bank profits. However, other researchers found that market concentration may not be related to banks' profitability (Berger, 1995). The results are controversial for ownership status. Some researchers argued that there is a weak relationship between ownership status and profitability (Bourke, 1989; Molyneux and Thorton, 1992). But, Barth et al. (2004) claimed that state-owned banks exhibit low profitability.

The drawback of evaluating banks using profitability can be mitigated by using bank values. First, widely-used profit indicators such as ROE and ROA (Athanasoglou et al., 2005; Gul et al., 2011; Olson and Zoubi, 2011) ignore the cost of equity. They only provide how much the asset/equity can earn during a certain period, but do not consider that there is a cost related to the equity provided. Only returns that exceed the cost of equity are beneficial to shareholders (Kyriazis and Anastassis, 2007). Second, data for the profitability calculation comes from listed companies' public announcements. Top management tends to rectify earnings due to the agency problem (Atik, 2009; Bikker and Metzemakers, 2002;). Third, profit ratios such as ROE and ROA can only reflect the status quo of companies with regard to their operational activities (Elton, 1999). Research on bank values suggests that valuation indicators such as Economic Value Added (EVA) can overcome the shortcomings associated with profit ratios (French and Cooper, 2000). Thus, it is generally possible to objectively evaluate the impact of technological innovation on the traditional financial industry using the residual income indicator - EVA. EVA is also helpful for determining whether the impact detected is industry differentiation or industry synergy.

In summary, current research from China and other countries is more inclined to the argument that third-party payment challenges the traditional financial industry. There is little data to support empirical research in the relevant literature. The theoretical implications of theoretical assumptions are not widely validated. Further exploration is needed in this field. This paper contributes in the following aspects: a) it explores the impact of technological innovation on the upgrading of the financial industry in emerging economies through a new perspective of empirical research; b) it supplements and perfects theories of technological innovation and industrial evolution and provides empirical research and analysis on related areas; c) it provides the emerging economies with the mechanism of the impact of third-party payment technological innovation on industrial evolution, which is innovative to the research object; d) it provides policy advice for technological innovation and industry integration. Based on the above discussions, we formulate the following hypothesis:

H1. TPP trading volume has a positive impact on AES in the financial industry.

3. Methods

3.1. Sample

Regarding the finance industry, the sample consists of all seventy-three listed companies that are categorized as financial institutions on the Shanghai and Shenzhen stock exchanges. An eight-year period (2007–2014) is used to ensure the reliability and the availability of data record. We utilized quarterly data for the number of samples required for empirical study. EVA related data is extracted from the China Stock Market & Accounting Research (CSMAR) Database - one of the most authoritative databases in the economic and financial fields in China. Information on TPP trading volume is gathered from the iResearch Consulting Group. The final dataset generates 2336 observations, which include all 73 listed companies in China's financial industry. The empirical research software used is EViews 8.0. In this research, third-party payment trading volume is the independent variable and Economic Value Added per share in the financial industry is the dependent variable.

3.2. Independent variables

3.2.1. TPP trading volume

TPP firms offer all kinds of payment services using Internet technology and mobile communication technology. They provide diversified and personalized products, and allow for payment types that are not offered by commercial banks. TPP has become an important part of the modern payment system. The term TPP as used in this paper refers to the total amount of funds incurred by the user through the payment transaction platform, including account payments, gateway payments, and inter-account transfers.

3.3. Dependent variables

3.3.1. Average EVA per share

Many scholars use profitability ratios such as ROE and ROA to represent financial companies' overall profitability (Athanasoglou et al., 2005; Gul et al., 2011; Olson and Zoubi, 2011). However, we adopted EVA, which is also a performance measure, to measure the values of companies in the financial industry (Shil, 2009). EVA was developed by a consulting company called Stren Stewart & Co. in the United States. It is a measure to assess how much the company has generated for its shareholders. Since EVA focuses on operating cash flows rather than earnings, which can be manipulated by accountants (Jackson, 1996), many scholars have adopted EVA to evaluate company performance and value (Heffernana and Fu, 2010; O'Byrne, 1996; Zheng, 2014). By taking a company's scale into account, EVA per share is used in this paper. It can reflect the operating results more effectively and measure the profitability and investment risks of ordinary shares. It is one of the most important financial indicators used by shareholders and stakeholders to evaluate the profitability of enterprises, to predict the growth potential of enterprises, and to make relevant economic decisions. Therefore, the average EVA per share (AES) of the financial industry is used in this paper as the dependent variable.

3.4. Model specification

3.4.1. Vector Auto-Regression (VAR) model

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{p-1} + \varepsilon_t;\ Y_t = \begin{bmatrix} AES \\ TPP \end{bmatrix} \quad (1)$$

Y_t represents the two-dimensional endogenous variable vector composed of AES and TPP in the VAR model. A denotes the corresponding 2 × 2 coefficient matrix. P denotes the lagged order of the endogenous variables. ε_t is the residual vector of 2 × 1 that satisfies $E(\varepsilon_t) = 0$ and $E(\varepsilon_t, \varepsilon_t') = \Omega$.

Table 1
Augmented Dickey-Fuller Unit Root Test on AES and TPP.

Augmented Dickey-Fuller Unit Root Test on AES			
Null hypothesis: AES has a unit root			
Exogenous: constant, linear trend			
Lag length: 1 (automatic - based on SIC, maxlag = 7)			
		t-Statistic	Prob.[a]
Augmented Dickey-Fuller test statistic		−0.024939	0.9939
Test critical values	1% level	−4.296729	
	5% level	−3.568379	
	10% level	−3.218382	
Augmented Dickey-Fuller Unit Root Test on TPP			
Null Hypothesis: TPP has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 7 (automatic - based on SIC, maxlag = 7)			
		t-Statistic	Prob.[a]
Augmented Dickey-Fuller test statistic		3.729503	1.0000
Test critical values	1% level	−4.394309	
	5% level	−3.612199	
	10% level	−3.243079	

[a] MacKinnon (1996) one-sided p-values.

3.4.2. Lag intervals

Both the impulse response function and cointegration test are sensible to the number of lag intervals. Different lag intervals can cause a significant difference in cointegration tests. According to the Lag Length Criteria, we choose 3 as the number of lag intervals under the principle of AIC & SC minimization.

4. Results

4.1. Unit root test and cointegration test

Since the impulse response function depends on the assumption that time series are stationary, we first test the stationarity of TPP and AES by using the Augmented Dickey-Fuller (ADF) test method (Dickey and Fuller, 1979). Test results indicate that TPPSA and EVASA series are non-stationary with a significance level of 5%, as illustrated in Table 1. However, their first order differential sequences are stationary, as shown in Table 2. Therefore, the following empirical studies are based on the first order differential sequence of TPP and AES—namely, DTPP and AES—to establish the VAR model. Meanwhile, in order to determine whether there is a long-term relationship between variables, this paper uses the Johansen test method to conduct cointegrated analysis on the linear relationship of these two time series. Table 3 presents the results of cointegration by using the Trace and Maximum Eigenvalue test of DTPP and DAES.

As shown in Table 3, the Trace Test and Maximum Eigenvalue Test results are consistent. At a 0.05 significance level, we rejected the null hypotheses, which indicated no cointegration relationship. Therefore, it can be inferred that there is one set of cointegration relationships between DTPP and DAES.

Table 2
Augmented Dickey-Fuller Unit Root Test on DAES and DTPP.

Augmented Dickey-Fuller Unit Root Test on DAES			
Null Hypothesis: DAES has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 0 (Automatic - based on SIC, maxlag = 7)			
		t-Statistic	Prob.[a]
Augmented Dickey-Fuller test statistic		− 6.588708	0.0000
Test critical values	1% level	− 4.296729	
	5% level	− 3.568379	
	10% level	− 3.218382	
Augmented Dickey-Fuller Unit Root Test on DTPP			
Null Hypothesis: DTPP has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 1 (Automatic - based on SIC, maxlag = 7)			
		t-Statistic	Prob.[a]
Augmented Dickey-Fuller test statistic		− 4.690709	0.0041
Test critical values	1% level	− 4.309824	
	5% level	− 3.574244	
	10% level	− 3.221728	

[a] MacKinnon (1996) one-sided *p*-values.

Table 3
Johansen cointegration test.

Johansen cointegration test				
Sample (adjusted): 2008Q2 2014Q4				
Included observations: 27 after adjustments				
Trend assumption: linear deterministic trend				
Series: DAES DTPP				
Lags interval (in first differences): 1 to 3				
Unrestricted cointegration rank test (trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.[b]
None[a]	0.661570	29.52729	15.49471	0.0002
At most 1	0.010114	0.274467	3.841466	0.6003
Unrestricted cointegration rank test (maximum eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.[b]
None[a]	0.661570	29.25283	14.26460	0.0001
At most 1	0.010114	0.274467	3.841466	0.6003

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.
[a] Denotes rejection of the hypothesis at the 0.05 level.
[b] MacKinnon et al. (1999) *p*-values.

4.2. VAR model and impulse response function

4.2.1. Stationary test of VAR model

The long-term validity of the relationship between the endogenous variables in the VAR model depends on the model's stability. Since two endogenous variables exist, and the lag interval is 3, there are six roots. Fig. 1 shows the unit circle of the inverse roots. It can be found that the absolute value of all inverse roots is less than 1 and falls within the unit circle. Hence, the VAR model passes the stability test.

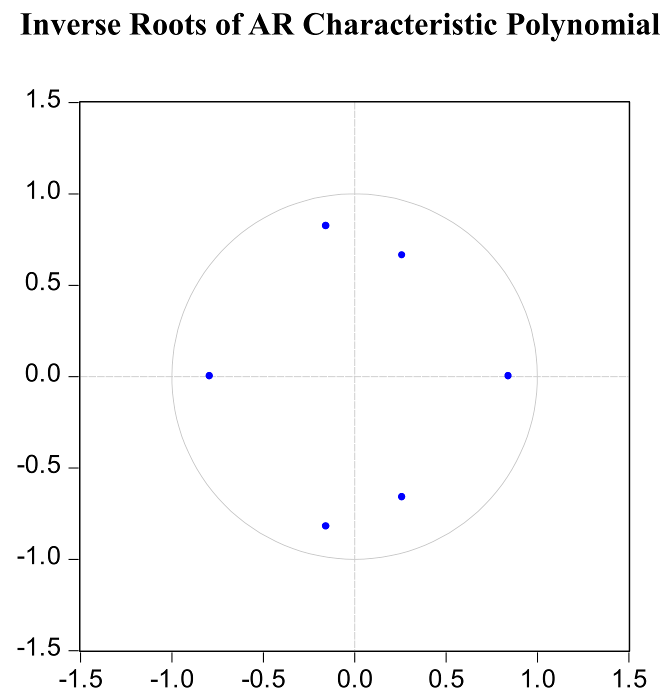

Fig. 1. Inverse roots of AR characteristic polynomial.

4.2.2. Model specification

We took 32 sets of data from the first quarter of 2007 to the fourth quarter of 2014 as the sample and built a model with the explanatory variable being TPP and the explained variable being AES. We also derived first order differential sequences of the original data in consideration of the data stationarity. The results of the VAR model are shown in Table 4.

From Table 4, the following model expression can be derived:

Table 4
Vector autoregression estimates.

Vector autoregression estimates		
Sample (adjusted): 2008Q1 2014Q4		
Included observations: 28 after adjustments		
	DAES	DTPP
DAES(-1)	− 0.488050	− 6374.334
	(0.23151)	(10,181.1)
	[− 2.10813]	[− 0.62609]
DAES(-2)	− 0.119940	2567.851
	(0.24571)	(10,805.8)
	[− 0.48813]	[0.23764]
DAES(-3)	− 0.337663	3361.259
	(0.22463)	(9878.63)
	[− 1.50319]	[0.34026]
DTPP(-1)	1.48E − 05	0.758612
	(4.7E − 06)	(0.20570)
	[3.16571]	[3.68799]
DTPP(-2)	− 1.41E − 05	− 0.546825
	(5.9E − 06)	(0.25875)
	[− 2.40276]	[− 2.11335]
DTPP(-3)	1.93E − 05	0.509585
	(5.6E − 06)	(0.24830)
	[3.42225]	[2.05227]
C	− 0.018917	545.3878
	(0.01126)	(495.174)
	[− 1.68004]	[1.10141]

Table 5
Effect of Cholesky (d.f. adjusted) One S.D. DTPP innovation on DAES.

Period			
1	0.000000 (0.00000)	17	− 0.001104 (0.00636)
2	0.029787 (0.01022)	18	− 8.18E − 05 (0.00573)
3	− 0.020379 (0.01287)	19	0.001653 (0.00551)
4	0.021712 (0.01514)	20	0.001061 (0.00429)
5	0.017540 (0.01460)	21	− 0.000776 (0.00420)
6	0.003544 (0.01580)	22	0.000531 (0.00367)
7	− 0.013535 (0.01502)	23	0.000872 (0.00307)
8	0.013821 (0.01415)	24	6.17E − 05 (0.00259)
9	0.007784 (0.01233)	25	− 0.000251 (0.00252)
10	− 0.000793 (0.01383)	26	0.000537 (0.00234)
11	− 0.002275 (0.01267)	27	0.000290 (0.00157)
12	0.007699 (0.01169)	28	− 0.000122 (0.00158)
13	0.000553 (0.00905)	29	3.66E − 05 (0.00145)
14	− 0.001073 (0.00944)	30	0.000316 (0.00131)
15	0.001641 (0.00888)	31	2.68E − 05 (0.00090)
16	0.003558 (0.00758)	32	− 5.99E − 05 (0.00091)

Cholesky Ordering: DAES DTPP.
Standard Errors: Analytic.

$$
\begin{aligned}
Y_t = & \begin{bmatrix} \text{-0.49} & 1.48E\text{-05} \\ \text{-6374.33} & 0.76 \end{bmatrix} Y_{t-1} \\
& + \begin{bmatrix} \text{-0.12} & \text{-1.41}E\text{-05} \\ 2567.85 & \text{-0.55} \end{bmatrix} Y_{t-2} \\
& + \begin{bmatrix} \text{-0.34} & 1.93E\text{-05} \\ 3361.26 & 0.51 \end{bmatrix} Y_{t-3} + \varepsilon_t; \\
Y_t = & \begin{bmatrix} DAES \\ DTPP \end{bmatrix}
\end{aligned} \tag{2}
$$

where D stands for the first order differential sequence of the original sequence.

4.2.3. Significance test of VAR model

In order to test the significance of the correlation between variables in the VAR model, we conducted a significance test. The results are shown in Table 5.

As shown in Table 5, the impact of DTPP on DAES is significant at a significance level of 5%. Thus, we rejected the null hypothesis. There is a significant relationship between third-party payment trading volume and EVA per share in the financial industry.

4.2.4. Causality test of VAR model

Significantly related variables do not necessarily indicate a causality link (Suppes, 1970). In order to ensure the economic value of the hypothesis that TPP has an impact on AES, it is necessary to determine a causal relationship among independent variables and dependent variables rather than using a simple quantitative correlation. We adopt the Granger Causality Test in this research, with DTPP as the independent variable and DAES as the dependent variable.

As shown in Table 6, the test results suggest that DTPP and DAES are Granger causally related at a significance level of 5%, and we rejected the null hypothesis that indicated that a spurious regression relationship exists. The above results show that DTPP as the independent variable and DAES as the dependent variable have a significant causal relationship. Accordingly, our empirical research has economic significance.

Table 6
Pairwise Granger Causality Tests.

Pairwise Granger Causality Tests			
Sample: 2007Q1 2014Q4			
Lags: 3			
Null hypothesis	Obs	F-Statistic	Prob.
DTPP does not Granger Cause DAES	28	6.76266	0.0023
DAES does not Granger Cause DTPP		0.23329	0.8721

4.2.5. Impulse response function

Based on the above cointegration test, it can be inferred that time series vectors in this VAR model are cointegrated. In other words, variables can reach long-term equilibrium in this model. In order to reflect the long-term relationship between variables more intuitively, we chose an accumulated response method to reveal the accumulated impulse effect of DTPP to DAES, since we use time series as our samples. Fig. 2 shows the accumulated response of DAES to one standard deviation of DTPP. The X-axis indicates the number of time intervals. The Y-axis represents the degree of change of DAES. The curve stands for the accumulated impulse response function, which represents the dynamic response caused by the independent variable (DTPP). The dotted lines on both sides are the impulse response function value plus or minus two standard deviations, indicating the possible range of impulse response (the confidence interval).

As can be seen from Fig. 2, DAES produces a positive response, since phase 0.5 under one unit of new information represents the impact from DTPP. This positive effect is fluctuating overall, but it increases gradually and approaches a steady state starting with phase 12. From the point of view of the dynamic correlation between the two variables, there is a positive relationship between them in general. The above empirical results recognized a positive impact of third-party payment on the average EVA per share in the financial industry. This impact reached its peak after three years (the 12th phase) and remained steady. This verified H1; namely, that third-party payment influences the financial industry in a significantly positive way.

4.3. Mechanism - dynamic variance decomposition

The impulse response function captures the dynamic response path of one variable's impact on another variable. Variance decomposition can decompose the variance of one variable in the VAR model system into each disturbance item. Therefore, the variance decomposition provides the relative effect of each interference factor on each variable in the VAR model and further explains the extent to which the explanatory variable affects the dependent variable.

As illustrated in Fig. 3, the curves are a percent of the DAES variance due to DAES itself, and the percent of DAES variance due to DTPP, respectively. As the time intervals increase, the explanatory power of the percent change in DAES variance due to itself decreases, and the explanatory power of the percent change of DAES variance due to DTPP increases. These results indicate that the influence of DTPP on DAES is becoming stronger, reaches its peak at phase 10 and converges to 50%. This means that, in this model, 50% of the variance in the financial industry's values is explained by third-party payment trading volume, and the influence is quite significant.

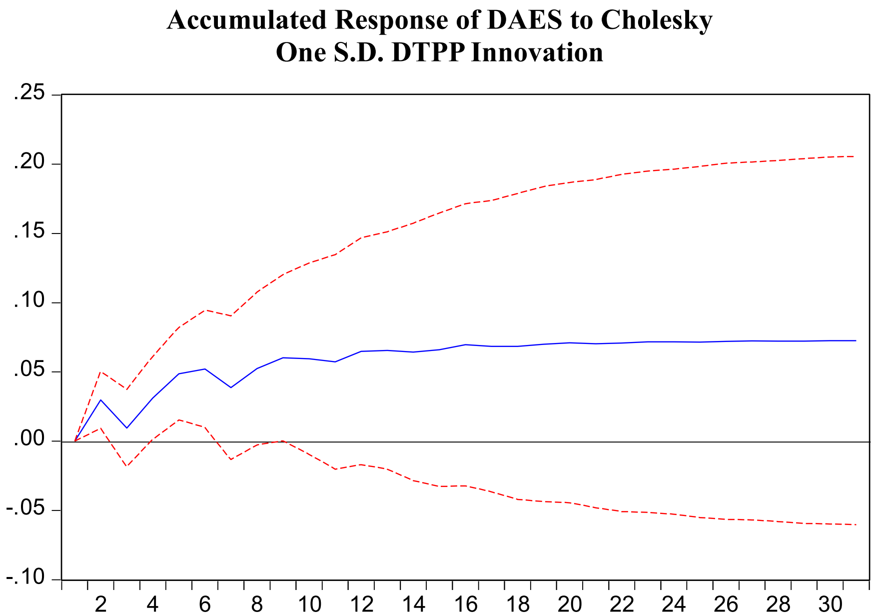

Fig. 2. Accumulated response of DAES to Cholesky One S.D. DTPP innovation.

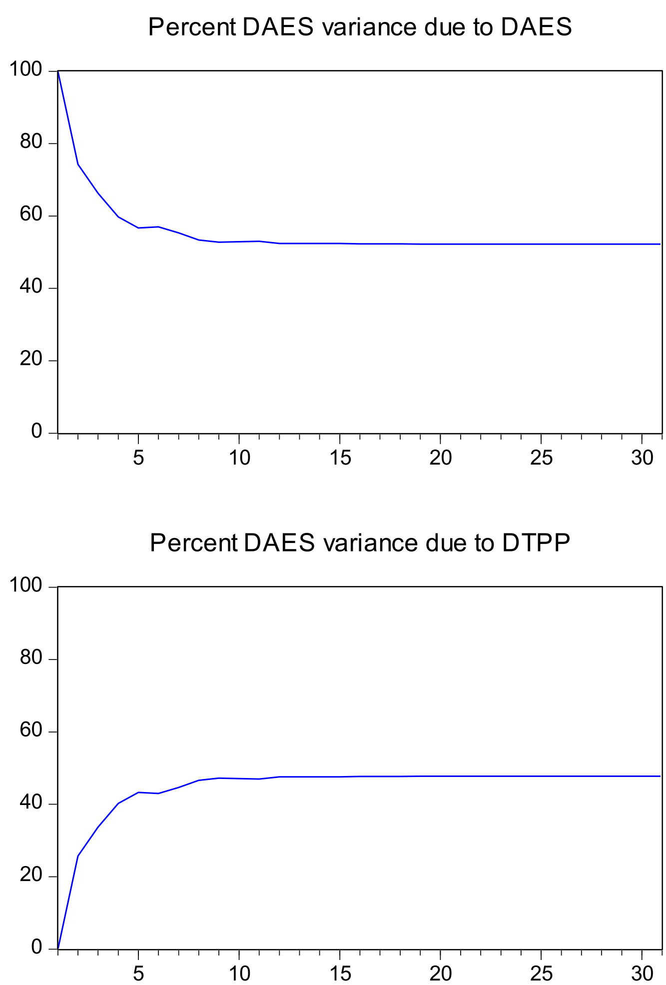

Fig. 3. Variance decomposition of DAES.

5. Discussion and conclusion

The combination of the Internet and traditional finance generates online finance. With the development of internet infrastructure and e-commerce, online finance has been growing rapidly in recent years in China, which dramatically facilitates e-commerce (Qin, 2016). However, the traditional payment methods are not fit for e-commerce. Accordingly, TPP becomes the main payment method for e-commerce. IoT and cloud computing further boost the adoption of TPP in e-commerce. This study examined the relationship between TPP trading volume and financial industry values. The relationship is significantly positive and approaches a steady-state in the long term. There is still room for third-party payment to influence the profitability of financial institutions. The empirical results support our hypothesis. Specifically, there are two phases in the relationship: 1) in the short term, there is evidence that TPP promotes the Economic Value Added to financial institutions gradually; 2) in the long-run, TPP has a significant and sustained positive effect on the Economic Value Added to the financial industry. This may be due to the fact that the effect of third-party payment on the indirect benefits of the financial industry is highlighted. There is a primary symbiotic relationship and industry synergy effect between them.

First, users need to become a client at a bank and activate its online banking services to use the TPP platform. This expands the commercial banks' client basis and online banking usage to a large extent, which then increases the bank's income through bank card administration fees and credit card late fees. Further, the TPP platform needs to pay a gateway fee to banks whenever a user pays through this platform. Additionally, the TPP monetary fund (e.g., Yu'ebao) must deposit its funds into a bank's custody accounts by following relevant laws and regulations. For example, Yu'ebao, with a scale of RMB500 billion (US $75.8 billion), has to pay RMB 1 billion (US$151.5 million) in custody fees to banks (Alipay, 2016). This increases banks' income. Finally, the acceleration effect of money returning to banks is even more significant. Money transacted through TPP platforms flows back to financial institutions, including banks, funds and trusts by various means. And the turnover in this process is much higher than the traditional consumption process in China. This improves liquidity in the financial sector to a certain extent, because TPP monetary funds can be purchased and redeemed in a relatively simple way, which helps bank absorb scattered funds.

In general, TPP does not cause liquidity risk, but rather increases money turnover. This influence contributes to financial institutions' earnings growth, generates more investment returns, creates value, and maximizes shareholders' wealth. The results of empirical research show that in China, the innovation of payment technology plays a role as an industry synergist in the evolution of the financial industry.

5.1. Practical and policy-making implications

Our study used a new empirical research method, selected an emerging economy (China) as a new sample, focused on a new perspective of payment technology innovation and financial industry evolution, and reached a conclusion indicating a significant positive relationship. The results provide useful insights into preventing irrational competition, promoting financial symbiosis, and win-win development and industry synergy between third party payment companies and the conventional financial industry. At the same time, our paper provides objective experimental data and empirical research using relevant theoretical research, and the related academic research is supplemented.

Based on the above conclusions, combined with China's actual situation, this paper proposes the following policy recommendations.

First, China should establish a clear legal status and regulatory system for third-party payment platforms. As to Third-party payment, the first issue is to determine its identity and business content. Only a legitimate identity and legitimate business scope will give third-party payment companies more confidence to innovate, to develop and to contribute to economic development to a greater extent. Once these companies have a legitimate identity and business scope, regulators should be identified. Since third-party payment platforms have a dual identity with financial and information technology, it is important to implement multi-sectoral co-regulation to prevent regulatory loopholes. Taking into account the complexity of the operation of third-party payment agencies, government and the relevant regulatory authorities should monitor and supervise the TPP evolutionary process dynamically from several aspects, including customer margins, fund security, anti-money laundering, fraud and other financial crimes. Establishing a strict mechanism of permission to enter this market is also necessary. In this way, regulations could promote the prosperous development of the entire financial industry.

Second, China should adhere to principles of market-orienting and innovation encouragement and increase governmental support for third-party payment platforms that comply with regulations. The most notable feature of third-party payment is technological innovation. Therefore, the government should adhere to market-oriented and innovation encouragement policies to maintain the operational vitality of payment technology innovation. The innovation of payment technology is responsive to the needs of the market. Regulatory measures should be based on the financial markets in order to promote the rational allocation of market resources. Regulators should be the catalyst for the development of third-party payment platforms, avoiding immature regulatory measures that hinder the expansion of innovation and experimentation, and leaving room for future development. Especially at this stage, third-party payment is still in a weak position and a start-up phase as compared with traditional financial institutions. From the perspective of fostering the development of emerging markets, government can implement strict governmental regulations and provide appropriate policy support at the same time.

Finally, China should strengthen the industry chain cooperation among third-party payment and financial institutions. Traditional financial institutions, as the executors and terminals of online payments, provide payment gateways and platforms to third-party payment agencies. It is necessary to enhance the industrial chain cooperation between them, constantly innovate in aspects of technology, customer relationship and service, and strengthen their own advantages. This would create a win-win pattern for internet finance and conventional finance to promote the development of industry synergy and to prevent the occurrence of vicious competition within the industry. The government should actively guide financial institutions to correctly approach the innovative development of payment technology, so that traditional financial institutions understand the advantages and necessity of complementing the third-party payment industry. This would help maintain the stability of the entire financial industrial chain. At the same time, third-party payment agencies can use their strong credit evaluation records and credit disclosure mechanisms to enhance cooperation with the financial industry. Third-party payment companies may also push financial institutions to improve their customer service by offering friendlier user interfaces, a more comfortable user experience and more convenient services, and to help create an environment of symbiotic development for the entire industry chain.

5.2. Limitations and future research

Our study took an innovative research perspective and a representative experimental sample, and the empirical research has achieved certain results. Nevertheless, this paper still suffers from several limitations. Further study is needed to complement this area. The limitations of this paper are reflected in the following two aspects.

First, this paper experienced some difficulties in the process of collecting data. Due to lack of relevant information disclosure, quarterly data regarding third-party payment before 2007 is unavailable. Meanwhile, due to the limitations of the CSMAR database resources, this study failed to obtain the industry average EVA per share data for 2015 and after. The above factors led to a sample time range of eight years (2007–2014), which failed to fully cover the entire time range that third-party payment has existed. In subsequent studies, annual reports and questionnaire surveys can be utilized to obtain more comprehensive data and information.

Second, we took the financial industry in China as the research object. However, China has a larger consumption scale, more demographic dividends and a more sophisticated e-commerce system than other emerging economies. Therefore, in different emerging economies, the strategic motive, market demands and macroeconomic environment of technology innovation may vary and be difficult to measure accurately. Hence, the empirical conclusion of this paper can explain the influence of technological innovation on industrial evolution only to a certain extent. Its explanatory power and applicability still needs to be further enhanced. Future research can be carried out to evaluate other emerging economies as compared to China and can further examine the applicable scope of this study.

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References

Abernathy, W.J., Utterback, J.M., 1978. Patterns of innovation in technology. Technol. Rev. 80 (7), 40–47.
Adner, R., Levinthal, D., 2001. Demand heterogeneity and technology evolution: implications for product and process innovation. Manag. Sci. 47 (5), 611–628.
Akhavein, J.D., Berger, A.N., Humphrey, D.B., 1997. The effects of megamergers on efficiency and prices: evidence from a bank profit function. In: Finance and Economic Discussion Series 9. Governors of the Federal Reserve System, Board of.
Alipay, 2016. What is Yuebao. Retrieved 06/18, 2016, from. https://yebprod.alipay.com/yeb/index.htm.
Antonelli, C., 2003. The digital divide: understanding the economics of new information and communication technology in the global economy. Inf. Econ. Policy 15 (2), 173–199.
Arthur, W.B., 1989. Competing technologies, increasing returns, and lock-in by historical events. Econ. J. 99 (394), 116–131.
Athanasoglou, P.P., Brissimis, S.N., Delis, M.D., 2005. Bank-specific, industry-specific and macroeconomic determinants of bank profitability. J. Int. Financ. Mark. Inst. Money 18 (18), 121–136.
Atik, A., 2009. Detecting income-smoothing behaviors of Turkish listed companies through empirical tests using discretionary accounting changes. Crit. Perspect. Account. 20 (5), 591–613.
Barth, J.R., Caprio, G., Levine, R., 2004. Bank supervision and regulation: what works best? J. Financ. Intermed. 13 (2), 205–248.
Bei, W., 2011. The impact of TPP platform on commercial bank's management. J. Financ. Res. 1, 40–44.
Berger, A.N., 1995. The profit-structure relationship in banking: tests of market-power and efficient-structure hypotheses. J. Money Credit Bank. 27, 404–431.
Berger, A.N., Hanweck, G.A., Humphrey, D.B., 1987. Competitive viability in banking: scale, scope and product mix economies. J. Monet. Econ. 20, 501–520.

Bi, Z., Xu, L., Wang, C., 2014. Internet of Things for enterprise systems of modern manufacturing. IEEE Trans. Ind. Inf. 10 (2), 1537–1546. http://dx.doi.org/10.1109/TII.2014.2300338.
Bikker, J.A., Hu, H., 2002. Cyclical patterns in profits, provisioning and lending of banks and procyclicality of the new Basel capital requirements. BNL Q. Rev. 221, 143–175.
Bikker, J.A., Metzemakers, P., 2002. Bank provisioning behavior and procyclicality. J. Int. Financ. Mark. Inst. Money 15 (2), 141–157.
Bourke, P., 1989. Concentration and other determinants of bank profitability in Europe, North America and Australia. J. Bank. Financ. 13, 65–79.
Cai, H., Xu, L., Xu, B., Xie, C., Qin, S., Jiang, L., 2014. IoT-based configurable information service platform for product lifecycle management. IEEE Trans. Ind. Inf. 10 (2), 1558–1567. http://dx.doi.org/10.1109/TII.2014.2306391.
Cheng, Y.W., Hsu, S.Y., Lo, C.P., 2017. Innovation and imitation: competition between the US and China on third-party payment technology. J. Chin. Econ. Foreign Trade Stud. 10 (3), 252–258.
Currie, W.L., Seltsikas, P., 2001. Exploring the supply-side of IT out-sourcing: evaluating the emerging role of application service providers. Eur. J. Inf. Syst. 10 (3), 123–134.
Deng, L., 2009. Research on the development of TPP and banks. Des. Manag. J. 6, 183–190.
Dickey, D.A., Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. J. Am. Stat. Assoc. 74 (366), 427–431.
Elton, E.J., 1999. Expected return, realized return, and asset pricing tests. J. Financ. 54 (4), 1199–1220.
Fang, S., Xu, L., Zhu, Y., Ahati, J., Pei, H., Yan, J., Liu, Z., 2014. An integrated system for regional environmental monitoring and management based on internet of things. IEEE Trans. Ind. Inf. 10 (2), 1596–1605. http://dx.doi.org/10.1109/TII.2014.2302638.
Frame, S., White, L., 2004. Empirical studies of financial innovation: lots of talk, little action. J. Econ. Lit. 42 (1), 116–144.
French, N., Cooper, R., 2000. Investment valuation models: annually in arrears data in quarterly in advance cash flows. J. Prop. Invest. Financ. 18 (2), 225–238.
Gorkhali, A., Xu, L., 2016. Enterprise application integration in industrial integration—a literature review. J. Ind. Integr. Manag. 1 (4), 1650014. http://dx.doi.org/10.1142/S2424862216500147.
Gu, B., Jiang, W., Tan, C., 2016. Theme: embracing the Internet of Things to drive data-driven decisions. J. Manag. Anal. 3 (1), 112–113. http://dx.doi.org/10.1080/23270012.2016.1140597.
Gul, S., Irshad, F., Zaman, K., 2011. Factors affecting bank profitability in Pakistan. Romanian J. Econ. Forecast 14 (39), 61–87.
Heffernana, S.A., Fu, X., 2010. Determinants of financial performance in Chinese banking. Appl. Financ. Econ. 20 (20), 1585–1600.
Jackson, A., 1996. The how and why of EVA at CS First Boston. J. Appl. Corp. Financ. 9 (1), 98–103.
Jiang, L., Xu, L., Cai, H., Jiang, Z., Bu, F., Xu, B., 2014. An IoT oriented data storage framework in cloud computing platform. IEEE Trans. Ind. Inf. 10 (2), 1443–1451. http://dx.doi.org/10.1109/TII.2014.2306384.
Kauffman, R.J., Liu, J., Ma, D., 2014. Innovations in financial IS and technology ecosystems: high-frequency trading in the equity market. Technol. Forecast. Soc. Chang. 99, 339–354.
Kim, J., 2017. A review of cyber-physical system research relevant to the emerging IT trends: industry 4.0, IoT, big data, and cloud computing. J. Ind. Integr. Manag. 2 (3). http://dx.doi.org/10.1142/S2424862217500117.
Kyriazis, D., Anastassis, C., 2007. The validity of the economic value added approach: an empirical application. Eur. Financ. Manag. 13 (1), 71–100.
Lerner, J., Tufano, P., 2011. The consequences of financial innovation: a counterfactual research agenda. Annu. Rev. Financ. Econ. 3 (1).
Li, S., Xu, L., Wang, C., 2013. Compressed sensing signal and data acquisition in wireless sensor networks and Internet of Things. IEEE Trans. Ind. Inf. 9 (4), 2177–2186. http://dx.doi.org/10.1109/TII.2012.2189222.
Lin, Y., Li, Y., 2001. Promoting the growth of medium and small sized enterprises through the development of medium and small sized financial institutions. Econ. Res. J. 1, 10–18.
Linck, K., Pousttchi, K., Wiedemann, D.G., 2006. Security Issues in Mobile Payment from the Customer Viewpoint.
Liu, Y., Han, W., Zhang, Y., Li, L., Wang, J., Zheng, L., 2016. An Internet-of-Things solution for food safety and quality control: a pilot project in China. J. Ind. Inform. Integr. 3, 1–7. http://dx.doi.org/10.1016/j.jii.2016.06.001.
Liu, F., Tan, C., Lim, E., Choi, B., 2017. Traversing knowledge networks: an algorithmic historiography of extant literature on the Internet of Things (IoT). J. Manag. Anal. 4 (1), 3–34. http://dx.doi.org/10.1080/23270012.2016.1214540.
Lyytinen, K., Rose, G.M., 2003. The disruptive nature of information technology innovations: the case of internet computing in systems development organizations. MIS Q. 27 (4), 557–596.
Ma, Z., 2005. Research on the Cooperation Pattern Between TPP Companies and Other Businesses (Doctoral dissertation). Capital University of Economics and Business.
MacKinnon, J.G., 1996. Numerical distribution functions for unit root and cointegration tests. J. Appl. Econ. 11, 601–618.
Mackinnon, J.G., Haug, A.A., Michelis, L., 1999. Numerical distribution functions of likelihood ratio tests for cointegration. J. Appl. Econ. 14 (5), 563–577.
Micu, A.E., Micu, A.E., 2016. Modeling a fuzzy system for assisting the customer targeting decisions in retail companies. 24(3).
Miller, S.M., Noulas, A.G., 1997. Portfolio mix and large-bank profitability in the USA. Appl. Econ. 29 (4), 505–512.
Molyneux, P., Thorton, J., 1992. Determinants of European bank profitability: a note. J. Bank. Financ. 16, 1173–1178.
Nicita, A., Pagano, U., 2016. Finance-technology complementarities: an organizational equilibria approach. Struct. Chang. Econ. Dyn. 37, 43–51.
O'Byrne, S., 1996. EVA and market value. J. Appl. Corp. Financ. 9 (1), 116–125.
Olson, D., Zoubi, T.A., 2011. Efficiency and bank profitability in MENA countries. Emerg. Mark. Rev. 12 (2), 94–110.
Pavitt, K., 1984. Sectoral patterns of technical change: towards a taxonomy and a theory. Res. Policy 13 (6), 343–373.
People's Bank of China, 2010. Non-financial Institution Payment Service Administration Regulations (PBC Publication No. 2010-2). People's Bank of China, Beijing.
Perry, P., 1992. Do banks gain or lose from inflation. J. Retail. Bank. 14 (2), 25–30.
Qin, Y., 2016. China's transport infrastructure investment: past, present, and future. Asian Econ. Policy Rev. 11 (2), 199–217.
iResearch Consulting Group, 2017. China TPP industry report, 2017. Retrieved 08/18, 2017, from. http://report.iresearch.cn/report_pdf.aspx?id=3035.
Revell, J., 1979. Inflation and Financial Institutions. Financial Times, London.
Safarzyńska, K., Van den Bergh, J.C.J.M., 2016. Integrated crisis-energy policy: macro-evolutionary modelling of technology, finance and energy interactions. Technol. Forecast. Soc. Chang. 114, 119–137.
Saviotti, P.P., 2001. Variety, growth and demand. J. Evol. Econ. 11 (1), 119–142.
Schumpeter, J.A., 1912. The fundamental phenomenon of economic development. Am. J. Econ. Sociol. 61 (2), 405–437.
Shil, N.C., 2009. Performance measures: an application of economic value added. Int. J. Bus. Manag. 4 (3), 169–177.
Short, B.K., 1979. The relationship between commercial bank profit rates and banking concentration in Canada, Western Europe and Japan. J. Bank. Financ. 3, 209–219.
Smirlock, M., 1985. Evidence on the relationship between concentration and profitability in banking. J. Money, Credit, Bank. 17, 69–83.
Sun, X., Zheng, H., 2010. Research on technological innovation and industrial evolution and its prospects. Foreign Econ. Manag. 32 (10), 20–26.
Suppes, P., 1970. Probabilistic grammars for natural languages. Synthese 22 (1), 95–116.
Tornatzky, L., Fleischer, M., 1990. The Process of Technological Innovation. Lexington Books, Lexington.
Wang, S., Zheng, S., Xu, L., Li, D., Meng, H., 2008. A literature review of electronic marketplace research: themes, theories and an integrative framework. Inf. Syst. Front. 10 (5), 555–571. http://dx.doi.org/10.1007/s10796-008-9115-2.
Whitmore, A., Agarwal, A., Xu, L.D., 2015. The Internet of Things-a survey of topics and trends. Inf. Syst. Front. 17 (2), 261–274.
Windrum, P., Ciarli, T., Birchenhall, C., 2009. Environmental impact, quality, and price: consumer trade-offs and the development of environmentally friendly technologies. Technol. Forecast. Soc. Chang. 76 (4), 552–566.
Xiang, J.Y., Jing, L.B., 2014. Electronic commerce in China: current status, development strategies, and new trends. Shanxi Sci. Technol. 3, 71–94.
Xie, C., Cai, H., Xu, L., Jiang, L., Bu, F., 2017. Linked semantic model for information resource towards cloud manufacturing. IEEE Trans. Ind. Inf. 13 (6), 3338–3349. http://dx.doi.org/10.1109/TII.2017.2723501.
Xu, L., 2011. Enterprise systems: state-of-the-art and future trends. IEEE Trans. Ind. Inf. 7 (4), 630–640.
Xu, L., He, W., Li, S., 2014. Internet of things in industries: a survey. IEEE Trans. Ind. Inf. 10 (4), 2233–2243.
Xu, B., Xu, L., Cai, H., Xie, C., Hu, J., Bu, F., 2014. Ubiquitous data accessing method in IoT-based information system for emergency medical services. IEEE Trans. Ind. Inf. 10 (2), 1578–1586. http://dx.doi.org/10.1109/TII.2014.2306382.
Yan, S.K., Chang, S.N., 2007. The payment mode and application of third party payment in e-commerce. Market Mod. 10 (502), 94–95.
Yang, B., Stankevicius, D., Marozas, V., Deng, Z., Liu, E., Lukosevicius, A., Dong, F., Xu, L., Min, G., 2018. Lifelogging data validation model for internet of things enabled healthcare system. IEEE Trans. Syst. Man Cybern. Part A Syst. Hum. 48 (1), 50–64. http://dx.doi.org/10.1109/TSMC.2016.2586075.
Yin, Y., Zeng, Y., Chen, X., Fan, Y., 2016. The internet of things in healthcare: an overview. J. Ind. Inform. Integr. 1, 3–13. http://dx.doi.org/10.1016/j.jii.2016.03.004.
Zhao, Q., Li, Y., Xue, J., 2016. Research on influence factors of the internet financial product consumption based on innovation diffusion theory. In: WHICEB, pp. 35.
Zheng, X., 2014. The application of Economic Value Added on performance evaluation of listed banks in China. J. Acad. Res. Econ. 6 (1), 103–118.

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