



Fourth Party Logistics Platforms: an Empirical Research on the Value of Users' Utility

SHI Gantu

Thesis submitted as partial requirement for the conferral of the degree of
Doctor of Management

Supervisor:

Prof. Virginia Trigo, Professor Emeritus, ISCTE University Institute of Lisbon

Co-supervisor:

Prof. CHEN Xu, Professor, University of Electronic Science and Technology of China,
School of Management and Economics

September, 2018



Instituto Universitário de Lisboa

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Abstract

In recent years, with the rapid development of logistics industry in China, many third party logistics enterprises have emerged in the market. However, most of them are "small, weak, and scattered", and experience high logistics costs. Such features push them to shift to the fourth party logistics business model. With the rapid development of e-commerce, fourth party logistics (4PL) make use of the Internet platform to integrate logistics resources so as to enhance logistics supply and demand matching to lower total logistics costs. The 4PL platform is a new type of development, but what kind of commercial value does it offer, what impact does it have on users , and to which extent does it address their concerns? This is the focus of our research. This thesis chooses a 4PL platform – the LHB platform – as the research object, so as to have relevant quantitative data from the perspective of the platform users enabling to analyze the impact such platform has on user utility and ultimately explore its value.

First, this thesis has sorted out in detail relevant literature about "4PL" and "user utility". Based on the research accomplishments of predecessors we have mainly analyzed the impact of the 4PL platform on users and put forward seven hypotheses. Then, we presented the research method and the research objec. The LHB platform is industrially representative of a 4PL platform and could provide favorable research conditions for this study. To analyze the data we used the DID model since it can effectively depict the impact of the 4PL on user utility. The research results indicate that the 4PL platform can improve the cargo owner's service utility perception, lower cargo owner's logistics costs, improve the truck owner's service utility perception as well as his/her logistics profits thus improving the utility for all users of the

platform.

The research results on the one hand enrich both the 4PL research perspective, and the DID model application fields; on the other hand, it provides reference for the actual operation of 4PL platforms, contributing to discerning the value of the 4PL platform industry.

Keywords: 4PL platform; Platform value; User utility; DID model

JEL: M10; M21

Resumo

Nos últimos anos, com o desenvolvimento rápido da indústria de logística da China, um grande número de empresas de logística de terceiros têm surgido no mercado. No entanto estas empresas são caracterizadas por serem “pequenas, fracas e dispersas” e têm de suportar custos elevados pelo que muitas delas estão a transformar-se em plataformas logísticas do tipo 4PL (Fourth Party Logistics). O progresso rápido do comércio eletrónico tem contribuído para este desenvolvimento na medida em que permite a integração de recursos logísticos numa plataforma na internet facilitando o encontro da oferta com a procura e assim melhorando o custo total da logística. As plataformas 4PL são um novo modelo de negócio, mas qual o valor que oferecem, que impacto têm nos utilizadores e em que medida respondem às suas necessidades? Este é o principal enfoque desta tese.

Considerando a disponibilidade de dados, esta investigação escolheu uma empresa de 4PL, a plataforma LHB, como objeto de estudo. Os dados obtidos permitiram analisar o impacto deste tipo de plataformas na utilidade para o utilizador e explorar o valor que elas representam para o mesmo.

Em primeiro lugar procedemos à revisão da literatura sobre os conceitos de “4PL” e de “utilidade para o utilizador” e daí extraímos informação que permitiu a formulação de sete hipóteses. De seguida apresentámos o método de pesquisa e a plataforma LHB enquanto objeto de estudo. A plataforma LHB é representativa desta indústria e proporcionou condições favoráveis à realização da pesquisa. Para o tratamento dos dados utilizámos o modelo DID, Diferença-em-Diferenças uma vez que permite retratar o impacto da plataforma logística em

estudo na utilidade para o utilizador. Os resultados indicam que a plataforma 4PL permite melhorar a perceção da utilidade do serviço do proprietário da carga, reduzir o seu custo logístico, e melhorar a perceção de utilidade do serviço do proprietário do camião, melhorando também os lucros assim contribuindo para a melhoria da utilidade de todos os utilizadores da plataforma.

Os resultados podem contribuir para enriquecer a investigação sobre 4PL e sobre a aplicação do modelo Diferença-em-Diferenças. Por outro lado, a tese pode constituir também uma referência para a operação real da plataforma 4PL e para a avaliação de valor na indústria logística.

Palavras-chave: plataforma 4PL; Valor da plataforma; Utilidade do utilizador; Modelo DID

JEL: M10; M21

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Chapter 1: Introduction

1.1 Research background

Since 2007, the logistics industry in China has developed rapidly. In 2017, the total freightage volume was 47.9 billion tons, an increase of 9.3% over the previous year, with freightage turnover of 19,613 billion tons an increase of 5.1% in relation to the previous year (National Bureau of Statistics of the People's Republic of China, 2018). After ten years of rapid development, the logistics industry has gradually entered into a stage of stability. Meanwhile, the government has put forward a "supply side reform", to wipe off excessive production capacity, and weed out enterprises failing to meet environmental requirements, most of them being medium and small logistics enterprises that are now confronted with a series of challenges for survival.

While the logistics scale grows rapidly, its cost has stayed at a high level. In 2016, the total expenses of social logistics were 17.2 trillion RMB Yuan (for reference 1 RMB Yuan is equivalent to about 0.13€), and accounted for 17.5% of the annual GDP of China. In comparison, the total expenses of logistics in America account for only 9% of the GDP, while for Germany and Japan are respectively 8.5% and 7%. Even compared with the global average, China is 6%~7% higher (Feng, 2017). Most third-party logistics enterprises are still small, young, weak and scattered, and disengaged logistics resources have found no way to be integrated and used, all of these being important reasons for the high costs of logistics. Such high costs have caused

the low earning power of the logistics industry and insufficient development potential. Moreover, cross-border e-commerce and new retail as well as new commerce models have new requirements for logistics, while China's traditional third-party logistics (hereinafter referred to as "3PL") have no way to meet the new demand of individualization and professionalism for the current logistics.

With the Fourth Party Logistics (hereinafter referred to as "4PL") now emerging and being applied, more profitable and efficient models of logistics forms may solve the above problems more effectively. The term 4PL is coined based on the 3PL, and refers to the integration of logistics resources and supply chain resources of third parties, plus information and Internet, in order to extend service all around China and even overseas, to offer logistics service products individually and promptly and to provide all rounded logistics solutions for customers (Badem, and Mueller, 1999). The 4PL makes use of the Internet technology to make the traditional logistics process informatized and e-commercialized, to enhance the orderly configuration of logistics resources, with speed circulation and lower costs.

The concept of 4PL has been put forward for more than 20 years, and has reached maturity out of China in terms of theoretical research and actual application, while in China the 4PL has started quite late (Yao, 2010; Li, 2011). In the early stages of 4PL development, the Fourth Party generally worked as a logistics consultancy services company to provide professional logistics solutions, address selection plans, campus plans and supply chain solutions. To provide corresponding solutions was the core value and function of the 4PL in its early stage. The 4PL, based on the demand of different customers, designs different solutions, and puts solutions into effect. Among the 4PLs, there are some platforms that do not simply provide supply chain

solutions, but offer matching between social logistics resources, where customers and logistics service providers are transparently presented on the platform and help to complete the logistics transaction.

Against the background of the robust development of e-commerce platforms, business models of the 4PL have turned to "road information port" and "vehicle-goods matching" information platform. With the help of the Internet, 4PL platforms featuring decentralization and non-boundaries have gradually become the mainstream of the logistics industry. In China, since 2013, such 4PL platforms as Yunmanman, Truck Alliance, Kaxingtianxia, Cainiao Logistics and the like have successively emerged. Cainiao Logistics platform, for example, has integrated different companies like STO Express, HTKY, ZTO Express, Yunda Express and SF Express into one whole, making use of a highly developed information technology that enables to integrate resources and satisfy customers' logistics demand through the Internet all around China and even around the world.

1.2 Research problem

The 4PL platform as the main development mode of the 4PL has become the basis for resource integration. The competitiveness of the 4PL platform lies in its traffic flow, services and active users, and more deeply lies in the value it brings to users, including what demands they have to meet, whether they work to keep user loyalty, and whether they work to lower costs and increase efficiency. On the one hand, the 4PL platform has been in the rise, and those in the market suffer increasingly intense competition; on the other hand, as a new industry, they have not seen yet a unified industrial standard. The correct evaluation of the value of the 4PL

platform and the actual effect it has on users have become a major concern for all those involved and such is the research problem studied in this thesis, which is to analyze and understand the value of the 4PL platform and its contribution to the logistics industry.

1.3 Research purposes

This thesis sorts out relevant literature on 4PL platform and user utility and, from the perspective of the 4PL platform users, puts forward seven hypotheses. We then conduct data collection and make use of quantitative research methods to process the data and, through regression analysis, test the research hypotheses, to withdraw relevant conclusions. Specifically, this thesis has the following three purposes:

First: to explore the impact of the 4PL platform on users' utility. We have read relevant literature, and carried out in-depth investigation on 4PL enterprises, centering around two questions: (1) "What kind of logistics services the 4PL platform offers to the users?" and (2) "What is the relationship between these logistics services and users' utilities?". We collected first-hand and second-hand materials and, in combination with the research theories and accomplishments of predecessors, we have conducted our analysis.

Second: based on the utility value theory, to depict the value of the 4PL platform. By surveying the subjective perception of users of the 4PL platform, we build models for users' utilities to have a quantification of values. We have extensively sorted out relevant literature concerning users' utility and conducted in-depth research on the 4PL platform users' utilities and explored the problem "how to quantify the utility of the users of the 4PL platform".

Third: to verify the seven theoretical hypotheses concerning the value of the 4PL platform and its implications for management. To directly reflect the values of the 4PL platform, this thesis puts forward seven relevant hypotheses from the perspective of the 4PL platform users. To verify the seven hypotheses, the Difference in Differences Model (DID for short) method is employed; the regression results have passed the robustness test, based on which we are able to draw implications for management.

1.4 Research significance

1.4.1 Theoretical significance

Recently, with the rapid development of 4PL, research efforts on its study have been active in the academic world. Having sorted out relevant literature, however, we have found that most research efforts have been made on the six aspects of concept definition, operation mode, network optimization, platform design, value creation and value assessment. Relatively few research efforts have been made on the value of the 4PL, and quantitative research on it can even more hardly be seen. Based on previous research, this thesis considers the value of the fourth party logistics platform from the perspective of user utility.

First, the fourth party logistics platform serves as the e-commerce platform of the logistics industry to connect users with high-quality logistics resources. Based on users' utility, this thesis studies the value of the fourth party logistics platform from the perspective of the users of the platform and aims at enriching the research perspective of the fourth party logistics.

Second, in previous research, the DID model has mostly been applied to policy evaluation

and has seldom been applied to research on a trade industry. Making use of the strength of the DID model to control beforehand differences of the object the intention is to more effectively depict the value change before and after users have employed the 4PL platform, which intends to contribute to the development of the DID model research field.

1.4.2 Practical significance

The 4PL platform represents an emerging industry that is developing rapidly, has diversified and is in want of a unified industrial standard. The research emphasis on the value of the 4PL platform lies in the evaluation of the capacity of the platform to integrate resources, and the business model of the platform. The research results will provide reference for platform development and design, service pricing, product strategy, operation promotion and the 4PL platform industrial valuation.

On the micro level, this research aims at providing theoretical guidance for which kind of business should be developed, what services should be established, how to price the products, and how to develop the existing business model when the platform builder optimizes the 4PL platform, through quantitative analysis of the key factors affecting users' utility.

On the macro level, this research may provide some bases for evaluating the trade of the 4PL platform, which in China, currently, do not benefit from a unified scientific industrial standard. This research on the value of the 4PL platforms may conduce to facilitating the establishment of an industrial standard for the 4PL platforms, and be practically significant in guiding the strategic development of their establishment and ideas on their operation. Furthermore, it aims at providing reference for the macro and industrial evaluation of 4PL

enterprises'.

1.5. Research method

In terms of research fields, this thesis involves economics and management, and the theoretical analysis of the 4PL and users' utility need to involve massive economics and management deductive methods. The thesis is then an interdisciplinary scientific research that mainly uses quantitative research methods, including users' utility model and DID model. When constructing users' utility model, the Delphi method is used to determine the weight of each index in the users' utility model.

For quantitative research, we collected first hand data from a selected object enterprise, conducted data cleansing and reduction, and made use of the users' utility model to generate data to express all information needed for the research. Finally a regression model was constructed and, using the software STATA 14 a statistics analysis was conducted to obtain regression results. The DID model is an effective method to cope with the effect of events in economics, and is able to effectively control beforehand differences and separate the real impact of the "application of the 4PL platform" event on users.

1.6 Research framework

This thesis is based on theoretical research, makes use of the approach of empirical quantitative data to analyze the empirical results and extract impact factors and management implications of the value of the 4PL platform. The research covers the 4PL platform value based

on the perspective of the users' utility, and is presented in six chapters as follows:

Chapter 1, introduction, mainly presents the research background, research questions, research objective and research significance, explains the research methods and research framework.

Chapter 2, literature review, analyses relevant literature on the 4PL and users' utility. It covers conceptual definition, operation mode, network optimization, platform design, value creation and value assessment. It explains in detail the relevant concepts and the theory of user utility, as well as the practical application of users utility in research, and makes a comment on the literature. Based on the relevant theories of the 4PL and users' utility, this thesis puts forward seven hypotheses, and provides specific research directions for quantitative research.

Chapter 3, research design and method, mainly involves four components: (i) Research object; (ii) Research variables and measurement; (iii) Data collection; and (iv) Statistical analysis. In this chapter a specific platform, the Lahuobao logistics platform which serves as the object of this research is detailed explained and interpreted in what concerns research variables, data sources, empirical analysis and DID model. In the section "variables and measurement", in order to measure the indicator regarding users' utility, a model for users' utility is built.

Chapter 4 introduces the research object of Lahuobao logistics platform (hereinafter referred to as LHB for short). This chapter introduces in detail the background, status quo, operation mode and transaction procedures of LHB, and makes use of the actual operating 4PL platform to explore its users' utility.

Chapter 5, data processing and empirical analysis, introduces in detail the data processing and data regression before regression analysis. Data processing includes randomness analysis and endogeneity test. At last, based on the DID model, we have empirical and regression analysis, to test the research hypotheses and have corresponding statistics results.

Chapter 6, conclusion and outlook, summarizes relevant conclusions of the research questions, and puts forward management implications, to provide reference for practical operation of the 4PL platform. Moreover, it analyzes the contributions and limitations of this study providing recommendations for follow-up research.

1.7 Summary

In this chapter, we first introduced the relevant background, the research problem and the main research questions that guide the research into exploring the value of a 4PL platform. Then this chapter explained the purpose of the research which is mainly to discuss and understand the value of a 4PL platform and presents both the theoretical and practical significance. Then the chapter introduces the research method, which is based on a quantitative research, and then briefly explains the relevant tools and methods applied in this specific quantitative research. Finally, the chapter presents the research framework and the layout of the chapters.

Chapter 2: Literature review

To study the value of 4PL further, this chapter takes a closer look at the research on 4PL by domestic and international scholars and reviews the relevant literature on user utility. Based on the perspective of 4PL platform users and the relevant literature, we propose corresponding research hypotheses to provide the theoretical bases and research direction in the following parts of this thesis.

2.1 4PL literature review

With the constant development of e-commerce and internet technology, the scale of the logistics industry is growing sustainably, and the 'logistics + e-commerce' mode has become the path for commerce mode innovation in the logistics industry. Information technology is highly developed, and the 4PL platform, as a specific form of 4PL, makes use of platform thinking to integrate resources, which goes through the internet to customers with logistics demands in China, and even around the rest of the world.

The concept of 4PL was proposed by Anderson Consultancy in 1998 and 4PL research now mainly covers the six aspects of concept definition, operation mode, network optimisation, platform design, value creation, and value evaluation which are detailed below.

2.1.1 Concept definition

In 1998, Anderson Consultancy innovatively put forward the concept of 4PL and defined

it as follows: 4PL is an integrator that assembles the resources, capabilities and technology of its own organisation with those of complementary service providers to design, build, and run comprehensive supply chain solutions (Bauknight & Miller, 1999). 4PL is a logistics service provider of strong leadership that does not only control and manage specific logistics services, but also integrates the resources, capabilities, and technology of 3PL suppliers, IT technology suppliers, management consultancy, and other value-added services providers to put forward comprehensive supply chain solutions in order to create value for customers.

During the development of 4PL, different scholars presented different implications for the concept as summarized in table 2-1. Christopher (1998) believes that 4PL can maximise the operation efficiency of the logistics industry by integrating socially shared resources, sharing logistics information, and using social resources. This author believes that 4PL is a logistics organisations association that can integrate relevant logistics activities and organisations or enterprises. Ying (2009) further points out that 4PL relies on complicated information technology to link up with manufacturing, sales, and distribution data. Further, in addition to monitoring and controlling the designated activities of customers, it puts forward optimal schemes for the entire process flow of logistics and integrates the process flow in the form of e-commerce, to provide systematic management services for the supply chain business. Li (2011), while explaining the traditional 4PL, points out that 4PL is a logistics scheme that deals with the decision-making capability of outsourcing logistics systems. Li further finds that its establishment is based on 3PL and is offered by the ‘fourth party’, which is different from each link in the existing logistics system and is not a stakeholder of the original logistics system. Further, by means of information technology, it combines its own resources, capabilities, and

technology with those of other service suppliers to optimise and reform the entire logistics system or partial links, and to provide systematic supply chain solutions. Dai (2010) believes that 4PL shall be based on the 4PL information platform, making resource integration and information match as a value-added point for 4PL enterprises. Furthermore, the 4PL platform is a logistics management and services integration platform that integrates multiple elements, including 3PL enterprises, vehicles, cash flow, and information flow.

Table 2-1 4PL definitions

Authors	Definitions
Christophe (1998)	Logistics organizations or enterprises on the supply chain have been effectively engaged and coordinated, to integrate logistics resources and enhance logistics information flow efficiency.
Ying (2009)	With IT technology, 4PL links up data of customers in all links, controls and supervises the logistics activities of customers, and formulates and optimizes the whole logistics flow and scheme, and makes use of the e-commerce platform to have one stop guidance services for the supply chain business of all links.
Dai (2010)	With the help of the 4PL information platform, 4PL make resources integration and information matching as value adding points of the 4PL enterprises. It is a comprehensive logistics management and service platform, and information integration platform.
Li (2011)	4PL is a kind of logistics solution for logistics service outsourcing, and based on the 3PL, provided by independent the "fourth party"; with the Internet technology, it integrates itself with the resources, capacity and technology of other logistics service providers, to make logistics links complete, to realize optimal supply chain system.

Although scholars have different ways of understanding the definition of 4PL, they share the following common points of recognition: it is based on e-commerce information platforms,

it integrates the resources of all nodes along the supply chain, and it features systematic unified allocation to reach the goal of adequate utilisation of resources and maximum benefits.

4PL is based on the development of 3PL, and some scholars have done research on the causes and characteristics of 4PL and the relationship between 4PL and 3PL. Craig (2002) generalises three aspects of the causes of 4PL, namely, globalisation of logistics, the promotion of client and management consultant experts, and the systematic optimisation which 3PL cannot achieve. Xing, Lin, and Da (2007) summarise the causes of converting 3PL into 4PL. First, thanks to the constraint of self-capabilities and to each 3PL enterprise acting in its own way, they cannot adequately utilise and integrate social resources to realise the maximum efficiency of economic operations. Second, the development of the logistics industry needs the promotion of technology experts and management consultancy experts, while 3PL lacks the support of high technology and high calibre talents. Third, the development of modern high technology provides an opportunity for 4PL, and a complete information system can test and master the supply and demand information of global material resources to offer favourable information flow support for 4PL operations in a timely manner.

As for the characteristics of 4PL, Guo (2010) points out that 4PL assumes the plan scheme of the entire supply chain logistics system, stressing the optimisation of the entire supply chain and the entire process flow, instead of independent individual links. Meanwhile, she believes that 4PL features lowers costs and transaction expenses, so it can achieve a ‘win-win’ within the supply chain, which objectively fits the trend of new circulation of commodities and is conducive to corporate core competitiveness. Moreover, Li (2012) believes that 4PL is information-intensive, and as a kind of low assets economy to provide logistics integration

services and supply chain solutions for terminal clients, needs to use IT technology to collect various dynamic information along the supply chain in a timely manner. In conclusion, 4PL mainly features supply chain integration and high information intensiveness.

To explore the relationship between 4PL and 3PL, Cao (2009) compares the four aspects of priority, service function, cooperative objective, and asset properties, and sums up that 3PL and 4PL have their own priorities in the logistical division of labour. 3PL has a very mature operation system in specific logistics services and has the advantage of conducting value-added services based on each logistics link. However, it lacks high-efficiency information circulation, and resources cannot be adequately utilised in time and space. On the other hand, 4PL establishes an information platform to ensure the high-efficiency operation of information flow, to re-allocate resources, to reduce costs and expenses, and to optimise the operation mechanism of the supply chain in order to realise maximum corporate benefits. Li (2013) describes 3PL as specialised corporate logistics and 4PL as service-type logistics from the perspective of logistics. Furthermore, Li points out that 4PL provides value-added services for 3PL and other logistics stakeholders, and works to promote the efficiency of 3PL and the competitiveness of the entire logistics supply chain. From the perspective of fixed assets, Li believes that 3PL engaged in warehousing and transport is capital-intensive and asset-heavy, while 4PL engaged in resource integration and information matching is information-intensive and asset-light. Yao (2016) analysed collaborative mechanisms and highlighted that 4PL and 3PL shall reduce conflicts to form strategic collaborative development, integrate social resources, promote logistics efficiency, realise win-win results, and form an interest community. To summarise, in specific logistics service operations, 4PL is inclined to the information level, committed to high

efficiency circulation of logistics information, while 3PL is inclined to the operation level, committed to building proven logistics circulation operation system. Logistics information and operation need to be mutually integrated, to ultimately realize the goal of optimal logistics services quality.

2.1.2 Operation mode

Bedeman and Gattorna (2003) sum up the three 4PL operation modes, namely, the collaborative operation mode, solution integration mode, and the industrial innovation mode. In the collaborative operation mode, 4PL and 3PL collaborate to develop the market and to fulfil projects, with 4PL playing the role of the information service and logistics solutions provider and 3PL playing the role of the specific implementer. In the solution integration mode, 4PL integrates its own into 3PL resources, capabilities, and technology, to provide clients with solutions for the entire supply chain or to solve partial problems from the perspective of the supply chain. In the industrial innovation mode, 4PL integrates 3PL, providing supply chain solutions for all clients in the lower reach links along the supply chain, and through effective operations strategies, advanced information technology, and a rational scheme it enhances the efficiency of the entire logistics industry. The three modes have broken through the limitations of the traditional 3PL, and have realised low-cost operations to reach maximum resource integration.

In addition to the three modes, 4PL also has a flexible operation mode and dynamic alliance mode, which means that relatively independent logistics service providers (like 3PLs, consultant organisations, suppliers, and distributors) and clients, as driven by the market, are

connected by information technology and form an alliance for a specific period of time to contribute their core capability as supply chain node enterprises in their respective fields of design, supply, manufacturing, and distribution, to share the benefits and risks (Ireland & Webb, 2007).

Table 2-2 4PL operation modes

Operation modes	Contents
Coordination mode	4PL and 3PL are coordinated; 4PL is in charge of making solutions, while 3PL is responsible for implementing the solutions.
Solution integration mode	4PL integrates itself and other resources endowment of other logistics service providers including 3PL, to provide systematic solutions for customers.
Industrial innovation mode	4PL takes 3PL as one of its components, with resources operation, information circulation and high efficiency logistics solutions to facilitate the efficiency of the whole logistics industry.
Dynamic alliance mode	4PL forms up alliances with specific logistics services providers and customers in specific periods, so that they give full play to their own advantages in design, supply, manufacturing, sales and distribution, to realize benefits and risk sharing.
Platform mode	4PL, relying on e-commerce platform, effectively links up between logistics suppliers and customers, and various logistics services providers can realize information exchange on the 4PL platform, and 4PL provides supporting logistics services.

Moreover and Zhang (2009) generalises the resource integration platform mode of 4PL with IT, and states that this mode employs IT to match the logistics demand with supply, integrates relatively scattered logistics service providers into the 4PL platform, and provides

corresponding public services and supporting services for logistics service providers. Meanwhile, all market opportunities and their expansion are seized by the 4PL platform and the logistics service providers on the platform. The 4PL platform develops the market with the overall logistics service level, while 3PL wins the recognition of the market with its own service levels, professionalism, and after-sales services. In the process, the 4PL platform will correspondingly enhance the IT application of 3PL, helping it have operations on the platform.

4PL operation modes are shown in table 2-2. Having sorted out the main operation modes of 4PL, we have found that various operation modes mainly differ in their methods, ways, and capabilities of resource integration. Some modes need the internet-dependent platform to complete the conversion of core resources, while others do not. The platform, which is the main development mode of 4PL, has become the basis for 4PL to integrate resources. This thesis is mainly focused on the platform mode of 4PL, with the purpose to reveal the value of these platforms.

2.1.3 Network optimisation

Optimising the logistics network plays an important role in research in the field of logistics. 4PL is a more complicated system than 3PL, and, therefore, its network optimisation is more important. Among existing research efforts, Smilowitz (2003) and Yao (2010) divide the issue of the 4PL network optimisation into the two inter-connected problems of path optimisation and 3PL supplier selection, and after determining the shortest path, specific designated models are utilised to select 3PL suppliers. Based on this, Christopher (2013) has conducted research on collaborative mechanisms of 4PL, and put forward an optimisation model for logistics

operation integration strategies. Fu (2014), based on the existing research on 4PL path optimisation, calculates a single path optimisation model through the Dijkstra algorithm. Cui, Huang, Yang, Lee, and Wang (2013) have established the fuzzy planning model for 4PL path optimisation, which considers some discounts of transportation expenses.

Wang, Wu, and Chen (2009) have found a new path, and after a comprehensive consideration of path optimisation and 3PL supplier selection, they have established an integrated optimisation model of the 4PL multi-agent job based on graph structure and proposed a two-layer domain search algorithm to solve the 4PL optimisation problem. Lin (2016) found that the existing problem in current research concerning the 4PL path optimisation is that the accuracy of the genetic algorithm drops with the expanding scale and proposed a local search-based optimisation strategy.

The former research on 4PL on path optimization is always based on deterministic data, but in reality, deterministic data are always missing; for this, Cui (2012) conducted 4PL path optimization research with deterministic data considered, and researched into the following five 4PL routing problems: single source to single destination 4th party logistics routing problem with fuzzy duration time with fuzzy processing time; multi-source to multi-destination 4PL routing problem with fuzzy processing time, cost discount considered 4PL routing problem with fuzzy processing time, travel schedule considered 4PL routing problem with fuzzy processing time, and 4PL routing problem system design; The algorithms used are genetic algorithm, short-circuit algorithm, ant colony algorithm, cultural genetic algorithm and self-organizing migration algorithm, realizing routing optimization under the circumstances of a fuzzy representational information vector.

In sum, currently, the research on 4PL network optimisation places emphasis on path optimisation and 3PL supplier selection, and solves the problems based on the intelligence algorithm by building a corresponding optimisation model. However, the optimisation of the 4PL network involves all aspects of 4PL and 3PL enterprises, including operation optimisation and resource integration optimisation. This thesis researches the value of the 4PL platform, which is conducive to effectively evaluate whether various complicated network optimisation strategies can optimise all corporate resource configurations under the 4PL framework or not.

2.1.4 Platform design

The 4PL platform is the basis for 4PL to integrate resources, and is the bridge linking the demand information of clients with the 3PL supply information. Therefore, ways to design an effective 4PL operation platform and to develop relevant systems and operation specifications affect the success of 4PL operations.

Hui (2003) has conducted research on the 4PL platform in the air freight industry in Hong Kong including three subjects, namely, the government, investors, and clients. As for the platform design, the benefit conflict among the three subjects needs to be considered. Based on the analytic hierarchy process and analytic network process, the earnings, costs, and risks of the platform have been evaluated. Based on the transaction cost theory, Bourlakis and Bourlakis (2005) have done research on the creation of a 4PL network platform for food retail chains in the UK. They believe that whether the 4PL platform can utilise the information technology to 'lower logistics complexity and reduce transaction costs' is the key to the selection of 4PL by retailers, and also the key to platform design. Dai (2010) has made use of the two-sided market

theory and studied the main influencing factors of platform service pricing by building up the two models of monopoly and competition and did an actual case study to propose pertinent platform design strategies. According to the characteristics of the 4PL market operation and from the perspective of the government, Yao (2010) has proposed a concept and theoretical framework of the government dominating 4PL, driving 3PL to develop and to have an innovative design of 4PL platform procedures and systems. Yao suggested procedural and system-integrated thinking and a platform design concept to ensure low costs and high efficiency in market transactions. Jia (2010) puts forward the electronic transaction logistics platform scheme based on 4PL for cargo transportation of Tianjin port, i.e. to establish the 4PL platform for cargo transportation of Tianjin port. This 4PL platform includes information release, transaction matching system, logistics tracking, and credit evaluation function, which can enhance port logistics and trade, and improve port management efficiency and service level. Hou (2017) is aimed at the logistics industrial status quo of China, and the road cargo transportation market, based on 4PL and network economic theory, and based on logistics cloud computing application, they designed a 4PL platform based on the Internet technology and information technology.

The 4PL operation platform must be information-intensive, and the platform needs to obtain logistics demand and supply information in a timely manner. Hence, it cannot operate without the support of information technology. Li, Ying, and Liu (2004) have analysed the 4PL operations procedures, put forward the key factors for the 4PL realisation process, designed a software function structural model, and developed technology development methods for implementing 4PL under the information communications technology. In turn, the focus of Fu,

Wang, and Tang (2007) is the multi-source heterogeneous data problem caused by building an information system during the 4PL operation process. Based on case studies they have utilised the Virtual Data Warehouse and XML (Extensible Markup Language) technology, interpreted the specific implementation algorithm of converters, and used the key design points of the 4PL information platform of the Browser/Web Server/Database Server (B/W/S) structure. From the perspective of information resource integration, Wang, Mu, and Li (2009) have analysed the specific business processes of 4PL, and for the common real-time tracking, vehicle monitoring, and contingency plan processing in the logistics process, they have designed and realised a WebGIS-based 4PL tracking and contingency system based on The Open Group Architecture Framework (TOGAF),

Li and Song (2013) consider the 4PL platform design from the operation model of 4PL, and in combination with the 4PL function demand and services characteristics, they make use of SOA framework to establish 4PL information platform, and based on the business flow of the 4PL information platform they designed an overall framework for the 4PL information platform. Yin (2016) based on the UML (Unified Modeling Language) has analysed the demand of the 4PL information platform and designed the framework characteristics and principles of the 4PL platform. Then in face of the services framework of thought theory, he chose a cross platform with high level autonomy RESTFUW (Representational State Transfer Service) to construct the 4PL information platform. Zhang (2016) has provided a complete design process flow on how to build the 4PL platform from the five levels of business, scenario, data, application, and technology.

The existing research on 4PL platform design places emphasis on logistics scheme design

and information platform integration from the technological perspective. This thesis has sorted out the relevant research on 4PL platform design to gain a better understanding of the interior construction of the platform, and to provide some theoretical support for depicting the implications of platform value.

2.1.5 Value creation

4PL integrates the 3PL supply chain, promoting information delivery efficiency and resource utilisation efficiency, and hence, scholars pay particular attention to the value 4PL has created. Reviewing the literature, we have found that research on value creation of 4PL has three main dimensions, namely, supply chain value creation, logistics enterprise value creation, and social value creation.

In his research on 4PL value creation for supply chains, Li (2004) argues that 4PL is a leading logistics service provider that has an impact on the entire supply chain, provides solutions for supply chains, and brings more value to clients. Pang (2005) puts forward the value creation of the 4PL suggesting that it embodies the corporate value on the supply chain, and the biggest difference between 4PL and the previous logistics mode lies in its value adding services. 4PL provides supply chain value addition through value chain integration of the supply chain, and added value will be distributed among all enterprises in the supply chain, instead of it being solely enjoyed by the 4PL enterprises, and this is an important reason for its sustainable blooming development.

Wu (2005) believes that 4PL value creation theories emerge because of the increasingly pervasive outsourcing phenomenon and the corporate demand for value chain. The value of

4PL creation embodies in helping the enterprises to enhance core competitiveness, lowering operation costs, and reducing operation risks, and enhancing tissue separation value. Ojala, Andersson, and Naula (2008) believe that 4PL has benefits for clients in the entire supply chain, and through the integration management of the supply chain it has overall bettered the four key factors impacting stockholders, including increases in income, reductions in operation costs, decreases in operation capital, and reductions in fixed assets. Barrows (2013) believes that 4PL increases the value by affecting the entire supply chain, providing an all-around solution to meet complex demands of clients, paying attention to all aspects of supply chain management, constantly updating and optimising technological solutions, and meeting the unique demand of clients, all at the same time.

In what concerns research on value creation by 4PL for logistics enterprises, Li (2004) believes that the realisation of value lies in the improvement of the quality of logistics services, and only by improving the quality of service can the core competitiveness of logistics enterprises be improved, while the key to improving the quality of logistics services lies in the control of logistics costs, which can be brought down dramatically by reducing inputs, lowering the capital occupation ratio, and lowering stock management costs. Laksono (2012) has summed up four 4PL value addition methods, namely, lowering logistics operation costs, reducing the proportion of working capital in the total assets, decreasing the input of logistics infrastructure, and increasing the corporate operation revenue.

Win (2008) introduces the classical value chain theories into 4PL research, and based on the value created by technological and management innovation, he points out that the value creation of 4PL mainly lies in the creation strategies of three intangible value chains, namely,

low costs, high efficiency, and the improvement of strategic competitiveness. Further, he argues that through the integration of all links along the value chain and by improving the relationships between enterprises on the value chain, the joint operation of all enterprises can be realised in order to benefit all relevant enterprises along the value chain. From the perspective of 4PL platform services, Zhang and Xie (2010) introduced the standard service procedures of the 4PL platform and the entire sound system. They state that the large-scale networked 4PL platform can lower the cost of services, draw clients to participate, improve matching efficiency, and improve the core competitiveness of logistics enterprises. Tang (2010) researched into the value creation of 4PL for small and medium enterprises, and through Evolutionary Game Theory, he analyzed the 4PL cooperation conditions, stability, logistics operation and logistics costs for small and medium enterprises to conclude that the value creation of 4PL to logistics enterprises mainly lies in enhancing operation efficiency and lowering logistics costs.

In the research of social value creation of 4PL, Yan (2006) considers that 4PL takes regional, national and global economy as the background, optimizes the allocation of social resources, effectively integrates 3PL enterprises, information technology services providers and e-commerce services providers. At the micro-level, 4PL provides whole sets of supply chain solutions, and at the macro level, 4PL breaks regional blocks to enhance social informatization development, speeds up social economic system reform, and drastically lowers social logistics expenses, creating social fortune and speeding up the national economy.

Cao (2009) points out that 4PL facilitates social and economic development, and produces tremendous social value in two ways. First, by optimising 3PL, it improves the overall utilisation of social logistics facilities to dramatically lower social logistics expenses. Second,

4PL operates logistics from the perspective of the entire social logistics system, and integrates the entire region, nation, and even the global social resources in order to promote rapid development of the national economy. Cezanne and Saglietto (2015) believe, on the one hand, that 4PL can satisfy the demand for the entire social logistics system, maximally integrating social resources, reduce logistics time, save logistics resources, improve logistics efficiency, and reduce environmental pollution. On the other hand, they argue that 4PL is also conducive to promoting the optimisation of logistics stock resources, including the integration of existing resources in the form of transportation tools, transportation route facilities, warehouse equipment, and telecommunications facilities, to avoid repeating construction and to improve the overall utilisation of social logistics facilities.

In conclusion, 4PL as an integrator of the supply chain, can create value for the entire supply chain, including relevant enterprises and the society, by integrating different resources, technologies, and capabilities.

2.1.6 Value evaluation

If 4PL is the resource-integrating logistics service provider, what about its logistics integration capacity? Does it boast powerful information processing capacity? To answer these questions, we must conduct a valid evaluation of the value of 4PL. Cheng, Chen, and Chuang (2008) have evaluated the supply chain integration capacity and information technology capacity of 4PL. Considering the fuzziness of evaluation indexes, Cheng, Chen, and Chuang, based on the Fuzzy Delphi Method (FDM), have established the 4PL evaluation index system and used the Fuzzy Analytic Hierarchy Process (FAHP) to evaluate 4PL. Based on the three

indexes of service capacity, IT capacity, and management capacity, Büyüközkan, Feyzioğlu, and Ersoy (2009), evaluated three operation modes, (namely, the collaborative operation mode, solution integration mode, and industrial innovation mode). With regard to the failure of the traditional multiple property decision-making method to process the interdependence among the indexes, Büyüközkan, Feyzioğlu, and Ersoy (2009) make use of the double fuzzy integral to depict the correlation among indexes.

4PL enterprises are also often taken as subjects of evaluation by scholars, and the evaluation involves their operation performance, corporate competitiveness, and risks. Krakovics, Leal, Mendes, and Santos (2008) have studied the logistics operation performance evaluation under the 4PL mode, introducing a 4PL enterprise that has signed a contract with a chemical enterprise from Brazil, in charge of management and supervision of 3PL operations. Founded on the S-curve method, Krakovics et al. (2008) standardised the performance indexes to establish an evaluation index system and to realise the evaluation of 3PL enterprises. Bian and Yu (2015) applied the balanced scorecard to the evaluation index system of 4PL to establish a 4PL corporate competitiveness evaluation method, from the point of view of six aspects of market competitiveness, which are, financial operation, information management, human resources, coordination capability, and innovation capability. Zhang (2011) also established an evaluation system based on the balanced scorecard theory, to evaluate 4PL enterprises from the perspective of corporate operation performance. This research focused on finances, customers, corporate internal conditions and 4PL platform development adding explanations on the setting of relevant weight, and enriching the 4PL value evaluation contents.

In terms of corporate competitiveness, Liu, Chen and Gao (2011) use comprehensive

evaluation model based on AHP (the analytic hierarchy process) and Delphi method to measure the competitiveness of 4PL enterprises. This model can accurately measure the core competitiveness of 4PL enterprises to provide references for 4PL enterprise operation and 4PL support policies. Bian and Yu (2015) also made use of the balanced scorecard to establish an evaluation system for the 4PL corporate competitiveness, which includes mainly six aspects to construct, including market competitiveness, finance operation, information management, human resources, coordination ability and innovation ability. In terms of risk evaluation, Luo (2013) analyzes the internal, external, and operation risks of 4PL enterprises to establish a quantitative identification mode to identify key risks in 4PL enterprises. This research also chose a 4PL company to conduct the actual application of the model. The author used Fuzzy comprehensive evaluation method and Delphi method to conduct the evaluation and the results indicate that this research method has accurate risk evaluation capability. Zheng (2015) presented a case study on producing cold chain logistics. Based on a series of risks in the 4PL production operation and Back Propagation Neural Network, Zheng (2015) established a neural network evaluation model to evaluate the internal risks involved in 4PL operations.

To sum up, among the existing 4PL value evaluation research, the evaluation indexes system and evaluation methods are relatively singular, and unified evaluation framework for the whole 4PL platform has not been established.

2.1.7 Summary of literature review

Based on the above literature review, research on 4PL mainly involves six focus areas, which are: concept definition, operation mode, network optimisation, platform design, value

creation, and value evaluation. In sum, existing research on 4PL is still not deep enough, research content is relatively independent and lacks connection. Based on existing studies, we can explore the following further:

(1) The rapid development of the logistics industry drives the logistics integration platform to accelerate, but the literature review shows that research on the logistics platform is still limited. The 4PL platform is the foundation for the survival of 4PL, and the high efficiency of the platform determines its success. The 4PL platform as a new operation mode needs extensive and intensive research.

(2) 4PL is a solution based on supply chains, creating value for the entire supply chain, participant enterprises, and society. Research on 4PL value evaluation mainly utilises supply chain theories, logistics management theories, value chain theories, and decision-making analysis theories. The value index system and evaluation method are relatively singular. It is worth mentioning that the 4PLs of different operation modes have different expressions of value, and currently, there is still relatively little research on 4PL value concerning platform modes.

The 4PL platform is a complicated system involving multiple aspects and dimensions of resource integration, and corporate collaboration. The measurement of 4PL platform value cannot be depicted depending only on the platform flow, services, and the number of users. Currently, the business model is gradually developing in the direction of user centeredness and domination of user experiences. Hence, in order to study the 4PL platform value, research efforts on user value and user utility are particularly important. By introducing the concepts of user value and user utility, we research the 4PL platform value from the perspective of user

utility, which may offer a new perspective for evaluating 4PL value.

2.2 User utility literature review

It has been over 20 years since scholars, both in China and abroad, undertook efforts to research user value and user utility. Different scholars in different fields have explored and studied user value and user utility from different perspectives. This section highlights the definition, theoretical development, and actual application of user value and user utility.

2.2.1 Research on user value

Scholars have had different explanations of user value since the concept was put forward in the 1980s. They also expounded the implications of user value from different perspectives.

There are three categories of user value shown in table 2-3. The first category takes users as the perception subject of the value and enterprises as the perception object of the value. The value is researched from enterprises to users, that is, the traditional user-delivered value. This category emphasises on investigating the satisfaction of users' demand. The second category of user value has the opposite value perception subject and object when compared to the first category, that is, enterprises as the subject of value perception and users as the object of value perception. Research on the value is done from users to enterprises, for value is created by the users. The emphasis of this category always lies on how enterprises put in efforts to retain and develop users, to promote user value. The third category of user value refers to user-exchange value, that is, it analyses the bidirectional flow of value between enterprises and users from the perspectives of enterprises and users. This category of research emphasises on the balance of

benefits between enterprises and users (Tian, 2014).

Table 2-3 Three categories of user value

User value	Sense subject	Research key
Category-1	Consumer	Emphasis on investigating the satisfaction of users' demand.
Category-2	Enterprises	How enterprises keep customers and develop customers
Category-3	Users and enterprises	Benefits balance between enterprises and users

For this thesis the first category of user value research perspective, that is, taking users as the subject of value perception, was selected. All of the following literature falls into the first category.

Forbis and Mehta (1981) put forward the concept of user-economic value. They believe that user-economic value refers to the price the user pays for competitive products after the user has gained some understanding of the products. Based on this, Christopher (1982) adds that the willingness of payment is derived from the users' perceived gains by buying products, and emphasizes the users' perception. Thus, user-perception value is a type of user value.

The user value put forward by the balancing theory presented by Zeithaml (1988) is actually the user-perception value. Zeithaml researched the user-perception value based on the subjective perception of the user, that is, to have an overall evaluation based on psychological gains and losses of the user. He defines user-perception value as the overall evaluation of product and service utility by the user, after having weighed the perceived benefits and costs

paid for the products or services. He believes that user value is not determined by the enterprises, but by the user. Monroe (1990) suggests that the value perception of the user represents the user's perception of product quality, and the weighing of perception gain and perception loss of the product price.

Table 2-4 Three users sense value theory

Users sense value theory	Representatives	Main ideas
Trade off theory	Zeithaml (1988), Monroe (1990), and Anderson (1998)	1. User perception value is the evaluation of products or services of users after compare their perceived benefits and perceived sacrifices; 2. It represents the trade off between their perceived benefits and perceived sacrifices in product quality or prices; 3. the customers compare their earnings with the costs they pay.
Multi-factor theory	Porter (1980), Gross (1997), and Sweeney & Soutar (2001)	1. The users perceived value is the combined action of multiple factors; 2. products bring about five values in function, society, emotion, recognition and situation; 3. the measurement of user perceived values is not just the expectation of product function or diversity, but also includes emotion value and social value derived from products and communications with others.
Comprehensive evaluation theory	Woodruff (1996), and Burn & Robins (2001)	1. User value is the users' preference evaluation of product properties, outward manifestation and application feelings and subjective expectation contrast; 2. user values include product value, application value, ownership value and evaluation value, and this evaluation originates from the users' subjective sense of the products.

Anderson (1998), based on the definition of the user-perception value by the market, believes that value is the economic and technological service, and social benefit represented in

the form of money that the user obtains by paying a price for some market offering. Hereby, the benefit refers to the 'net benefit' and is a comparison between the benefits that the user has obtained and the cost that the user has paid. This belief differs from that of the balancing theory scholars. Zeithaml argues that the perception value represents the balance between outstanding gains and losses, including monetary and non-monetary parts, and cannot be expressed by currency. In Anderson's user value theory, the value is the balance between the benefits obtained and the costs paid and can be expressed as currency.

In what concerns the multiple factor theory scholars believe that the user-perception value is the combined action of multiple factors. Earlier, Porter (1980) proposed his user value theory from the perspective of competitive edge. He posits that the implication of user value is corporate income, that the value chain of an enterprise must match the value chain of the users, and that the competitive edge of an enterprise lies in the value that it has created for the users. As for the costs that users have paid, he goes beyond the concept of financial costs and introduces other factors, including time costs and convenience. Gross (1997) believes that the product offers five values to the users, namely, functional value, social value, emotional value, recognition value, and situation value. After that, Sweeney and Soutar (2001) have developed a simple and practical four-dimensional scale to further investigate the user-perception value. They add utility and pleasure factors to the construction of the scale, that is, the measurement of user-perception value does not only involve the product function or diversity expectation, but also includes the emotional value and social value derived in the process of communication with others through the product. Multiple factor value dimensions interpret the user-perception value better than the singular money value, and when actually investigating consuming value,

it can help obtain better results.

The comprehensive evaluation theory is presented by Woodruff (1997) who has expounded user value from the perspective of the user's changing cognition of value. Following an empirical study of how users look upon value, he suggested that user value refers to the user's preference and evaluation of the properties and performance of the product, and the factors for or against the benefit of their obtaining the targeted results during its use. Moreover, he has stressed that value comes from the perception, preference, and evaluation that the user has obtained by learning. Burn and Robbins (2001) believe that user value does not only include the three value forms of product value, application value, and ownership value, but also involves the user's overall evaluation formed during the evaluation of the product and originating from the user's subjective perception of the product.

Currently, the application research of user value mainly lies in product satisfaction evaluation, and product design. Li (2005) researched into users' satisfaction of governmental information portal through user value. The research conducted statistics analysis of value demand through different users, user sense value, user expectation value and satisfaction difference, to have relevant recommendations on improving governmental information portal service quality from user value and satisfaction. This research also found that all factors of user sense values have different influence on user satisfaction, and "services" has the maximum impact on satisfaction while "costs" has the least impact. Later, Zeng (2010) researched into the design of home appliances from the perspective of user value. The research first analyzed the constitution of user value, and based on the relevant theory of user value hierarchy, analyzed user appeal, preference, and habit to know user demand, and design competitive products.

In an overall view, the user value is the subjective perception of the user, different from the objective indexes of product or service quality (Meng, Han, & Wu, 2006), which is an important basis for measuring users satisfaction, and conducting product design and commercial decision making. When it comes to the object of study for this thesis, i.e. the 4PL platform, user value refers to the user's overall subjective perception of all services offered by the platform, which is significant for research on the fourth party logistics platform value.

2.2.2 Research on user utility

2.2.2.1 Utility theory

Utility is a common concept in Western economics. In its broad sense, utility refers to the measurement of satisfaction of users who, through consumption or enjoyment of leisure time, have their demand and desire satisfied. Scholars have put considerable research efforts on utility, which have been relevant to the topic.

As early as in BC, Xenophon, an ancient Greek thinker, proposed his idea of the utility theory in his work *Oeconomicus* or *Economics*. Much later, the utility theory has been officially proposed by Bernoulli (1954) who interprets the St. Petersburg paradox in his 'Exposition of a New Theory on the Management of Risk'. The St Petersburg Paradox refers to the game where the players toss a coin to earn bonus, the average of the bonus earned is much less than the bonus expectation based the probability theory, and for this the author proposes the concept of utility to challenge the decision making criteria based on the bonus expectation. There have been plenty of research achievements regarding utility throughout history. The development of psychology and sociology makes utility measurable with a questionnaire, and the utility theory

has been gradually applied to research on the human resource incentive mechanism and investment management risk item selection. Based on application conditions, the utility theory can be divided into the utility theory under certainty and the utility theory under uncertainty.

The utility theory under certainty looks into how users distribute their income among commodities and labour to maximise satisfaction. According to the measurement of utility, the utility theory under certainty is divided into the cardinal utility theory and the ordinal utility theory. The cardinal utility theory measures utility with cardinal numbers (1, 2, 3, etc.), which is a measurement according to absolute numbers. The cardinal utility theory, as an important theory in economics, places emphasis on consumption psychology and diminishing marginal utility law (Ren, 1990). The ordinal utility theory reflects the utility ordinal or grade according to the ordinal number (first, second, third, etc.) and is a method to arrange the order according to preference. The ordinal utility makes use of the indifference curve analysis method. It can interpret market behaviour of the user under more loosely assumed conditions. Hence, it can replace the cardinal utility theory and become the standard analysis paradigm of the modern utility theory. However, the ordinal utility theory still has many shortcomings and insufficiencies, mainly the fact that cardinal comparison is still regarded as a precondition when the user conducts ordinal comparison of commodity utility, as well as the error of a vicious circle of argument as revealed by the display preference theory and the fact that preference maximisation and welfare maximisation often see inconsistencies (Hao, 2011).

The utility theory under uncertainty refers to the utility theory that solves the decision-making problem under uncertainty conditions, that is, the expected utility theory which refers to the weighted average of all kinds of structure utility which the user can obtain under

uncertainty. The expected utility theory has been proposed by Bernoulli in the 1700s, and Neumann and Morgenstern (1947) have improved putting forward the concept of expected utility for investors to make decisions under risk. They point out that the utility of investors is the weighted average of all kinds of possible results in the future and do so on the basis of axioms. In most cases, the probability under natural state is not objective, but subject to human judgement, that is, it contains a subjective probability. Savage (1954) put forward the concept of subjective expectation value, and the utility function has become a weighted function including subjective probability until Schmeidler (1989) proposed the Choquet expectation and Gilboa and Schmeidler (1989) proposed a multi-priori expected utility model (Guo, 2005). These expected utilities have been widely applied to the analysis of uncertainty decision-making and there is a consensus that economic analysis should consider risk and uncertainty (Brav et al., 2005).

Ellsberg (1961) discussed a paradox indicating that when faced with decision-making under uncertainty, most people dislike uncertainty. For example, while risk gambling, people tend to systematically go against the subjective expectation theory. Aimed at this paradox, scholars have improved the axiom system of the subjective expectation theory, mainly including the Choquet expectation utility model as proposed by Schmeidler (1989) and the multi-priori expected utility model as proposed by Gilboa and Schmeidler (1989). The multi-priori expected utility model does not require unique subjective probability distribution and is currently one of the most widely applied uncertainty decision-making theories.

2.2.2.2 Utility value theory

In the 1870s, Menger (1871) and Jevons (1871), based on the research of their predecessors, put forward a far-reaching utility value theory that starts with the value theory and advances to production theory and distribution theory, to open up a new era in economics. Menger (1871) believes that the utility of meeting the subjective wishes of humans is the source of value, and value has double subjectivities, that is, it is not only subjective in nature, but its measurement scale is also subjective. Jevons (1871) raises the value theory to the subjective psychology level, with utility as the basis and mathematical analysis as the tool to measure the ultimate utility as the core, and the extent of ultimate utility determines value. He believes that the origin of utility is happiness and increasing happiness helps calculate utility. He described this utility as value and believed that utility decreases along with an increase in commodities. The ratio of the increase of utility caused by an increase in commodities to the increase of commodities is the marginal utility, which determines the value of commodities.

The utility value theory takes utility as the core and believes that the value of commodities does not come from the process of fabrication, but from the user's subjective utility of commodities. The bigger the subjective utility, the bigger the value of the commodity, and vice versa. This thesis defines value based on the utility value theory, believing that value comes from the subjective utility that the user has obtained.

2.2.2.3 User utility

(1) Concept definition

User utility modifies the concept of utility with the user. Referring to the resource distribution of utility in economic studies—maximum value matching definition—user utility, in the scope of logistics services that concern this thesis, refers to the satisfaction of demand or desire of the user while using cargo or services (Cai, 2008). User utility is a pattern of manifestation of the user's subjective perception value, and is the comprehensive perception that the user has of the product and service to meet his or her demand according to his or her economic level, cultural background, and property preference.

Li and Nie (2002) understand utility as an important power to meet the internal demand of the user. Based on research on brand cognition structure and brand core assets, and through a detailed analysis of evolution of the three related recursion hierarchy elements in product properties, user benefits, and user value to build the user utility hierarchy model, these scholars believe that user utility is weighing the comprehensive perception of the three aspects. Li and Jiang (2008) propose the concept of user utility value engineering based on the value engineering theory and believe that the value of user utility depends on the user's perception efficacy, and the user's consumption costs suggesting that it is the ratio of the user's perception efficacy to the user's consumption costs. Thus, the user's perception efficacy is the application value that the user perceives based on product or service performance, quality, and price, and it is affected by the objective property elements of products and the objective preferences of the user.

Some scholars have researched the relationship between user utility and user value. Dong, Qiu, and Qv (1999) use the mature utility theory in economics to expound the user value and propose that user value is the ratio of utility to costs from the perspective of the entire

consumption process, known as L-model. In turn, Xiao, Wang, and Yang (2003) believe that user utility involves the product property value and user enjoyment value.

Some scholars have studied the user utility of a specific industry or a certain type of commodity. Zhao (2006) has researched the pricing of heavy-duty vehicles and believes that the utility of a commodity to the user has two parts. The first part is determined by observable relevant features of commodities, relevant features of the user, and other relevant variables. The main features of commodities include the brand, price, and promotion conditions. The main features of the user include income, education, and marital status. The second part – for example, determined by product quality – cannot be observed directly. After buying the product, the utility that the user can obtain depends on the product performance, price, and the personal preferences of the user. Li and Li (2007) have studied user utility in the logistics industry, proposing that research on the utility of logistics users should begin with logistics services. They suggest that the utility of logistics users is understood as the user's preference and evaluation of their underlying motivations, which logistics service functions, properties, performance, and application results satisfy.

(2) Measurement

Scholars, aiming at different research questions, have put forward different user utility measurement methods. For example, Li and Nie (2002) take utility as important forces to satisfy the internal demand of users. Based on research on brand recognition structure and brand core assets, they conducted a detailed analysis of the evolutionary process of the three relevant recursion order hierarchy structures of product properties, user benefits, and user value, to

construct a user utility hierarchy model. They believe that user utility is the trade-off of the comprehensive perception of the three aspects. Li and Jiang (2008) proposed the concept of user utility value engineering based on value engineering and believe that utility value depends on the user's perception efficiency and consumption costs, and their ratio. Therefore, user-perception efficiency is the user's utilisation value perceived mainly based on product or service performance, and quality and prices. It is affected by objective property elements and users' subjective preferences.

Zhang (2003) aimed at Customer Relationship Management (CRM) in the finance industry, and put forward the evaluation method for CRM utility. He initially established the utility evaluation system made up of corporate financial measurement index, customer and market measurement index, and internal business measurement index. Thereafter, he evaluated and analysed items of all indexes, such as customer satisfaction and service quality, and finally, based on the evaluation of indexes and items, he conducted a multilevel fuzzy comprehensive evaluation, to obtain the CRM utility value. Ma, Zhang, and Sheng (2003) apply the utility theory to corporate performance evaluation to measure the performance of logistics enterprises. First, they determine the logistics performance evaluation index system and establish an efficiency function model, aimed at three hierarchy index systems. Then, they determine the efficiency values of the primary indexes and make use of the least square method, to determine the weight of each level of the indexes. Finally, each level of the indexes is weighted, from the low-level to the high-level indexes, to recurse level by level, in order to obtain the total utility value and to use the total utility value to measure the performance of logistics enterprises.

(3) Application research

Currently, the research and application of user utility by scholars lies mainly in the three aspects of commodity pricing, decision analysis, and resource optimisation.

Some scholars have studied the role of user utility in commodity pricing. He (2012) has researched the pricing strategies of the internet service market. In this context, He proposed the Quality of Service (QoS) and the utility model combined with the internet pricing strategy, made use of the complementary advantages of the two methods to understand ways to improve user satisfaction, and drew on the utility model to balance the benefits of the Internet Service Provider (ISP) and the user. Wei, Wang, and Sun (2012) have researched the application of user utility in the specific case of insurance product pricing and introduced the utility function to depict the risk attitude of the decision-maker. They applied the subjective expectation utility model to the interpretation and specification of insurance pricing and pointed out that an insurance product is a kind of commodity whose success in the market operation lies in the satisfaction of people's subjective utility, that is, by purchasing insurance, people obtain the subjective satisfaction that matches the price he or she has paid.

Qiu and Liu (2014) have applied user utility to the pricing strategies of online education products, and by establishing the relationship between user utility and product price, they improved the profit function and determined the best price of online education products under the condition of maximisation. Wang (2012) combined the incomplete information bargaining theory with Kelly's utility function and applied a hagggle regression method. Further, aiming at logistics software customisation service, he established the optimal pricing model. To discuss the pricing strategies of logistics providers, Cui, Zhang, and Shi (2010) have used the utility function to depict the risk aversion characteristics of logistics providers and manufacturers,

which reflects the impact of manufacturer's risk aversion characteristics on the pricing decision of logistics providers.

Some scholars have combined user utility with mathematical modelling, applied it to decision analysis and target optimisation, and made use of the expectation utility theory or maximal utility model to make decisions. Jiang (2006) constructed models according to the actual risk preference system classification, and proved that the decision-maker utility function must be a linear and exponential function, whereby the former refers to risk neutrality, and the latter refers to risk aversion and risk seeking. The different values of the function parameters determine the risk preference nature and extents uniquely, and this method provides a valid and practical programme for the evaluation of investment value. Yang, Chen, and Sun (2014) take the maximal user utility as the goal, construct a route operation organisation optimisation model, select particle swarm optimisation, and utilise Matlab to write programmes, seek solutions, and to obtain the optimisation model for urban and rural passenger traffic lines.

More recently, Liu (2017) has synthesised both Chinese and international research status quo of satisfaction concerning user perception, user sales return, user utility, and closed-loop supply chain. Based on this, he introduced the closed-loop supply chain recycling mode and its characteristics and summarised manufacturers' selected return mode standards to establish two optimisation models, where one of them considers the trading centre that trades the waste products with the user group, and the other considers both: the trading centre and the user group's returning behaviour. These two models were utilised to discuss how manufacturers consider optimal comprehensive corporate benefits and maximum user utility at different stages of development.

Some scholars apply user utility to network resource optimisation and cloud computing. Song (2013), to overcome the difficulty in the traditional network resource distribution method to meet the QoS demand of the user, studied the user utility network resource distribution methods, and put forward a utility function cluster based on a utility class and service double-layer resource distribution model (known as ‘U-S’) from the perspective of the user research resource distribution. Resource distribution methods and technologies are topics of current interest in the field of cloud computing, but existing solutions do not fully consider the users’ actual demand in resource distribution and scheduling.

Tang, Zhu, Yang, Tang, and Li (2014) explored the concept of user utility and designed a depicted model of user utility in the cloud environment and provided a user's quantitative method of task implementation and expense satisfaction to further offer an optimisation model of task scheduling oriented toward user utility. Yang (2011) pointed out that security and utility have become two issues that draw the most attention in the field of cloud computing. He built a mathematical model for security and utility in the cloud environment aimed at ensuring the security of data resources and the improvement of user utility. He then analysed and optimised the model, and finally, worked out the optimisation configuration scheme of security strategy in the cloud environment.

2.2.3 Summary of literature review

This section sorted out the literature on the two concepts of user value and user utility. First we introduced the three categories of user value. The first considers that users are value sensing subjects, therefore the concept of user sensing value was introduced through the

perspective of three schools. Then we have reviewed the literature on the measuring tool of user sensing value, that is, user utility as a seminal concept for this research. The theoretical research of user utility provides theoretical support of value evaluation other than money value, thus making commodity value to be measured not only by money. Meanwhile, the user utility theory provides basis and method for measuring the subjective perception value of users. With the economy and society developing, people are improving their living standards and currently the market put more and more emphasis on user orientation, and individual customization. Therefore user utility evaluation has become the most important development basis for commodities and commercial modes, to meet the demand for social development.

The review of the existing literature shows that user utility has been applied in commodity pricing strategies and in decision-making analysis, but so far it has not been much applied to the value of logistics platforms. This study applies user utility to the 4PL platform value evaluation aiming at enriching the scope of application of the user utility theory.

2.3 Research hypotheses

The 4PL platform, as an information platform linking logistics demand and supply, is facing a multilateral market that includes 3PL, management consultancy providers, technology providers, and customers. For convenience, this thesis names the party that provides cargo sources as the cargo owner, and the party that provides the truck and transport capacity as the truck owner. Cargo owners and truck owners together make up the users of the 4PL platform. Researching the value of the 4PL platform means analysing whether the 4PL platform has an impact on cargo owners and truck owners or not, and if so, what kind of impact it has. Based

on the above user-perception value, utility value, and user utility theories, we propose the relevant hypotheses for the 4PL platform value research from the perspective of the 4PL platform users.

As for cargo owners, we consider that the 4PL platform has an impact on the cargo owner's service utility perception, logistics costs, and utility.

The cargo owner's utility perception of logistics services is affected by the two aspects of the objective property elements and the cargo owner's subjective preference of logistics services. Logistics Enterprises Classification and Evaluation Indexes define logistics services as a series of logistics activity processes implemented to meet customer demand and their generated outcome, while comprehensive logistics services refer to systematic logistics function solutions and organised and implemented logistics services formulated for customers (Standardization Administration of China, 2005). From the perspective of forms of logistics, Ma and Chen (2007) believe that logistics services refer to the comprehensive reflection of response speed, logistics costs, order completion punctuality, and order delivery reliability of a given logistics platform system, during the entire process flow from accepting customer demand to order processing to cargo sorting to transportation to delivery.

From the perspective of dispatching logistics services, Daugherty, Stank, and Ellinger (1998) have researched the relationship between dispatching services and market shares in the consumer goods industry and sorted out the logistics dispatching service capability of 11 elements including load factor, order fulfilment rate, cycling time consistency, cycling time duration, delivery punctuality, delivery frequency, communication questions and change, goods

accuracy, application of advanced logistics information technology, and customisation services. From the perspective of reaction capacity, Lu and Yang (2010) have evaluated the critical logistics service capacity of the Taiwan International Distribution Center, and pointed out that the logistics service reaction capacity mainly refers to customer response, innovation, obtaining economies of scale, flexible operations, and logistics knowledge capability that logistics enterprises have, among which customer response capability has been taken as the most important logistics services capability.

As to the 4PL services, Zhang (2005) argues that the utilisation and development of the 4PL information transaction platform have changed the form of traditional logistics operation, and realised that the timely transfer of information between the cargo owner and the carrier has led to the improved efficiency of the operation of the entire transaction process, reduced labour time in society and corporate costs, besides better services for cargo owners. The 4PL platform as a resource and information integration platform has a built-in leading advantage in logistics services capabilities. The logistics services of the 4PL platform have a high automation level and may have automatic tracking and identification with the application of internet technology, and with big data that shows the historic and tendency data of suppliers and demand in the logistics market, it can make logistics services more elaborate and user-friendly.

In conclusion, we believe that the 4PL platform can provide better logistics services to cargo owners, and better logistics services bring about improved service utility perception of cargo owners. Thus, hypothesis 1 is proposed.

Hypothesis 1: The 4PL platform improves cargo owners' service utility perception.

Besides service utility perception, the logistics costs of cargo owners are also a component of the user utility of cargo owners. Daganzo (1997) divides logistics costs into transfer costs that overcome the spatial obstacle of commodities and holding costs that overcome the time obstacle of commodities. The transfer costs specifically include transportation costs and loading and unloading costs, and the holding costs include rental costs and waiting costs. Logistics costs classification based on transportation and warehousing helps reveal the relationship between all functions of logistics costs (Hua & Zhang, 2008). Thus, Gríful-Miquela (2011) divides logistics costs into costs during warehousing operations and costs during transportation.

As for cargo owners' logistics costs, these include two aspects: first, costs generated during the logistics phase and paid to the manpower, costs expended on machinery and equipment, and costs paid to external third parties; second, potential costs generated by ownership and storage during the logistics phases, such as capital costs and insurance charges (Healy & Palepu, 2001).

Cargo owners make use of the 4PL platform for direct logistics transactions and to avoid utilising middle men, which allows them to save costs that otherwise would have to be paid to an external third party (Yang, Zhang, Cao, & Li, 2011). Moreover, the 4PL platform speeds up the matching between truck and cargo (Xie, 2017), which infers that this lowers the costs for holding cargo. Furthermore, Zhang (2005) mentions that the 4PL platform lowers corporate costs. The cargo owners in this thesis refer to the enterprises that the 4PL platform serves, whose costs shall also decrease. Thus, hypothesis 2 is proposed.

Hypothesis 2: The 4PL platform reduces cargo owners' logistics costs.

The cargo owner user utility includes the two components of cargo owner service utility

perception and cargo owner logistics costs. User utility of cargo owners represents the overall impact of the 4PL platform on the cargo owner, that is, the cargo owner's overall evaluation of the 4PL platform. The logistics services provided for the cargo owners by the 4PL platform will, on the one hand, affect their service utility perception, and, on the other, will also affect their logistics costs. Therefore, the cargo owner user utility can be understood as the subtraction of cargo owner utility perception and cargo owner logistics costs. Based on hypotheses 1 and 2, the cargo owner service utility perception increases and the logistics costs decrease. Thus, hypothesis 3 is proposed.

Hypothesis 3: The 4PL platform improves cargo owners' user utility.

As for truck owners, we assume that the 4PL platform has an impact on the services utility perception, logistics profits, and user utility of truck owners.

The truck owners' utility perception of logistics services is affected by the two aspects of objective property elements, and the truck owner's subjective preference for logistics services. The services which the 4PL platform provides, mainly cargo source information, smart matching information function, transaction functions of online bidding and receipt discount, and the management function of logistics stewards (Lin, 2009), cannot be provided by the traditional logistics platform, that is, the 4PL platform provides more services than the traditional logistics platform does. Thus, hypothesis 4 is proposed.

Hypothesis 4: The 4PL platform improves truck owners' service utility perception.

The 4PL platform mainly works to integrate transport capacity resources, making logistics middle men redundant, and lowers the total logistics costs of each cargo deal during

transportation (Zhao, 2012). Although the total costs during the entire logistics process will decrease, the truck owner cannot determine the cost decrease or increase. The logistics costs of the truck owner mainly include fuel costs, loading expenses, road toll, freight transport surcharge, vehicle maintenance fees, vehicle repair expenses, vehicle depreciation costs, and vehicle insurance premium (Chen, 2015), and these expenses are not directly influenced by the 4PL platform. Moreover, due to unknown cost fluctuations, the income of the truck owners cannot reflect the obtained benefits or their user utility. Costs and income of truck owners cannot explain their utility, hence we chose the truck owners' profits for consideration and evaluation. Profits are income subtracted by costs, which provide more explanatory power for truck owners' utility. Thus, hypothesis 5 is proposed.

Hypothesis 5: The 4PL platform improves truck owners' logistics profits.

Truck owner user utility includes the two components of truck owner service utility perception and truck owner logistics profits. It represents the overall impact of the 4PL platform on the truck owner, that is, the truck owner's overall evaluation of the 4PL platform. The services provided for the truck owners by the 4PL platform, will, on the one hand, affect their service utility perception, and, on the other, affect their logistics profits. Therefore, truck owner user utility can be understood as the sum of their utility perception and logistics profits. Based on hypotheses 4 and 5, the truck owner's service utility perception and logistics profits increase. Thus, hypothesis 6 is proposed.

Hypothesis 6: The 4PL platform improves truck owners' user utility.

The users of the 4PL platform consist of cargo owners and truck owners. The user utilities

of the cargo owners and the truck owners both increase, and hence it indicates that the 4PL platform user utility increases. Thus, hypothesis 7 is proposed.

Hypothesis 7: The 4PL platform improves user utility.

Table 2-5 Research hypotheses

Hypothesis	Hypothesis description
Hypothesis 1	The 4PL platform improves cargo owners' service utility perception.
Hypothesis 2	The 4PL platform reduces cargo owners' logistics costs.
Hypothesis 3	The 4PL platform improves cargo owners' user utility.
Hypothesis 4	The 4PL platform improves truck owners' service utility perception.
Hypothesis 5	The 4PL platform improves truck owners' logistics profits.
Hypothesis 6	The 4PL platform improves truck owners' user utility.
Hypothesis 7	The 4PL platform improves user utility.

The above 7 hypotheses include the 4PL's impact on the two types of users: cargo owners and truck owners. The first three hypotheses center on the cargo owners utility, and the next three on the truck owners utility, while the last hypothesis is the summary of the previous six hypotheses, embodying the overall impact of the 4PL platform on user utility. The 7 hypotheses are presented in table 2-5.

2.4 Summary

In this chapter, we reviewed relevant research on 4PL and user utility and, drawing from

it, we presented seven hypotheses. Sorting out the main research contents of 4PL, including the six aspects of concept definition, operation mode, network optimisation, platform design, value creation, and value evaluation, we determined the 4PL of platform model operation which is the research object of this thesis. Platform value is the core of this study, and for this we also reviewed value theory, and based on the first category of user value, we ascertained our research perspective on users as sensing subjects.

User utility is an important medium for research on platform value and, thus, we reviewed and established the relevant concepts, theories and applications. Furthermore, we clarified the relationship between user utility and platform value. We analysed the value of the 4PL platform from the perspective of users, that is, we utilised user utility to measure users' subjective perception of the 4PL platform. Based on this, we presented seven research hypotheses that impact the 4PL platform. The 7 hypotheses embody the overall sensing of the truck owners and the cargo owners on the platform. Empirical research will be conducted to test these hypotheses.

Chapter 3: Research design and methods

From the literature review on 4PL and user utility in the previous chapter, we could have a better understanding of the theoretical research on 4PL value. To test the research hypotheses proposed in Chapter II, a representative 4PL platform, Lahuobao Logistics Platform (LHB), was utilized as the supplier of first-hand and second-hand data. Then we used the statistical approach, Difference-in-Differences (DID), to analyse the data and test the research hypotheses.

3.1 Research object

The 4PL platform LHB under the umbrella of Hongtu Logistics Enterprise in China was chosen for two main reasons:

(1) It is industrially representative. The LHB platform was launched in August, 2015; by December, 2017, it boasted around 90,000 valid registered users and monthly transactions of nearly 150 million RMB yuan, with a monthly compound growth rate of 30%. The Ministry of Transports of the People's Republic of China launched recently a non-truck operation carriers survey, and it showed that the LHB platform ranked No. 10 in freight and No. 4 truck in integrating capacity ranking.

(2) Data acquisition is convenient and accessible. The operation data of 4PL platforms are in general confidential and represent a corporate trade secret. However, although these data are difficult for outsiders to acquire, we have privileged access to the top executives of Hongtu Logistics, the parent company of the LHB platform. This benefit is two-fold: the LHB platform

can provide this research with adequate platform operation data and historical materials and data, as well as with support for the survey of platform users that is necessary for this research.

In this thesis, the LHB platform users are not common consumers of e-commerce websites, but cargo owners and truck owners engaged in logistics transactions. This thesis mainly researches the impact of the 4PL platform on user utility. Therefore, the objects of the survey can be divided into two categories: the experimental group, comprising those users who started to use the LHB platform to conduct logistics transactions at a point in time and have been using only the LHB platform ever since; and the control group, comprising those users who have never used the LHB platform, or any other 4PL platform to engage in logistics transactions.

3.2 Research variables and measurement

Based on the research hypotheses proposed in the previous chapter, the key research variables of this thesis can be divided into two categories: cargo owner-related variables and truck owner-related variables. The cargo owner-related variables include the cargo owner's service utility perception, cargo owner's logistic costs, cargo owner's user utility, and cargo owner control variables. The truck owner-related variables are truck owner's service utility perception, truck owner's logistic profits, truck owner's user utility, and truck owner control variables. The cargo owner's user utility and truck owner's user utility ultimately form the user utility for the 4PL platform. To further measure these key variables, we need to know the specific operation flow of the 4PL platform.

According to the summary of Anderson Consultancy (Cheek, 2003), the general operation

flow of the 4PL platform is as follows: a user posts logistic demand information on the 4PL platform; upon receipt of the order, the platform first tests if there are logistic hardware and logistic service providers meeting the conditions. If not, the platform inquires whether the customer can alter the conditions and test again. If the 4PL platform can meet the requirements of the order, it will undertake the assignment. Then, the platform starts to optimize the logistic schemes of this logistic requirement and looks for logistic service providers; it then analyses comprehensive benefits. Once the logistic solutions are confirmed, the platform will issue the logistic command to real logistic enterprises to start the implementation of the logistic activity and conduct valid tracking until the logistic activity ends. Based on the general operation flow of the 4PL platform, we find that the cargo owner posts the cargo distribution order on the platform to look for cargo carriers and pays logistics fees after the logistic distribution; the truck owner undertakes cargo distribution orders on the platform, covers oil consumption and vehicle maintenance during cargo distribution, and obtains logistics freight upon cargo distribution.

3.2.1 Cargo owner-related variables

3.2.1.1 Cargo owner's service utility perception

We define cargo owners' service utility perception according to the definition of service utility by Li (2017), namely, cargo owners' service utility perception is the comprehensive perception of logistic service meeting the demand when the truck owner uses the 4PL platform to handle the logistics transaction. Referring to the logistic service quality index system constructed by Ma, Zhang & Sheng (2003), we applied the Delphi method as it will be explained in detail late in this thesis (section 3.2.3.3 and following). Finally, we measured the

cargo owner's service utility perception (CSUP) with the two indexes of rate of service realization and rate of service completion in time. The specific definitions of the indexes are as follows.

The rate of service realization (RSR) refers to the probability that the cargo owner finds a truck each time he wants to deliver cargo. This index is measured by the ratio of cargo owner's monthly average actual consignment over the total number of consignment demands. For example, a cargo owner posts cargo freight information to truck owners engaged in freight transport on the 4PL platform; a truck owner successfully takes the order in the specified time, which means this freight transaction service is realized. If in 48 hours after the freight information is posted, no appropriate truck owner takes the order, this freight transaction service is not realized.

The rate of service completion on time (RSC) refers to the probability that the truck owner, after taking the freight order, can deliver the cargo to the destination within the time specified by the cargo owner. According to long, medium and short distance transports, the ratio of the number of times the truck can timely deliver cargo to the destination to the number of times of actual consignment in the month is the rate of service completion in time (RSC). For example, for short distance freight, the cargo owner requires that the truck owner deliver the cargo to the destination within 24 or 48 hours. When the cargo carrier can deliver the cargo to the destination on time or ahead of schedule, it means the service completion rate of this consignment is reached in time; otherwise, it is not reached.

3.2.1.2 Cargo owners' logistic costs

Cargo owners' logistic costs (CLC) is measured by freight amount per average unit cargo that the cargo owner consigns; its unit is hundred Yuan/ton (1 yuan equals about 0.13 €).

3.2.1.3 Cargo owner's user utility

Cargo owners' user utility (CUU) refers to the overall utility that the cargo owner obtains from the logistics transaction, and specifically includes the two components of cargo owners' service utility perception and cargo owner's logistics costs. The loss of freight transport and its duration are mainly related to cargo type, truck condition, and running route, and not closely related to the 4PL platform; therefore, these objective factors are not within the scope of our research.

The rate of service realization is expressed by m_i^c ; the rate of service completion in time is expressed by t_i^c ; the cargo owner's logistic costs are expressed by c_i^c ; cargo owner's monthly user utility is expressed by U_i^c . Superscript refers to one cargo owner, and subscript refers to a particular month.

The function of the cargo owner's user utility is as follows:

$$U_i^c = \alpha * \exp(m_i^c + t_i^c) - \beta * c_i^c \quad (3.1)$$

The cargo owner's service utility perception is expressed by s_i^c , and is the sum of the two indexes of the rate of service realization and the rate of service completion on time, using the natural exponential represented by the equation 3.2.

$$s_i^c = \exp(m_i^c + t_i^c) \quad (3.2)$$

Equation 3.1 can be simplified as:

$$U_i^c = \alpha * s_i^c - \beta * c_i^c \quad (3.3)$$

In equation 3.3, α and β respectively represent the weight coefficients of cargo owner's service utility perception and cargo owner's logistic costs. The coming text will include a detailed explanation of the setting of weight coefficients.

3.2.1.4 Control variables for cargo owners

Table 3-1 Cargo owner-related variables

Variables	Symbols	Definitions
Rate of service realization	RSR	The ratio of cargo owner's monthly average actual consignment over the total number of consignment demands
Rate of service completion in time	RSC	The ratio of the times the truck can timely deliver cargo to the destination within the time duration the cargo owner specifies over the times of actual consignment in the month
Cargo owner's service utility perception	CSUP	Includes the two indexes of rate of service realization and rate of service completion in time
Cargo owner's logistic costs	CLC	Average freight charges for unit consignment of cargo owner
Cargo owner's user utility	CUU	The cargo owner's user utility is the difference between two components of cargo owner's service utility perception and cargo owner's logistics costs
Size of cargo transportation	SCT	Total weight of goods - owners' annual average consignment
Frequency of cargo transportation	FCT	Cargo owners' annual average consignment frequency

To substantiate the research we added two control variables to the model size of cargo transportation (SCT), and frequency of cargo transportation (FCT). SCT refers to the cargo owner's annual average total weight of consignment in tonnes while FCT refers to the cargo

owner's annual average total number of consignments. SCT and FCT to some extent reflect the characteristics of the cargo owners in freight transactions. This thesis controls the impact of the cargo owners' characteristics by controlling these two variables. For definitions of cargo owner-related variables see table 3-1.

3.2.2 Truck owner-related variables

3.2.2.1 Truck owner's service utility perception

According to Li's (2017) definition of service utility, we define truck owner's service utility perception as the comprehensive perception of logistic services meeting the demand, when the truck owner uses the 4PL platform to handle logistics transactions. Similarly, referring to the logistic service quality indexes system constructed by Ma, Zhang & Sheng (2003), we apply the Delphi method. The truck owner's service utility perception (TSUP) is calculated taking into consideration the truck's turnover rate, number of trucking days per month, ratio of truck no-load transportation, and time of receipt of cargo waybill. The specific definitions of the indexes are as follows.

The truck's turnover rate (TTR) refers to the number of freight transactions per month that the truck owner has on average. For the truck owner, the monthly frequency of logistics transactions can well reflect how busy the truck owner is.

The number of trucking days per month (NT) refers to the days per month on average that the truck owners are trucking and reflects how busy the truck owner is with logistics transactions in that month.

The ratio of truck no-load transportation (RTN) refers to the ratio of truck no-load times

to total number of cargo transportation. No-load truck travel indicates that the truck and cargo are not effectively matched, meaning a waste of transport capacity resources. For truck owner, no-load travel means losses, and this is something the truck owner does not expect.

The time of receipt of cargo waybill (TRC) refers to the days the truck owner spends sending cargo receipt to the cargo owner after delivering the cargo to its destination. After the truck owner has delivered the cargo to its destination as the cargo owner requires, he will send the cargo receipt to the cargo owner. Upon seeing the receipt, the cargo owner will pay. This period is called time of receipt of cargo waybill. The methods to transfer the receipt are usually mailing, and taking and uploading the picture of cargo waybill.

3.2.2.2 Truck owner's logistic profits

Truck owners' logistics revenue (TLR) refers to the monthly logistic freight revenue of the truck owner on average. This index indicates the freight revenue per month of the truck owner who is engaged in freight transactions.

The truck owner's fixed logistics expense (TLE) refers to the fixed expenses for the truck including maintenance and insurance fees per month on average. This index indicates the fixed expenses per month of the truck owner who is engaged in freight transactions.

The truck owner's logistics fuel costs (TLF) refer to the costs of oil consumption the truck owner incurs each month on average. This index indicates the oil consumption expenses per month of the truck owner who is engaged in freight transactions.

The truck owner's logistics profits (TLP) is measured by the difference between the average monthly income and average monthly costs for the truck owner in freight transactions.

3.2.2.3 Truck owner's user utility

The truck owner's user utility (TUU) refers to the overall utility that the truck owner obtains from logistics transaction, and specifically includes the two components of the truck owner's service utility perception and his or her logistic profits.

The truck's monthly turnover rate is expressed by t_i^t ; the number of trucking days per month is expressed by d_i^t ; truck no-load transportation is expressed by n_i^t ; the time of receipt of cargo waybill is expressed by w_i^t ; truck owner's logistics revenue is expressed by r_i^t ; logistics expenses include truck owner's fixed logistics expense expressed by e_i^t and truck owner's logistics fuel costs expressed by f_i^t ; the truck owner's monthly user utility is expressed by U_i^t . Superscript t refers to one truck owner, and i refers to a particular month.

The function of the truck owner's user utility is as follows:

$$U_i^t = \gamma[(t_i^t + d_i^t) - n_i^t - w_i^t] + \delta * (r_i^t - e_i^t - f_i^t) \quad (3.4)$$

The truck owner's service utility perception is expressed by s_i^t , which is calculated comprehensively with the following four indexes: the truck's turnover rate, number of trucking days per month, ratio of truck no-load transportation and time of receipt of cargo waybill; this is shown by equation 3.5. The truck owner's logistics profits are expressed by p_i^t , which is calculated comprehensively with the truck owner's logistics revenue, fixed logistics expense, and logistics fuel costs; this is shown by equation 3.6.

$$s_i^t = (t_i^t + d_i^t) - n_i^t - w_i^t \quad (3.5)$$

$$p_i^t = r_i^t - e_i^t - f_i^t \quad (3.6)$$

Equation 3.4 can be simplified as:

$$U_i^t = \gamma * s_i^t + \delta * p_i^t \quad (3.7)$$

In equation 3.7, γ and δ respectively represent the weight coefficients of truck owner's service utility perception and truck owner's logistic profits. The coming text includes a detailed explanation of setting these weight coefficients.

3.2.2.4 Control variables for truck owners

Table 3-2 Truck owner-related variables

Variables	Symbols	Definitions
Monthly turnover rate	TTR	Number of freight transactions per month that the truck owner has on average
Monthly days in transit	NT	The days per month on average for the truck owners to spend in transportation.
Ratio of truck no-load transportation	RTN	The ratio of truck no-load times to total number of cargo transportations
Time of receipt of cargo waybill	TRC	The days the truck owner spends in sending cargo receipt to the cargo owner by mail (or other ways)
Truck owner's service utility perception	TSUP	Including truck's turnover rate, number of trucking days per month, ratio of truck no-load transportation, and time of receipt of cargo waybill
Truck owner's logistics revenue	TLR	Monthly average logistic freight revenue of the truck owner
Truck owner's fixed logistics expense	TLE	Truck owner's monthly average fixed costs on maintenance and insurance
Truck owner's logistics fuel costs	TLF	The costs of oil consumption the truck owner has each month on average
Truck owner's logistic profits	TLP	The difference between monthly freight transaction income on average and expenses (including truck owner's fixed logistics expense and truck owner's logistics fuel costs).
Truck owner's user utility	TUU	The truck owner's user utility is the sum of two components of truck owner's service utility perception and truck owner's logistics profits.
Truck owner's age	TA	Truck owner's age
Truck owner's working years	TW	Truck owner's years engaged in freight transportation

Similarly, for the study of truck owners, we take truck owners' age (TA) and truck owners' working years (TW) as control variables and apply them to the empirical model. The TA and TW reflect to some extent the characteristics of individual truck owners. For definitions of truck owner-related variables, see table 3-2.

3.2.3 Index weight setting

Cargo owners and truck owners have different ways to obtain their indexes, and in combination with the research questions and actual operation conditions, we made use of the Delphi method to determine the weight of various indexes. As it will be explained below, the Delphi method, also known as the expert opinion method, makes use of anonymous opinion declarations that follow specific procedures, i.e. experts cannot talk to each other and, through repeated inquiry, generalization, and modification a consensus is reached among the experts to predict results (Chen & Zhao, 2010).

The Delphi method predicts complex problem based on the expertise and experiences of experts and scholars, and as a subjective and qualitative method it is widely applicable to the decision making system. In this research the specific operation procedures of the Delphi method is 1) identifying and contacting experts in the trade; 2) ascertaining the grade one indexes of user's utility; 3) ascertaining the weight of the grade one indexes of user's utility; 4) ascertaining the grade two indexes of user's utility. Specifically, it goes as follows.

3.2.3.1 Identifying and contacting experts

This research has identified four 4PL corporate business executives, and two college professors engaged in logistics trade research, to form an expert advisory group of 6 people.

Before consultancy, we have called the experts for agreement, telling them of the research background, goal, purpose and expert judgement methods. The six experts' profiles are listed in table 3-3.

Table 3-3 Expert advisory group members profile

Name	Organization affiliated	Title	Trade experience
Yi Xinbin	Luzhou Lianzong Logistics Co., Ltd.	President	15 years' experience in logistics operation management
Yang Jian	Sichuan Changhong Mingsheng Logistics Co., Ltd.	President	15 years' experience in logistics and user relation management
Du Junwen	China Railway Engineering Logistics Worldwide Co., Ltd	Vice GM	8 years' experience logistics information construction
Zhuang Qi	Luzhou Naxi Shulian Logistics Co., Ltd	GM	10 years' experience in logistics operation and management
Ai Xingzhen	University of Electronic Science and Technology of China	Professor	Expert in logistics and supply chain
Jiang Wen	Sichuan Agricultural University	Associate professor	Expert in logistics and supply chain

3.2.3.2 Ascertaining the grade one indexes of user's utility

To ascertain the indexes of user's utility, we first referred to relevant literature in the 4PL logistics field and user's utility research, and made a draft of user's utility; then we consulted the 6 experts about the draft in July 2017 for the first time, and the experts were asked to answer the question "which grade one indexes of user's utility are more important?" Based on the

answers of the experts, we conducted statistics and sorted out the votes of the grade one indexes (see table 3-4).

Table 3-4 Experts screening of grade one indexes of user's utility

Indexes	Cargo owners			Truck owners		
	Service utility perception	Logistics income	Logistics costs	Service utility perception	Logistics income	Logistics costs
Votes	6	1	6	6	4	4
Percentage of votes	100%	17%	100%	100%	100%	83%

Based on the screening of grade one indexes of user's utility, 5 experts believe the logistics income of the cargo owners mainly comes from the logistics cargo, and does not have a lot to do with the 4PL platform, so they set cargo service utility perception and logistics costs as grade one indexes of user's utility. As for logistics income and logistics costs, two experts pointed out logistics costs or logistics income alone of the truck owner cannot explain the user's utility of the truck owners, and the truck owners' profit has stronger explanation of the user's utility, so they suggested we combine logistics income and costs into one index of logistics profit, so this research set the truck owner's service utility perception and logistics profit as the grade one index of user's utility.

3.2.3.3 Ascertaining the grade one index weight of user's utility

Based on the grade one indexes of user's utility, we have the second consultation of the experts in August 2017. The experts assigned weight to grade one indexes of user's utility based on their individual knowledge and trade experiences. We retrieved 6 questionnaires of experts, to conduct statistics of the weighted value of the grade one indexes of the cargo owner's and

truck owner's utility, whose results are shown in table 3-5. After these rounds, the cargo owner's service utility perception weight was set as $\alpha=55\%$, and the cargo owner's logistics costs weight was set as $\beta=45\%$. The truck owner's service utility perception weight was set as $\gamma=40\%$, and the truck owner's logistics profits weight was set as $\delta=60\%$)

Table 3-5 Expert inquiry about grade one indexes of user's utility

Indexes	Cargo owners		Total	Truck owners		Total
	Service utility perception	Logistics costs		Service utility perception	Logistics profit	
Average weight	55%	45%	100%	40%	60%	100%

3.2.3.4 Ascertaining grade two indexes of user's utility

Table 3-6 Expert inquiry results of grade two indexes for user's utility

Cargo owner			Truck owner		
Grade one indexes	Weight	Grade two indexes	Grade one indexes	Weight	Grade two indexes
Service utility perception	55%	rate of service realization	Service utility perception	40%	monthly vehicle turnover rate
					monthly days in transit
		rate of service completion in time			ratio of truck no-load transportation
					time of receipt of cargo waybill
Logistics costs	45%	/	Logistics profits	60%	Logistics revenue
					Logistics costs

Based on the above expert inquiry, this research ascertains four grade one indexes and

their weighted value of cargo owners and truck owners. Then, we sent notification of the previous two researches, and conduct the third expert inquiry in October 2017. The experts group set the grade two indexes for 4 grade one index of user's utility, and pointed out the grade one indexes have been given weighted value, so there is no need to set weighted value for the grade two indexes.

Finally, the experts group discussed and ascertained the cargo owner's service utility perception includes the rate of service realization and the rate of service completion in time, and there is no secondary indexes for cargo owner's logistics costs; the truck owner's service utility perception includes four grade two indexes of the monthly vehicle turnover rate, the monthly days in transit, the ratio of truck no-load transportation and the time of receipt of cargo waybill, and the logistic profits includes the two grade two indexes of logistics revenue and logistics costs (see Table 3-6).

3.3 Data collection

To evaluate the impact of the LHB 4PL platform on user utility, we needed two groups of objects: the experimental group and the control group. The experimental group consisted of those users who started to use the LHB platform to conduct logistics transaction when the LHB platform was launched and the control group consisted of users who have never used the LHB platform, or any other 4PL platform to engage in logistics transactions. We compared the user utility of the two groups before and after the LHB platform was launched, to determine the impact of the LHB platform on user utility.

3.3.1 Experimental group data collection

We took those users who started to use the LHB platform to conduct logistics transactions when the LHB platform was launched as the experimental group; these users may have different user utility before and after the LHB platform was launched. The LHB platform was launched in August 2015; therefore, we collected relevant data two periods before and after the LHB platform was launched, August 2014 to August 2015, and August 2016 to August 2017, respectively. We then compared the data collected before and after.

As for the data of the experimental group before the LHB platform was used, we obtained the data from Hongtu Logistics, the parent company of the LHB platform, which could provide the transaction data of these users before August 2015 for this research. The data include the basic information of the cargo owners and the truck owners, transaction information, and the contracts the cargo owners and the truck owners signed with Hongtu Logistics. Through these data, we screened and sorted out relevant data of cargo owners and truck owners before the LHB platform was launched, for this research.

We obtained the data of the experimental group after the LHB platform started to be used from the database of the LHB platform after it was launched. The LHB platform's system database can provide the transaction data of these users on the LHB platform after August 2015 for this research. These data includes\ the basic information of the cargo owners and the truck owners, truck and cargo information, and order and transaction information. By screening and sorting out the system data, we obtained relevant data of cargo owners and truck owners after the LHB platform was launched.

To ensure the continuity of data of the experimental group before and after, the users' relevant information must exist in both the historic data of Hongtu Logistics and the system database of the LHB platform. Therefore, those users who did not have complete data were rejected. Finally, we sorted out and found 10 cargo owners and 114 truck owners that met the research requirements of the experimental group.

3.3.2 Control group data collection

We took users who have never used the LHB platform, or any other 4PL platform engaged in logistics transaction as the control group. These users have never used any 4PL platform, so they are engaged in logistics transactions mainly through connections and logistics information brokerage. These users formed the control group; we collected relevant data before and after the LHB platform was utilized, specifically for the periods August 2014 to August 2015, and August 2016 to August 2017.

To collect the data of the users who have never used any 4PL platform, we visited Chuanhua Highway Harbour in Chengdu, Xindu Logistics Center, Shanxing Aluminum Logistics Park in Guanghan, and Luzhou Old Cellar Logistics Park in Luzhou. Questionnaire surveys were administered through face-to-face interviews with cargo owners and truck owners, asking them about logistics transactions between August 2014 and August 2015 (before the LHB platform was launched) and between August 2016 and August 2017 (after the LHB platform was launched). We conducted a random investigation of common logistics users and therefore we could not tell whether they had ever used a 4PL platform; therefore, we designed corresponding questions to reject users who did not meet the criteria. As for cargo owners, we

released 60 questionnaires and retrieved 60 questionnaires, including 8 valid questionnaires. As for truck owners, we released purposefully 300 questionnaires and retrieved 260, including 51 valid questionnaires.

To sum up, we mainly obtained the data of the experimental group through Hongtu Logistics, the parent company of LHB platform and the system database of the LHB platform, and the data of the control group through a questionnaire style survey. Finally, we obtained 18 cargo owners that satisfied the research requirements, including 10 cargo owners in the experimental group and 8 in the control group; we obtained 165 truck owners, including 114 truck owners in the experimental group and 51 in the control group, as shown in table 3-3.

Table 3-7 Sample data sources

	Before LHB platform was launched	After LHB platform was launched
Experimental group (10 cargo owners, 114 truck owners)	LHB platform parent company historical data of Hongtu Logistics	LHB platform system database
Control group (8 cargo owners, 51 truck owners)	Questionnaire	Questionnaire

3.4 Statistical analysis

To evaluate the 4PL value, scholars mostly use the hierarchy analysis process and Delphi method, both of which are dependent on the preferences of the decision makers for original information; therefore, the phenomenon of research results not in line with the actual situation

may easily occur (Saaty & Vargas, 2012). To ensure the research results are in line with the actual cases, we make use of the Difference-in-Differences (DID) method to research the value of the 4PL platform.)

The DID method uses comparisons of the experimental group and the control group before and after the implementation of a certain event the researcher wants to study in order to determine the effect of that event (Chen & Wu, 2015).) The theoretical frame of the DID method is established on the basis of a natural experiment. Natural experiment differs from real experiment in that the researchers of natural experiment conduct experiment without controlling all irrelevant factors, i.e. the researchers cannot control the external factors, and there are various disturbing factors that have impact on the experiment (Chen & Wu, 2015). We regard using the 4PL platform as the implementation of an event, and the empirical study of the 4PL platform is a natural experiment.

This research evaluates the platform by investigating the utility change before and after the users' using the 4PL platform. Conventionally, this could be done by directly comparing the difference before and after the user's using the platform, as Formula 3.8:

$$\bar{Y}_{\text{after}} - \bar{Y}_{\text{before}} \quad (3.8)$$

In Formula 3.8, before and after represent “before using 4PL” and “after using 4PL”, and the value of the formula indicates the utility change before and after using the 4PL platform. This method ignores the impact of the market supply and demand change, logistics industry development and the like disturbing factors which have nothing to do with using the 4PL platform.

With the DID method, we make the users using the 4PL platform as the experimental group, and the users not using the 4PL platform as the control group, and we have Difference in Differences Estimator as follows:

$$DID = (\bar{Y}_{t\text{experimental group,after}} - \bar{Y}_{\text{experimental group,before}}) - (\bar{Y}_{\text{control group,after}} - \bar{Y}_{\text{control group,before}}) \quad (3.9)$$

In Formula 3.9, this estimator does not only consider the difference before and after the user's using the 4PL platform, but also the difference between the users using the 4PL platform and the users of the same kind not using the 4PL platform, to eliminate the impact of other factors than using the LHB platform on the user's utility, and it ultimately indicates the real impact of "using the 4PL platform" on the user's utility.

To sum up, this thesis uses the DID model as the research method for empirical study for two reasons: First, this research is a natural experiment, and using the DID method, we can eliminate the impact of other factors than using the 4PL platform, and compared with the conventional method, this method can help obtain realer and more accurate research findings. Second, this research collects data from before the 4PL appeared to after it appeared, involving users using the 4PL platform and the users not using the 4PL platform, as is in line with the DID model's requirements for establishing the experimental group and the control group.

3.5 Summary

In this chapter, we first explained why we identify the LHB platform as the research object; the LHB platform is representative in this trade and provides convenience for data acquisition;

hence, it offers some favourable conditions for research. Then, we defined the research variables and corresponding indexes; by establishing the user utility model measurement, we have the key variable of user utility, and introduce the setting of weight of relevant indexes. After that, we divided the research objects into experimental group and control group and explained our three ways of collecting data: visits to Hongtu Logistics, the parent company of the LHB platform, for collecting historical data, accessing the system database of the LHB platform, and questionnaire survey. Finally, we explained why the DID method is employed in this thesis to research the value of the 4PL platform.

Chapter 4: The research object: the LHB platform

The previous chapter explained the reason for selecting the LHB platform as the research object, whereas this chapter introduces in detail the research object itself. The LHB platform is described in three parts, namely, the establishment background and status quo, operation mode and system function, and transaction procedures. By introducing these three parts, we can respond to the research hypotheses and variables, arrive at a realistic basis, and provide the upcoming empirical analysis with a realistic background.

4.1 Establishment background and status quo

In recent years, with the in-depth integration of internet technology and freight transport logistics industry, a new operation mode of the non-truck operating common carrier (hereinafter referred to as NTOCC for short) has emerged in the freight transport logistics market. NTOCC refers to those individuals or entities who are engaged in freight transport but have no trucks. These entities utilise the internet technology to establish the logistics information platform to intensively integrate and scientifically dispatch trucks, logistics parks, cargo sources, and other logistics resources. The NTOCC has no need of buying a truck because it has strong resources integrating capacity, a wide brand effect, and a significant network effect. The NTOCC mode utilises the internet technology and innovative organisational mode to effectively enhance the resource integration of the freight market and the standard development of the logistics industry, thereby playing a significant role in transforming and upgrading the logistics freight industry and promoting its quality and efficiency (Ministry of transport of the People's Republic of China

[MTPRC], 2016). The LHB platform, as an open internet transaction integrated service platform for the 4PL services, is also an NTOCC.

To promote the development of NTOCCs, the Chinese government has issued a series of policies. In September 2015, the General Office of the State Council of the People's Republic of China officially issued the Opinion on Encouraging Online and Offline Interaction and Speeding up Innovation, Restructuring, and Upgrading in Commerce Circulation. This marked the policy recognition and support of non-truck operation enterprises and their freight operation. On April 6, 2016, the executive meeting of the State Council proposed to build a public service cloud platform for commerce to allow non-truck operation enterprises to be engaged in cargo transportation. On August 26, 2016, the General Office of the Ministry of Transport of the People's Republic of China issued the Opinions on Promoting Reform Pilot and Speeding up Innovative Development of Non-Truck Operation Carriage Logistics, according to which from October 2016 to December 2017, the Ministry of Transport of the People's Republic of China had to have a pilot group for a NTOCC around China. The parent company of the LHB platform, Hongtu Logistics Co., Ltd. was selected among the first batch of NTOCC pilot enterprises, and the LHB platform was among the first batch of non-truck operation carrier platforms.

The LHB platform was established in June 2015, headquartered in Chengdu, Sichuan. It is a wholly owned subsidiary of the Hongtu Logistics Co., Ltd. and a national high-tech enterprise, awarded with nine software copyright register certificates. The LHB platform is dedicated to the freight transport market, building a road transportation online to offline (O2O) e-commerce platform. Its main business is to provide cargo and truck services for truck owners, cargo owners, and logistics enterprises. According to the NTOCC Pilot Medium-Term

Operation Monitoring Analysis Report (Ministry of Transport of the People's Republic of China, 2017), from January to June 2017, the LHB Company had accomplished 23,000 freight notes and ranked No. 10 in the country. Furthermore, it had effectively integrated 5,394 trucks, ranking No. 4 in the country, and was the only enterprise listed in central and western China. By December of 2017, the LHB platform had gained approximately 90,000 valid registered users, with a monthly transaction of 150 million RMB yuan and monthly compound growth rate of 30%. The LHB platform has now developed into a comprehensive non-truck operation carrier platform based on the carrier of the logistics, with joint participation of the manufacturing, commerce, finance, insurance, and other services.

4.2 Operation mode and system function

4.2.1 Operation mode

With the rapid development of the internet technology, the consequent operation-mode innovation driven has been endless, and online and offline interactions have become one of the most dynamic economic forms. In nature, the LHB platform operation mode integrates the disengaged logistics resources via the internet platform to assist cargo and truck owners to have an O2O-integrated e-commerce platform mode. With the LHB platform available for integrating the logistics resources, the cargo and truck owners can have direct transaction without middleman misappropriating the difference. On the LHB platform, the prominence of big-data technology and smart mobile terminals assist in matching the cargo and truck owners rapidly. Concurrently, the means of payment and evaluation system under the e-commerce

mode are gradually maturing, and both parties of a transaction can rapidly build understanding, trust, and agreement as it expedites the development of the logistics industry.

Under the operation mode of the LHB, the market on the platform includes the two parts of front-end market and back-end market. In the front-end market, the LHB provides freight-related services including freight information release, truck and cargo match, logistics management, advance payment of the freight, and transport insurance. The front-end market has a transparent charge and can be adjusted flexibly according to the service contents. The LHB platform depends on the services provided by the front-end market and complete insurance. It helps the cargo owners to control the transport quality and risks and lower the logistics costs and has become the 'online logistics service provider' of the cargo owners.

Concurrently, the LHB platform provides the truck owners with a more selective and large supply of cargo and smart-supply recommendation services rather than the traditional mode. This promotes the opportunities of the truck owners for receiving orders, so that the truck owners can directly bargain with the cargo owners and reach an agreement on the price. In the back-end market, the LHB unites with the suppliers through the platform (gasoline suppliers, truck maintenance garage, and insurer) to provide the truck owners with truck consumption-related services, mainly including the fuel consumption, fixed-point refuelling, truck maintenance, and insurance purchases. Currently the back-end market business is still under construction, and so this research stresses on the impact of the front-end market of the LHB platform on the users.

4.2.2 Operation system and business functions

The operation mode of the LHB platform needs an innovative operation system and business functions for support. Furthermore, these features need to be established based on the demand of the users. The cargo owner demand of the platform includes two aspects: (1) the demand of the logistics services provided by the platform, mainly including the truck search services and payment and settlement services; (2) the demand for lower logistics demand. The truck owner demand includes two aspects: (1) the demand of the logistics services provided by the platform, mainly including cargo search services and payment and settlement services; (2) the demand for higher logistics profits.

The LHB platform designs the complete operation system and business functions based on the demand of the users. The operation system of the LHB platform includes six systems: information product system, marketing system, logistics service system, operation network system, financier service system, and data application system. Furthermore, it correspondingly provides nine business functions including information release, self-help matching and system recommendation, independent bargain, online payment, store services, 400 customer services centres, finance services, LHB 'ecosphere', and risk assurance credit extension. Please see figure 4-1.

The information product system includes the cargo sources information openness, truck sources information openness, transaction prices transparency, and logistics flow information. Based on the system, the platform realises its information release and self-help matching and system recommendation functions.

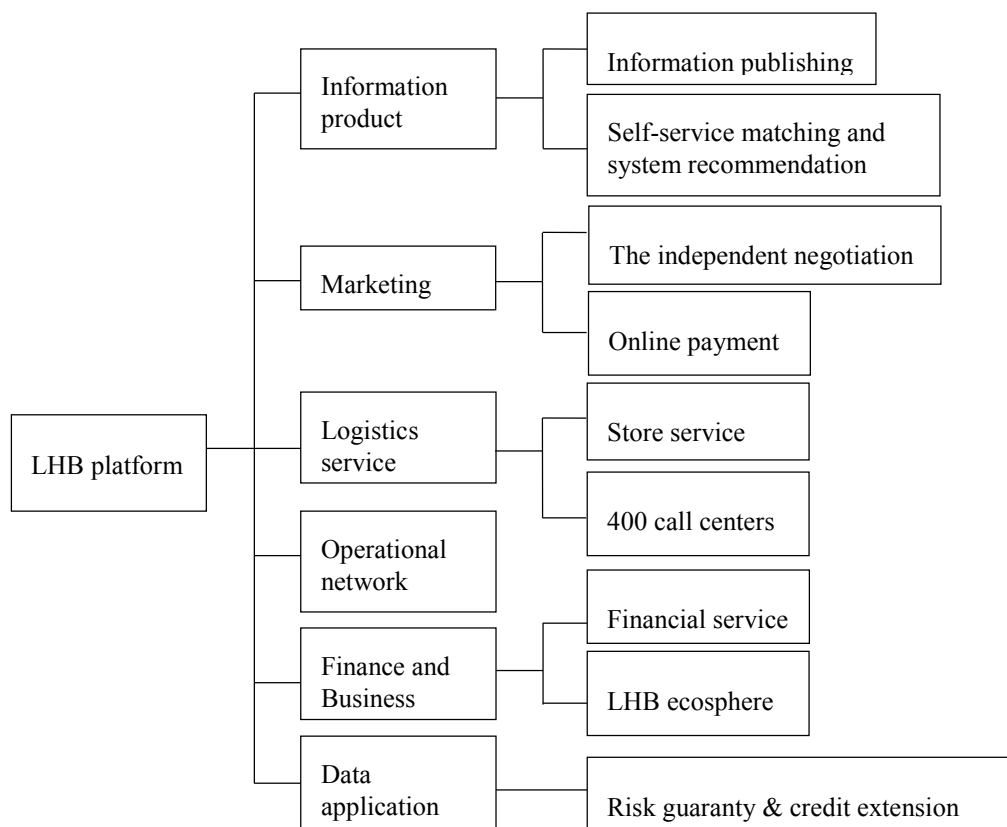


Figure 4-1 Operating system & service functions

The information release function helps the cargo owners to release their cargo sources on the internet and obtain more transport capacity options. The truck owners also have more opportunities to receive orders by uploading their own truck transport information, which is transparent on the internet, avoiding the middleman from misappropriating the difference. In the earlier stage, based on the characteristics of the audience, the self-help matching and system recommendation function offers common screening conditions to help the users to rapidly and easily search for their demands. In the later stage, based on the habit of the users and historical data, it automatically matches the truck length, carrying capacity, goods types, regular route, and price level to conduct automatic recommendation to realise the purpose of the individual services.

The marketing system includes logistics transaction disintermediation (cargo and truck owners have a direct transaction), 'zero' brokerage fee (the platform does not charge any brokerage fee), buy-now price + collective bidding, and platform-supervised payment. Based on this system, the platform realises the independent bargain and online payment functions. In independent bargain, the cargo owners can independently set the means of the bargain, including the buy-now price and collective bidding. Buy-now price refers to the cargo owner setting a target price, and if any truck owner accepts the price, they conclude a transaction. Under collective bidding, after the cargo owner provides a target price, the truck and cargo owners make a price bargain through the platform, and the cargo owner chooses the truck owner who meets the demand for the price best among the truck owners to have the transaction.

The platform only provides the cargo owner with a reference price and quotation services and does not affect the pricing. Online payment refers to the cargo owner paying the freight to the truck owner through the LHB platform; if the cargo owner also chooses other services, the system will include automatic settlement, offering multiple payment means to the cargo owners to pay the freight. The platform also has monitoring of the online payment as it assures the security of the payment. Moreover, the online payment function provides the basis for the financier service system of the platform.

The logistics service system includes the O2O and online platform logistics services. The O2O logistics services mainly refers to the LHB store helping the users to go from online to offline to have a face to face transaction, i.e. store services function. The online platform logistics services refer to the online customer services of the platform, i.e. 400 customer service centre function. The LHB outlet, as an offline physical store of the platform, provides a window

to contact the users, allowing the customers to visit the store for a fine user experience. The physical outlet service function, first, helps the customers to test the LHB platform services. Second, the outlet personnel guides the platform users to conduct their online to office transaction procedure flow. Third, it connects to the cargo owner customers, and when necessary provides the cargo sources supplies for the platform. Moreover, the outlet is a window to showcase the image and strength of the LHB platform. The 400 customer service centres provide the customers with platform application inquiries, insurance ordering, cargo tracking, and abnormality and dispute handling guarantee services.

The operation network system includes the LHB outlet building, regional subsidiary building, and project services team building of the major client cargo owner. The operation network system is mainly aimed at building platforms and conducting business. It does not directly embody a user-oriented function but functions as the core support of the platform operation.

The financier service system includes the financial appreciation services of the platform account balance of the cargo owner and services for the truck owners including gasoline card, ETC, truck maintenance, insurance purchase, and park consumption. Based on this system, the platform realises the financial services functions and LHB 'ecosphere' function. The financial services function provides derivative financial services, helping the user to solve his/her financial services demand in the business. The LHB ecosystem mainly includes the cargo owners, truck owners, financial organisations, and post-market suppliers. The cargo owners provide the logistics transport cargo sources for the LHB platform, and the LHB platform solves the logistics transport problem for the cargo owners. Although the truck owners provide the

transport capacity resources for the LHB platform, they also bring a tremendous consumption demand of the post market of the truck, i.e. although the LHB platform provides stable cargo sources for the truck owners, it makes use of the large scale of the truck owners to provide some discount and privilege for various consumptions in the post market. The financial organisations can utilise the capital pool of LHB platform accounts to provide small credit business to the LHB cargo owners and lend the truck owners consumption support and other financial business. The LHB utilises the resources of the truck owner on the platform and his/her consumption demand resources to cooperate with the post-market suppliers to make profits. Currently, this system is still in the early stage of construction, and so it is not that complete and only a few users are using the current financial services and LHB 'ecosphere' functions.

The data application system includes the credit system and risk control evaluation, three-certificate inquiry (ID card, license of driver, and vehicle travel license) of the truck owners, and three certificates (business license, tax registration and organisation code certificate) of the cargo owners. The cargo and truck owners pay the platform transaction performance bond, the platform has credit guarantee for the truck and cargo owners, and the bank issues credit cards to the truck and cargo owners according to the guarantee of the platform. This system realises the risk guarantee credit extension function. In the early stage of this function, the users pay some amount of cash deposit and the platform allows them 'certain times of amount to pay' as the credit-awarding amount as the guarantee for the transaction within the credit. In the later stage, the users can avail of the fine-user credit evaluation grade accumulation on the platform, and the platform can increase its credit line under the precondition of controllable risks. This function is an important guarantee for securing the logistics transaction between the cargo and

truck owners.

The above six operation system and business functions are at once independent and dependable, and they together realise effective operation of the LHB platform.

4.3 Transaction procedures flow

Based on the operation mode and system function of the LHB platform, we use Figure 4-2 to further describe the logistics transaction procedure flow through the LHB platform for the cargo and truck owners. The transaction procedure flow includes the online and offline parts. The online transaction procedure flow mainly includes the information release, truck and cargo matching, online bidding, online payment, financial services, logistics housekeeper services, and risk guarantee. The offline transaction procedure flow primarily includes signing the logistics contract and cargo transport.

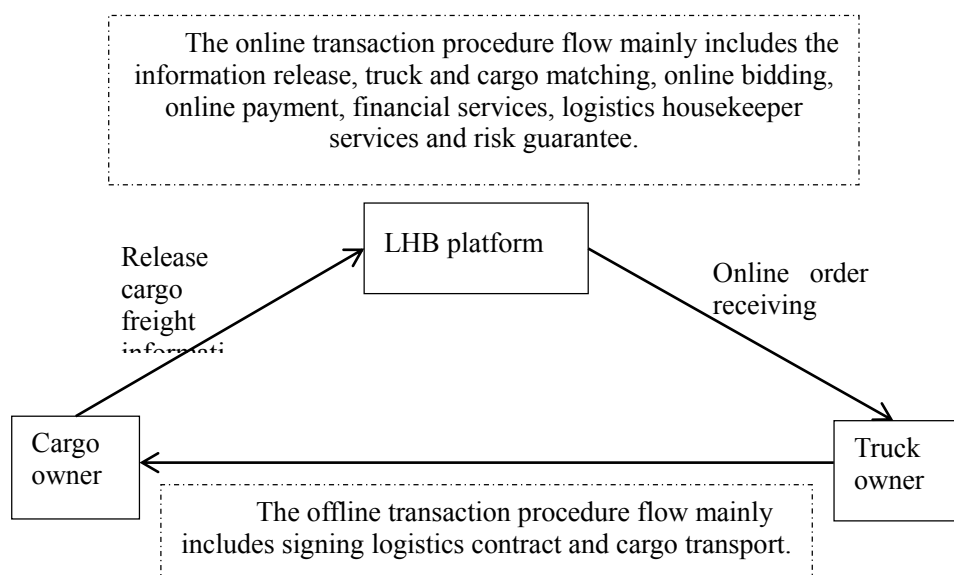


Figure 4-2 Transaction procedure flow

4.3.1 Online transaction procedure flow

According to the time order, we divide the online transaction flow into the three stages of transaction preparation, transaction confirmation, and transaction fulfilment.

Transaction preparation stage: The cargo owner as the side of demand, through the PC and cell phone terminals of the LHB platform, uses the information release function to edit online the cargo transport requirements and initial price and other similar series of information of the freight source and release them. Following this, the information of the freight source appears on the online freight source hall of the LHB platform. Concurrently, the truck owner uses the self-help matching and system recommendation function to search for a freight. As per the self-help matching procedure, the truck owner uses computers or a cell phone application to log in to the LHB platform, browse for the freight source information in the freight source hall, and select the appropriate freight source. In the system-recommended procedure flow, the backstage system of the LHB platform provides smart matching based on the freight source requirements and truck owner information to push a suitable freight source to the truck owner, who views the push information and chooses a suitable freight.

Transaction confirmation stage: When the truck owner selects a suitable freight source, he will bargain with the cargo owner on the platform. The cargo and truck owners can negotiate and vary the quotations until their negotiation fails or they reach an agreement on the prices and click to confirm before the logistics transaction. While the cargo owner clicks to confirm, both the cargo and truck owners can choose other services (advance payment of freight, logistics housekeeper services, insurance services) and the system will automatically close the

costs for them.

Transaction fulfilment stage: After the price confirmation between the cargo and truck owners, the cargo owner waits for the truck owner for an appointment address to sign the contract, and subsequently, the truck owner goes to the procedure for offline cargo transport. Concurrently, the LHB platform enters the procedures for the transport management services for the cargo owner and the next push for the truck owner. The platform performs GPS tracking of the truck owner and supervises the whole transport process, and the cargo owner can view the transport of the truck owner via the platform. If any abnormality occurs during the transport process, the platform will immediately send feedback for achieving timely handling, conducting logistics aid, obligation determination, insurance payment, and expenses settlement. During the truck owner transport, on one hand, the system will smartly predict their return trip according to the location, transport route, and historical information of the truck owner, and push the return trip freight source information in advance; on the other hand, the truck owner can set the return trip information so that the platform can match the return trip freight source for him to lower the ratio of the truck no-load transportation. When the truck owner delivers the freight, he can immediately apply for cargo delivery, send back the receipt, or upload the receipt on the platform. The platform is designed with the receipt uploading function to shorten the receipt sending time. After the cargo owner confirms the receipt, he needs to click signing and confirmation and pay the transport fees. The platform provides multiple payment approaches, and the cargo owner can select a suitable approach to pay the freight. The truck owner can withdraw the freight through the platform at any time.

4.3.2 Offline transaction procedure flow

The offline transaction procedure flow starts with the confirmation of the online transaction, until the online transaction fulfilment is completed.

After the cargo and truck owners confirm the transaction price, the truck owner needs to go to their appointment address in a specified time to sign the freight transport contract with the cargo owner. If the freight source is where the LHB offline outlet is located, the LHB outlet personnel will receive the cargo and truck owners. Following this, the logistics contract will be signed at the outlet and all the procedures will be handled before the contract and procedure information are submitted to the LHB platform. If the freight source is not where the LHB offline outlet is located, the logistics contract will be signed and all the procedures will be handled as the cargo and truck owners negotiate before the contract and procedure information are submitted to the LHB platform.

After the cargo and truck owners handle all the procedures, the truck owner can take the cargo to start the cargo transport. The transport process will be monitored by the LHB platform all the time, during which they can seek for aid by calling 400 customer service call centres in case of any problem. During transport, particularly long-distance transport, the truck owner can stay tuned to the LHB platform information or set the return trip information to confirm the return trip freight source in advance. After the cargo is delivered, the cargo receiver needs to sign on the receipt to show he/she has received the cargo. Next, the truck owner sends the signed receipt back to the cargo owner or uploads on the platform and submits to the cargo owner. After the receipt is uploaded, the truck owner only needs to wait for the cargo owner to confirm

and pay and receive the payment of the freight. The truck owner then starts the next transport according to the next freight source confirmed in advance or searches for the next freight source via the self-help matching and system recommendation on the LHB platform to start a round of new transaction.

At this stage, the online and offline transactions for one round are completed. In addition to the above transaction procedure flow, there are other auxiliary procedures and systems to ensure the secure and effective logistics transaction of the users.

Truck owner audit procedures: Selecting suitable carriers is the basis for the success of a non-truck operation carrier platform. The LHB platform, in addition to verifying the basic information of the cargo and truck owners, has audited the truck owners in various aspects. The data application system of the LHB platform allows it complete information data exchange and processing capacity and the ability to audit the qualifications of the truck owner, vehicle travel license, road transport license, driver license, and professional qualification certificate. Moreover, the LHB platform, aimed at truck-owner selection, abides by the following principles: 1. Selecting the truck owner according to the properties of the transport business (cargo property, volume, and delivery frequency). 2. Truck owner service quality: the previous delivery accuracy and breakage rate. 3. Customer service capacity of the truck owner: In-time delivery of the truck owner, abnormality tackling capacity, and information exchange capability.

Liability of the carrier and insurance pay-out system: The LHB platform as an NTOCC shall be liable for through carriage, with dual legal identities as the carrier of the cargo owner and consignor of the truck owner. The LHB platform utilises the platform resources and

corporate insurance agency qualifications by signing contract with multiple insurance companies to provide the cargo owner with freight insurance business, mainly including compensation in advance and risk early warning. The cargo owner only needs to select the insurance service while confirming the freight price to benefit from the insurance coverage. Concurrently, the platform also purchases the freight insurance of the carrier, with a total amount of 300 million RMB Yuan/year. Having a definite liability mechanism and providing complete insurance services are the key for the platform to draw users, and they also guarantee the property security of the user.

Management system: To have a better internal governance of the platform, the LHB platform gradually establishes and conducts platform internal management and successively releases the following systems: safe production supervision and audit system, safety regular meeting system, safety training and education learning system, practitioners' safety management system, and service quality supervision management system.

4.4 Summary

The LHB platform is currently a NTOCC platform that ranks within the top 10 in China (MTPRC, 2017), and has a relatively mature 'internet + logistics' O2O platform operation mode. It has established the six systems of information product, marketing, logistics services, operation network, financial service, and data application. Accordingly, various platform functions have been developed to provide the users with richer services than the traditional mode. Based on the current system and functions of the LHB platform, we introduced the logistics transaction procedure flow between the cargo and truck owners and other auxiliary

procedures and systems of the platform. The system functions and transaction procedures described in this chapter have an impact on the various variables of the research, are important realistic bases for the future empirical research, and provide realistic bases for the interpretation of the research results.

Chapter 5: Results

Chapters 3 and 4 introduced the data collection, statistical analysis and research object. This chapter specifically explains the process and results of the statistical analysis. First, we provide a descriptive statistical examination of the collected sample data, following which we describe an empirical analysis with the DID model. The empirical analysis introduces in detail the stochastic analysis, endogeneity test of the data, and DID empirical model building and data regression process; finally, we explain the regression results. The statistical analysis software used is the measuring software STATA.14.0.

5.1 Descriptive statistics

5.1.1 Cargo owner data

As mentioned previously, following screening and sorting, we have 18 sample cargo owner users. The data obtained from the cargo owners includes two continuous periods: August 2014 to August 2015 and August 2016 to August 2017, so the observed values of the relevant variables are 36.

Table 5-1 displays the descriptive statistics results of the cargo owner relevant variables. Table 5-1 indicates that the rate of service realisation (RSR) and rate of service completion in time (RSC) for cargo owner logistics transactions are 80%, which means that service in the logistics industry exhibits significant room for improvement, and the phenomena of failure to find trucks or trucks failing to arrive on time still occur. The cargo owner logistics cost of the

average unit freight is 535.80 Yuan/t, which reflects the average freight costs in China. The observed values of cargo owner service utility perception (CSUP) and cargo owner user utility (CUU) are both calculated using the model of cargo owner user utility, and the values of the two variables reflect the extent to which the logistics services meet the demands of cargo owners. The observed mean values of the size of cargo transportation (SCT) and frequency of cargo transportation (FCT) are 741.8 t/year and 27.028 times/year, respectively.

Table 5-1 Descriptive statistics of cargo owner data

Variable	Symbol	Sample size	Min. value	Max. value	Mean value	Standard deviation
Rate of service realisation	RSR	36	0.59	0.936	0.827	0.121
Rate of service completion in time	RSC	36	0.5	1	0.792	0.150
Cargo owner service utility perception	CSUP	36	3.342	7.114	5.358	0.989
Cargo owner logistics costs	CLC	36	0.545	0.985	0.810	0.133
Cargo owner user utility	CUU	36	2.731	4.781	3.812	0.537
Size of cargo transportation	SCT	36	3.212	12.463	7.418	2.674
Frequency of cargo transportation	FCT	36	13.218	32.463	27.028	5.510

5.1.2 Truck owner data

As mentioned previously, following screening and sorting, we have 165 sample truck owner users. The data obtained from the truck owners are from two continuous periods: August 2014 to August 2015 and August 2016 to August 2017, so the observed values of the relevant variables are 330.

Table 5-2 displays the descriptive statistical results of the truck owner relevant variables. Table 5-2 indicates that the mean value of the monthly turnover rate (TTR) of the truck owners is 12.136 times, with a standard deviation of 13.181, which is substantially higher than the standard deviation of other observed values, mainly because no difference is observed between the transport types of long distance, medium distance and short distance, leading to relatively large standard deviation.

The mean value of the monthly days in transit (NT) is 23.033 days, the minimum value is 12 days, and the maximum value is 30 days. The mean value of the ratio of truck no-load transportation (RTN) is 14.8%, which indicates that, during freight transport of the truck owners, 15% of the travel is no load. The mean value of the time of receipt of the cargo waybill (TRC) is 6.682 days, which indicates that, after the truck owner completes a logistics transaction, it takes approximately one week to send the receipt to the cargo owner. The mean value of the truck owner logistics revenue (TLR) is 10,523.9 RMB Yuan/month, the mean value of truck owner fixed logistics expense (TLE) is 1,743.5 RMB Yuan/month, and the mean value of the truck owner logistics fuel costs (TLF) is 936.1 RMB Yuan/month. The minimum value of the truck owner's logistics profits (TLP) is 3,601.2 RMB Yuan/month, the maximum value is 11,513.3 RMB Yuan/month, and the mean value is 7,859.2 RMB Yuan/month. The observed values of the truck owner service utility perception (TSUP) and truck owner user utility (TUU) are both calculated using the model of the truck owner user utility, and the values of the two variables reflect the extent to which the logistics services meet the demands of truck owners. The average truck owner age (TA) is 40, the average truck owner working years (TW) is 12 years and the minimum working time is 3 years. Considering that we require the truck owner

logistics transaction data one year before and after the LHB platform is launched, the minimum truck owner working years is 3 years.

Table 5-2 Descriptive statistics of truck owner data

Variable	Symbol	Sample size	Minimum value	Maximum value	Mean value	Standard deviation
Monthly turnover rate	TTR	330	4	70	12.136	13.181
Monthly days in transit	NT	330	12	30	23.033	4.514
Ratio of truck no-load transportation	RTN	330	0	1	0.148	0.171
Time of receipt of cargo waybill	TRC	330	0	25	6.682	5.191
Truck owner service utility perception	TSUP	330	3.485	8.392	5.983	1.767
Truck owner logistics revenue	TLR	330	44.912	188.961	105.389	5.828
Truck owner fixed logistics expense	TLE	330	6.215	29.822	17.435	8.704
Truck owner logistics fuel costs	TLF	330	5.913	41.163	9.361	6.906
Truck owner logistics profits	TLP	330	36.012	115.133	78.592	3.714
Truck owner user utility	TUU	330	1.380	3.965	2.272	0.418
Truck owner age	TA	330	24	55	39.644	6.664
Truck owner working years	TW	330	3	30	12.412	6.093

5.2 Empirical analysis

5.2.1 DID data test

In chapter 3, we pointed out that the precondition for DID research is that the research object should be in line with "natural experiment" conditions. Thus, before conducting DID empirical analysis, we need to test the launching of the LHB platform and to make sure that the user selection of the LHB platform is a "natural experiment", that is, that the user selection of the LHB platform is random. For this purpose, we need to conduct a stochastic analysis of the experiment. Secondly, we need to determine whether the use of the LHB platform causes a change in the user utility or the change in the user utility causes their use of the LHB platform. To this end, endogeneity testing of the users, namely cargo owners and truck owners, is required, rejecting the causality relation of the change in the user utility causing their use of the LHB platform. Therefore, we have conducted a stochastic analysis and an endogeneity test as described below.

5.2.1.1 Stochastic analysis

A natural experiment refers to an experiment with data obtained from naturally occurring circumstances, and this experiment can effectively reflect the social reality and embody validity. The purpose of the stochastic analysis is to determine whether the research is a "natural experiment". The establishment of the LHB platform reduces the asymmetry of information in the logistics industry, reduces costs, increases efficiency and provides the users with additional quality logistics services such as corporate internal decisions. The consumers in the external

market have no means of dominating the R&D, promotion, and operation of a logistics platform, so the launching of the LHB platform has no direct relation to consumers in the external market, that is, the launching of the LHB platform has no relation to the user utility of the cargo owners and truck owners and can be taken as an exogenous variable. Moreover, following the launching of the LHB platform, the selection of the LHB platform is based on personal subjective will, so we take the event of "choosing to use the LHB platform" as a "natural experiment".

5.2.1.2 Endogeneity test

For an economic subject (individual or enterprise), endogeneity refers to the properties the economic subjects can determine on their own. The word "endogeneity", originating from the biology field, refers to the self-development and self-healing mechanism of the internal organisation of a living body. With the development of economics, particularly economic growth, the concept of endogeneity has been introduced into the field (Ling, 2013). This thesis takes the cross-multiplication of the event "whether to use the LHB platform" and the time "before and after the LHB is launched" as independent variables, which is referred to as "use of the LHB platform" and encoded as "E*T". For cargo owners, the dependent variables include the cargo owner service utility perception, cargo owner logistics costs and cargo owner user utility; for truck owners, the independent variables include the truck owner service utility perception, truck owner logistics profits and truck owner user utility. The endogeneity test determines whether the above dependent variables have an impact on the variable "E*T"; if the results of the endogeneity test reveal that the dependent variable causes a change in the variable "E*T", this indicates that the variable "E*T" is not a suitable independent variable, while the

variable "use of the LHB platform" cannot explain the dependent variable in this research.

Firstly, the method of probability analysis is employed to conduct the endogeneity test for the cargo owner relevant variables, as indicated in table 5-3. This table demonstrates that the cargo owner service utility perception (CSUP), cargo owner logistics costs (CLC) and cargo owner user utility (CUU) have no remarkable impact on the "use of the LHB platform", there is no endogeneity problem and the sample data of the cargo owner pass the endogeneity test.

Table 5-3 Cargo owner data probability

VARIABLE	E*T
CSUP	0.857(0.129)
CLC	0.149(0.966)
CUU	-0.122(0.986)
Constant	-2.208(0.198)
Observations	36

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

We conducted the same test for the relevant variables of truck owners, the results of which are presented in table 5-4. This table demonstrates that the truck owner service utility perception (TSUP), truck owner logistics profits (TLP) and truck owner user utility (TUU) have no remarkable impact on the "use of the LHB platform", there is no endogeneity problem and the sample data of the truck owner pass the endogeneity test.

Table 5-4 Truck owner data probability

VARIABLE	E*T
TSUP	-0.0181(0.656)
TLP	-0.0090(0.737)
TUU	-0.0937(0.231)
Constant	0.0409(0.881)
Observations	330

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.2.2 DID model building

The LHB platform was launched in August 2015. We are concerned with its impact on user utility before and after the users use the platform. We depict the platform value by comparing the user utility before and after using the platform. Thus, we not only compare the difference before and after the users use the LHB platform, but also compare users using and not using this logistics platform. We then comprehensively consider the two differences, thereby using a DID model in econometrics. If the dataset consists of panel data, the DID model may also apply the fixed effect method for controlling the impact of unobservable individual heterogeneity on independent variables. Therefore, the DID model has become one of the main approaches for economists to evaluate the impact of a specific policy or measure in recent years.

In this thesis, we use the DID model to process the research and the panel data are set in accordance with the two-way fixed effects. Adding fixed effects to panel data models is quite common in evaluating public policies and could be applied in our case. Panel data by setting fixed effects may remove the impact of unobservable certainty factors on dependent variables.

In this thesis, we construct DID models for the cargo owners and truck owners, respectively, as follows:

DID model for cargo owners:

$$Y_{it} = \alpha_0 + \alpha_1 E * T + \alpha_2 X_{it} + \lambda_i + v_t + \varepsilon_{it}, \quad (5.1)$$

where Y_{it} are dependent variables, indicating the rate of service realisation, rate of service completion in time, cargo owner service utility perception, cargo owner logistics costs and cargo owner user utility; E is a dummy variable, indicating whether the user uses the platform: if they use the LHB platform, the E value is 1; if they do not use the LHB platform, the value is 0. Moreover, T is a dummy variable, indicating whether the time is before or after the platform is launched: if it is before the LHB platform is launched, the T value is 0; if it is after, the T value is 1. The X_{it} values indicate the vectors of the control variables, including the cargo transportation size and frequency, and λ_i is an individual fixed effect. An unobserved cargo owner individual factor impact on the model is included in the individual fixed effects. Furthermore, v_t is the time fixed effect; the impact of the time dimension on the model is placed in the time fixed effects; ε_{it} is a residual.

DID model for truck owners:

$$Y'_{it} = \beta_0 + \beta_1 E * T + \beta_2 Z_{it} + \lambda_i + v_t + \varepsilon_{it}, \quad (5.2)$$

where Y'_{it} are independent variables, indicating the monthly turnover rate, monthly days in transit, ratio of truck no-load transportation, time of receipt of cargo waybill, truck owner service utility perception, truck owner logistics revenue, truck owner fixed logistics expense, the truck owner logistics fuel costs, truck owner logistics profits and truck owner user utility.

Moreover, E is a dummy variable: 0 for not using the LHB platform and 1 for using the LHB platform; T is also a dummy variable: 0 for before the LHB platform appears and 1 for after; Z_{it} indicates the vectors of control variables, including the truck owner age and working years; λ_i is the individual fixed effects and the unobserved truck owner individual factor impact on the model is included therein; v_t is the time fixed effect and the impact of the time dimension on the model is placed therein; and ε_{it} is a residual.

5.2.3 DID model analysis

5.2.3.1 Cargo owner DID model analysis

Prior to the data regression analysis, we conduct the Hausman test and the test results reject our original hypothesis of the random effect method and fixed effect method not having systematic differences; thus, this research uses the two-way fixed effects DID model.

In order to test hypotheses 1, 2 and 3, we conduct a formal data regression analysis. For the cargo owner data DID model, all independent variables are the cargo owner "use of the LHB platform", encoded as " $E \cdot T$ ", while the dependent variables are the rate of service realisation (RSR), rate of service completion in time (RSC), cargo owner service utility perception (CSUP), cargo owner logistics costs (CLC) and cargo owner user utility (CUU), respectively. The control variables are the size of cargo transportation (SCT) and frequency of cargo transportation (FCT). The regression results are displayed in Table 5-5.

In models (1), (2) and (3), the dependent variables are the rate of service realisation (RSR), rate of service completion in time (RSC) and cargo owner service utility perception (CSUP).

Table 5-5 indicates that the cargo owner "using the LHB platform" and the three variables of rate of service realization (RSR), rate of service completion in time (RSC) and cargo owner service utility perception (CSUP) exhibit significant positive correlation, with significances of 0.01, 0.1 and 0.1, respectively. The cargo user "using the LHB platform" significantly improves the cargo owner logistics transaction rate of service realisation (RSR), rate of service completion in time (RSC) and cargo owner service utility perception (CSUP), so hypothesis 1, namely "the 4PL platform improves cargo owner service utility perception" is not falsified.

The coefficients indicate that the cargo owner "using the LHB platform" effect is very obvious, which makes the cargo owner rate of service realisation (RSR) increase by 24.8%, while the monthly average rate of service completion in time (RSC) grows by 13.3% and the cargo owner service utility perception (CSUP) increases by 10.7%. Moreover, the control variable size of cargo transportation (SCT) and three variables of rate of service realisation (RSR), rate of service completion in time (RSC) and cargo owner service utility perception (CSUP) exhibit a significant negative correlation, with significance levels of 0.1, 0.05 and 0.1, respectively, which to a certain extent reflects that a larger size of cargo transportation results in a lower logistics service utility perception of the cargo owner enterprise. The control variable frequency of cargo transportation (FCT) and the three variables rate of service realisation (RSR), rate of service completion in time (RSC) and cargo owner service utility perception (CSUP) exhibit a significant positive correlation, with significance levels of 0.1, 0.05 and 0.1, respectively, which indicates that when the cargo owner consigns cargo more frequently, the cargo owner enterprise has a higher logistics services utility perception.

In model (4), the dependent variable is the cargo owner logistics costs (CLC). Table 5-5

indicates that the cargo owner "using the LHB platform" and cargo owner logistics costs (CLC) exhibit a significant positive correlation, with a significance level of 0.05. The cargo owner "using the LHB platform" significantly lowers the logistics expenses per unit cargo of the cargo owners, and hypothesis 2, namely "The 4PL platform reduces cargo owner logistics costs" is not falsified. In terms of the coefficient, the cargo owner "using the LHB platform" causes the logistics expenses per unit cargo to decrease by 10.3%.

Table 5-5 Cargo owner regression results

VARIABLE	(1)	(2)	(3)	(4)	(5)
	RSR	RSC	CSUP	CLC	CUU
E*T	0.248*** (-0.00042)	0.133* (-0.0605)	0.107* (-0.0984)	-0.0503** (-0.0023)	0.315*** (-0.0049)
SCT	-0.0476* (-0.495)	-0.128** (-0.032)	-0.104* (-0.0555)	-0.287* (0.0620)	-0.257*** (-0.00533)
FCT	0.00313* (-0.956)	0.102** (-0.0469)	0.0829* (-0.0767)	0.170 (0.187)	0.178** (-0.02)
Constant	1.047*** (-8.63E-04)	1.074*** (-8.50E-05)	1.033*** (-5.84E-05)	7.467*** (3.34E-09)	4.593*** (-1.06E-10)
Individuality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	36	36	36	36	36
R-squared	0.576	0.856	0.837	0.464	0.83

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In model (5), the dependent variable is the cargo owner user utility (CUU). Table 5-5

indicates that the cargo owner "using the LHB platform" and cargo owner user utility (CUU) exhibit a significant positive correlation, with a significance level of 0.01. The cargo owner "using the LHB platform" significantly improves the cargo owner user utility, and hypothesis "The 4PL platform improves cargo owners' user utility" is supported. In terms of the coefficient, the cargo owner "using the LHB platform" causes the cargo owner user utility to increase by 31.5%. Moreover, the impact of the two control variables is significant: a larger size of cargo transportation results in a lower cargo owner user utility; a higher frequency of cargo transportation results in a higher cargo owner user utility. Therefore, hypotheses 1, 2 and 3 are supported.

5.2.3.2 Truck owner DID model analysis

(1) Analysis of impact of truck owner using LHB platform

Similar to the regression analysis of the cargo owner data, in order to test hypotheses 4, 5 and 6, we also use the two-way fixed effects DID model. In the DID model for the truck owner data, the independent variables are the truck owner "using the LHB platform", encoded as 'T'. The dependent variables are the truck owner monthly turnover rate (TTR), monthly days in transit (NT), ratio of truck no-load transportation (RTN), time of receipt of cargo waybill (TRC), truck owner service utility perception (TSUP), truck owner logistics revenue (TLR), truck owner fixed logistics expense (TLE), truck owner logistics fuel costs (TLF), truck owner logistics profits (TLP) and truck owner user utility (TUU). The control variables are the truck owner age (TA), and truck owner working years (TW). The regression results are displayed in tables 5-6 and 5-7.

Table 5-6 Truck owner regression results (1)

VARIABLE	(6)	(7)	(8)	(9)	(10)
	TTR	NT	RTN	TRC	TSUP
E*T	1.817*	1.657***	0.00691	-0.213	0.294***
	(-0.0547)	(-0.0042)	(-0.593)	(-0.642)	(-0.001)
TA	-0.0623	0.141***	-0.0003	0.0697	0.0170**
	(-0.495)	(-0.0093)	(-0.862)	(-0.27)	(-0.0313)
TW	0.136	-0.0619	0.00251	0.0748	-0.0146*
	(-0.17)	(-0.294)	(-0.25)	(-0.278)	(-0.0862)
Constant	16.89***	18.89***	0.153*	0.108	5.957***
	(-2.64E-05)	(0)	(-0.0657)	(-0.968)	(0)
Individuality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	330	330	330	330	330
R-squared	0.4539	0.1792	0.3128	0.2431	0.3744

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

In models (6), (7), (8), (9) and (10), the dependent variables are the truck owner monthly turnover rate (TTR), monthly days in transit (NT), ratio of truck no-load transportation (RTN), time of receipt of cargo waybill (TRC) and truck owner service utility perception (TSUP). Table 5-6 indicates that the truck owner "using the LHB platform" and truck owner monthly turnover rate (TTR) exhibit a significant correlation and the coefficient is positive, with a significance level of 0.1, which indicates that the truck owner "using the LHB platform" significantly improves the truck owner monthly turnover rate (TTR). The truck owner "using the LHB

platform" and monthly days in transit (NT) exhibit a significant correlation and the coefficient is positive, with a significance level of 0.01, which indicates that the truck owner using the LHB platform significantly improves the truck owner monthly days in transit (NT). The truck owner "using the LHB platform", ratio of truck no-load transportation (RTN) and time of receipt of cargo waybill (TRC) exhibit insignificant correlations. The truck owner "using the LHB platform" and truck owner service utility perception exhibit a significant correlation, where the coefficient is positive and the significance level is 0.01, which indicates that the truck owner "using the LHB platform" significantly improves the truck owner service utility perception (TSUP).

The improvement in the truck owner monthly turnover rate indicates that, after the truck owner uses the LHB platform, the truck and cargo matching efficiency is improved and the transaction frequency is increased. The improvement in the monthly days in transit (NT) indicates that, after using the LHB platform, the truck owner working time is increased. The ratio of truck no-load transportation reflects that the truck owner travels with no load, which is a waste of logistics resources. The time of receipt of the cargo waybill reflects the time for the truck owner to obtain freight payment after finishing the cargo transport assignment. The truck owner service utility perception is constructed based on four indices: although the truck owner "using the LHB platform", ratio of truck no-load transportation (RTN) and time of receipt of cargo waybill (TRC) exhibit no significant correlation, the truck owner "using the LHB platform" and truck owner "service utility perception" (TSUP) exhibit a positive correlation at the level of 0.01; in terms of the coefficient, the truck owner "using the LHB platform" causes the truck owner service utility perception to increase by 29.4%; thus, hypothesis 4, namely "The

4PL platform improves truck owners' service utility perception", is supported.

In models (11), (12), (13), (14) and (15), the dependent variables are the truck owner logistics revenue (TLR), truck owner fixed logistics expense (TLE), truck owner logistics fuel costs (TLF), truck owner logistics profits (TLP) and truck owner user utility (TUU). Table 5-7 indicates that the truck owner "using the LHB platform" and three variables of truck owner logistics revenue, truck owner logistic profits and truck owner user utility exhibit significant positive correlations, with significance levels of 0.05, 0.05 and 0.01, respectively, which indicates that the truck owner "using the LHB platform" significantly improves the truck owner logistics revenue, truck owner logistics profits and truck owner user utility.

The truck owner "using the LHB platform" and truck owner logistics fuel costs exhibit a significant correlation and the coefficient is positive, with a significance level of 0.05, which indicates that the truck owner using the LHB platform increases the truck owner logistics fuel costs, because along with the truck owner monthly turnover rate growth, the logistics travel distance increases, leading to an increase in the logistics fuel costs. The truck owner "using the LHB platform" and truck owner fixed logistics expenses have an insignificant correlation. The truck owner fixed logistics expenses are usually truck maintenance and insurance expenses, which are fixed within a year. The truck owner logistics profits are calculated by means of the three indices of the truck owner logistics revenue, truck owner fixed logistics expenses and truck owner logistics fuel costs. The regression results indicate that using the LHB platform can improve the truck owner logistics profits. The truck owner user utility is calculated by means of the two indices of truck owner service utility perception and truck owner logistics profits, the regression results of which also indicate that using the LHB platform can improve

the truck owner user utility; thus, hypothesis 5, namely “The 4PL platform improves truck owners' logistics profits”, and hypothesis 6, namely “The 4PL platform improves truck owners' user utility”, are supported.

Table 5-7 Truck owner regression results (2)

VARIABLE	(11)	(12)	(13)	(14)	(15)
	TLR	TLE	TLF	TLP	TUU
E*T	0.0900** (-0.0289)	-0.0826 (-0.0874)	0.0963** (-0.027)	0.1019* (-0.1)	0.116*** (-0.00775)
TA	0.0104 (-0.146)	0.0119 (-0.137)	0.00114 (-0.913)	0.0027 (-0.779)	0.0121*** (-0.000749)
TW	0.00589 (-0.466)	-0.00376 (-0.696)	0.0119 (-0.347)	8.7094*** (0)	-0.00677 (-0.186)
Constant	9.592***	7.450***	8.579***	8.709***	2.112***
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	330	330	330	330	330
R-squared	0.2539	0.3158	0.4609	0.2789	0.3211

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

(2) Further analysis

In order to depict further the impact of the truck owner using the LHB platform on the truck owner service utility perception and user utility, we divide the samples into long distance travel (LT), medium distance travel (MT) and short distance travel (DT) for regression of the

truck owner data. The regression results are displayed in tables 5-8 and 5-9.

Table 5-8 Further analysis: different transport types of truck owners (1)

VARIABLE	Long distance travel (LT)	Medium distance travel (MT)	Short distance travel (DT)
	TSUP	TSUP	TSUP
E*T	0.078 (0.405)	0.056* (0.0856)	0.106* (0.504)
TA	-0.244 (0.909)	1.629 (0.382)	3.342 (0.119)
TW	0.500* (0.810)	-2.219 (0.226)	-3.906* (0.0641)
Constant	16.89*** (-0.00264)	18.89*** (0)	23.38*** (0.280)
Individual fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	116	88	126
R-squared	0.333	0.018	0.231

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5-8 indicates that different types of truck owner “using the LHB platform” have different impacts on their service utility perception. For medium and short distance travel truck

owners, the truck owner using the LHB platform and truck owner service utility perception (TSUP) exhibit significant positive correlations, with significance levels of 0.1 and 0.1, respectively. The medium distance travel truck owner "using the LHB platform" to conduct logistics transactions can improve the truck owner service utility perception by 5.6%, while the short distance travel truck owner "using the LHB platform" to conduct logistics transactions can improve the truck owner service utility perception by 10.6%. For long distance travel truck owners, the truck owner using the LHB platform and the truck owner service utility perception (TSUP) exhibit an insignificant positive correlation, which indicates that, for long distance travel truck owners, whether or not to use the LHB platform has no impact on their service utility perception. The main reason for this lies in long distance freight truck owners always having stable goods sources and numerous consignments, so that they are not dependent on the LHB platform.

Table 5-9 indicates that different types of truck owner "using the LHB platform" have different impacts on their user utility. For long and short distance travel truck owners, the truck owner using the LHB platform and truck owner user utility (TUU) exhibit significant positive correlations, with significance levels of 0.1 and 0.1, respectively. The long-distance travel truck owner "using the LHB platform" to conduct logistics transactions can improve the truck owner user utility by 5.4%, while the short distance travel truck owner "using the LHB platform" to conduct logistics transactions can improve the truck owner user utility by 7.37%. For medium distance travel truck owners, the truck owner "using the LHB platform" and truck owner user utility exhibit insignificant correlations, and the regression data do not support the theory that using the LHB platform can result in an increase in the truck owner user utility. In summary,

the LHB platform can provide truck owners with various cargo sources, and more transparent quotations may enhance the truck owner service utility perception and extend transaction limits, while also increasing income sources, to add to the user utility in the logistics transactions of truck owners.

Table 5-9 Further analysis: different transport types of truck owners (2)

VARIABLE	Long distance travel	Medium distance	Short distance travel
	(LT)	travel (MT)	(DT)
	TUU	TUU	TUU
E*T	0.054* (0.723)	-0.128 (0.162)	0.0737* (0.229)
TA	0.01000 (0.943)	0.140 (0.591)	-0.091 (0.988)
TW	0.0880* (0.535)	-0.132 (0.615)	-0.0696 (0.691)
Constant	10.96*** (0.0310)	7.031*** (0.778)	9.669*** (0.388)
Individual fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	116	88	126
R-squared	0.114	0.012	0.139

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

According to the regression analysis of the goods owner data, hypotheses 1, 2 and 3 are supported, and the use of LHB can improve the service utility perception of the cargo owner and user utility of the cargo owner, while decreasing the logistics costs of the cargo owner. According to the regression analysis of the truck owner data, hypotheses 4, 5 and 6 are supported, and the use of LHB can improve the truck owner service utility perception, truck owner logistics profits and truck owner user utility. As using the LHB platform can improve the cargo owner user utility and truck owner user utility, hypothesis 7, namely "The 4PL platform improves user utility", is naturally supported. In summary, the data regression analysis for the two user types demonstrates that all seven hypotheses in chapter 2 are supported.

5.3 Robustness test

In order to research the impact of the LHB platform on user utility, in the above text, we have discussed the regression analysis of the cargo owner and truck owner data and found that "using the LHB platform" can significantly enhance the user utility and that all theoretical hypotheses are supported. In order to verify the robustness of the regression results, in this section we conduct a robustness test on the cargo owner and truck owner data.

5.3.1 Goods owner data robustness test

To ensure the generality of the conclusion and that the regression results are established in different regression models, we firstly provide the robustness test of the cargo owner data. As we do not have data for certain cargo owners from August 2015 to August 2016, we remove these when conducting formal regression, and in the robustness test, we include these data with

missing values in samples again, in order to form non-balanced panel data for August 2014 to August 2017.

Table 5-10 Cargo owner data robustness test

VARIABLE	(1)	(2)	(4)	(3)	(5)
	RSR	RSC	CSUP	CLC	CUU
E*T	0.248*** (0.000480)	0.348*** (1.46e-05)	0.298*** (4.78e-05)	-0.140** (0.0118)	0.299*** (4.63e-07)
SCT	-0.0476 (0.397)	-0.0858 (0.196)	-0.0667 (0.272)	-0.300** (0.0165)	-0.220** (0.0162)
FCT	0.00313 (0.925)	0.0235 (0.593)	0.0133 (0.728)	0.194** (0.0317)	0.111 (0.117)
Constant	1.047*** (0.000564)	1.145*** (0.000719)	1.096*** (0.000582)	6.446*** (5.85e-11)	4.654*** (0)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	86	86	86	86	86
R-squared	0.576	0.672	0.646	0.417	0.754

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The cargo owner data robustness test results are displayed in table 5-10. The cargo owner "using the LHB platform" (E*T) and rate of service realisation (RSR), rate of service completion in time (RSC) and cargo owner service utility perception (CSUP) still exhibit significant positive correlations, which is in line with the formal regression results; thus, hypothesis 1, namely "The 4PL platform improves cargo owners' service utility perception", is

still supported. The cargo owner “using the LHB platform” (E*T) and logistics costs (CLC) still exhibit a significant negative correlation, so hypothesis 2, namely “The 4PL platform reduces cargo owners' logistics costs”, is still supported. The cargo owner “using the LHB platform” and cargo owner user utility still exhibit a significant positive correlation; thus, so hypothesis 3, namely “The 4PL platform improves cargo owners' user utility”, is still supported. Therefore, theoretical hypotheses 1, 2 and 3 pass the tests and are supported. Using the LHB platform can aid in improving cargo owner service utility perception, reducing the cargo owner logistics costs and increasing their user utility in logistics transactions.

5.3.2 Truck owner data robustness test

The truck owner data robustness test results are displayed in tables 5-11 and 5-12. The truck owner “using the LHB platform” (E*T), truck owner monthly turnover rate (TTR), monthly days in transit (NT) and truck owner service utility perception (TSUP) still exhibit a significant positive correlation. The truck owner “using the LHB platform” (E*T) ratio of truck no-load transportation (RTN) and time of receipt of cargo waybill (TRC) still exhibit no correlation; thus, hypothesis 4, namely “The 4PL platform improves truck owners' service utility perception”, is still supported. Using the LHB platform can aid in increasing the truck owner monthly turnover rate and promote the truck owner monthly days in transit in order to improve the truck owner service utility perception.

Table 5-11 Truck owner data robustness test (1)

VARIABLE	(1)	(2)	(3)	(4)	(5)
	TTR	NT	RTN	TRC	TSUP
E*T	1.782* (0.0568)	1.779*** (0.00529)	-6.82e-06 (1.000)	-0.515 (0.273)	0.311*** (0.00272)
TA	-0.0495 (0.574)	0.135 (0.783)	-0.00402 (0.696)	0.0262 (0.943)	0.00693 (0.930)
TW	0.122 (0.197)	-0.789 (0.123)	0.00601 (0.575)	0.303 (0.424)	-0.147* (0.0766)
Constant	17.15*** (1.17e-05)	22.30 (0.104)	0.219 (0.447)	3.102 (0.760)	6.290*** (0.00503)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	330	330	330	330	330
R-squared	0.198	0.097	0.054	0.063	0.178

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The truck owner "using the LHB platform", truck owner logistics profits (TLP) and truck owner user utility (TUU) still exhibit significant positive correlations, so hypothesis 5, "The 4PL platform improves truck owners' logistics profits", and hypothesis 6, "The 4PL platform improves truck owners' user utility", are still supported. Therefore, theoretical hypotheses 4, 5 and 6 pass the tests and are supported. Thus, the use of the LHB platform can improve truck owner service utility perception, truck owner logistics profits and truck owner user utility.

Table 5-12 Truck owner data robustness test (2)

VARIABLE	(6)	(7)	(8)	(9)	(10)
	TLR	TLE	TLF	TLP	TUU
E*T	0.0871** (0.0347)	-0.0628 (0.233)	0.0811** (0.0330)	0.136** (0.0444)	0.124*** (0.00517)
TA	0.0108 (0.735)	0.0329 (0.422)	0.0231 (0.430)	-0.0264 (0.610)	-0.00863 (0.800)
TW	-0.0866*** (0.00976)	-0.0287 (0.500)	-0.0803*** (0.00929)	-0.0861 (0.115)	-0.0557 (0.118)
Constant	10.66*** (0)	6.884*** (1.03e-08)	8.999*** (0)	11.36*** (0)	2.964*** (0.00214)
Individuality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes
Observations	330	330	330	330	330
R-squared	0.385	0.028	0.261	0.287	0.212

NOTE: Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.4 Summary

This chapter introduces the processes and results of statistics analysis of data, including descriptive statistics analysis. In the section of descriptive statistics we have provided sample data of cargo owners and truck owners. In the section of regression analysis, first we have conducted stochastic analysis and performed the endogeneity test of data, to ensure the data meet the requirements for the research. Then, we build two-way fixed effects DID model, to

conduct regression analysis, and interpret the regression results. Finally to further verify the reliability of the results, we conducted a robustness test of data, and in the end, all the seven research hypotheses have been supported.

Chapter 6: Conclusions and prospects

6.1 Research conclusions

With the blooming development of the logistics industry, 4PL platforms have gradually become an important carrier for the logistics industry to transform and upgrade, and currently there have been few quantitative researches on the value of the 4PL. Against this background, this thesis has conducted a quantitative study of the 4PL value from the perspective of platform users. First, based on the relevant theory of "4PL" and "user utility", we put forward seven hypotheses; then, we chose the LHB platform as the specific research object due to the availability of indispensable research data that would be otherwise unavailable. We focused on their 4PL platform, and collected relevant sample data; finally, we have empirical analysis of the impact of the LHB platform on the "user utility", to depict the value of the 4PL platform. The specific conclusions are as follows:

First, the 4PL platform can significantly improve the cargo owner's user utility. The empirical study results indicate that "using a 4PL such as that of the LHB platform" has a remarkable positive impact on the rate of service realization (RSR), the rate of service completion in time (RSC), and the cargo owner's service utility perception (CSUP) for cargo owner's logistics transaction, and has a remarkably negative impact on the logistics transaction costs of the cargo owner, i.e. using the LHB platform can effectively lower the cargo owners' logistics costs. In the earlier stage of transaction, the LHB platform and the cargo owners have active interaction, to have efficient matching between the logistics demand of the cargo owner

and massive data on the platform, to recommend ideal transport capacity resource, help the cargo owner to solve the problems of difficulty to find truck and late delivery, and enhance cargo owners' service utility perception. The LHB platform has established an information channel from the cargo owners to the truck owners, changing the mode of layers of subcontracts and drip pricing, and greatly lowering the logistics costs of the cargo owners.

Second, the 4PL platform can significantly improve the truck owner's user utility. The empirical study results indicate that "using the LHB 4PL platform" has remarkably positive impact on truck owner's service utility perception and truck owner's logistic profits. Specifically, "using the LHB 4PL platform" has improved the truck owner's service utility perception by improving the monthly vehicle turnover rates and monthly days in transit, and improved the truck owner's logistics profits by enhancing the truck owner's logistics revenue. The LHB 4PL platform, as a collecting and distributing center of logistics information provides the truck owners with more opportunities. Meanwhile, since this platform is based on massive logistics information it can provide smart recommendation to truck owners, greatly enhancing the success rate of truck owners receiving orders, and helping the truck owners to solve the problem of difficulty to find cargo, and slowness in finding it. Moreover, the LHB 4PL platform replaces the traditional logistics agency by directly linking cargo owners with truck owners, saving logistics broker fees.

Based on these results, we can conclude that the 4PL can remarkably improve users' utility. The platform provides the cargo owners and the truck owners with specialized logistics services, optimizing logistics transaction links, improving the user utility of both cargo owners and truck owners. The platform user is the foundation to realize the platform value, and the value of the

platform embodies the provision of quality services both for product and contents to meet the utility of users. The benefits redistribution of the 4PL platform allows the zero-sum game between the cargo owner who pays and the truck owner who offers services to transform into a positive sum game whereby one side saves costs, and the other increases income, and both benefit: cargo owner and truck owner have increased benefits.

In combination with the research conclusions, and the actual operation of the 4PL platform including the LHB platform, this research has the following recommendations for the development of the 4PL platform.

First, platform procedures need to be further optimized and attention paid to user experience. Aiming at different cargo owners and truck owners, we should design different procedures, and timely optimize the procedures in accordance with the platform operation. Complete procedures can make logistics information flow more quickly and accurately to users, enhancing users transaction experience, so the platform can gather more information flow and capital flow, to constantly produce value.

Second, enhance the information processing ability of the platform. The 4PL platform is an Internet platform in nature, and its processing ability of various information and data is crucial. The 4PL platform can make use of the cutting-edge technology of data mining, analyzing the potential demand of users, offer pertinent logistics services, and develop the habit of the users, to form a unique competitive edge.

6.2 Research insufficiency and prospects

This thesis makes use of relevant theories of 4PL and user utility, and conducted an empirical study of the 4PL platform value through the DID model. Due to the limitation of research expertise and research conditions, the research on the 4PL platform value is still insufficient, and needs to be further enriched, completed and developed. We recognize that the following needs to be improved in future research:

(1) There is some limitation in the sample selection. Considering the actual difficulty of data collection, and the availability of data in this one company, we chose only one 4PL platform, i.e. the LHB platform to investigate the impact of the platform on users. In future research, it is recommended to expand the scope of the sample.

(2) To research into the 4PL platform value from the user's perspective, the view is relatively singular. The 4PL platform is a complex system integrating various resources, and the platform value is not just dependent on the platform users, but also relies on the various aspects of platform strategy, brand and cooperative parties. To measure the platform value from the perspective of user utility is relatively new, and still needs to be enriched.

(3) Data collection can be further completed. Due to the limitation of data collection conditions, there are some limitations on variable settings and, in this specific research, different truck types and different transportation routes have not been considered to conduct multi-dimensional empirical research. In future studies, we can group users from multiple dimensions, and increase the sample quantity, to have more elaborate and instructive research conclusions.

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Appendix

Interview Questions (cargo owner)

Thank you for taking time from your busy schedule to finish this questionnaire. This is a study regarding to the logistic transaction situation of logistic platform users, aiming to improve your using experience of the logistic platform. We promise that all the contents you fill out will be kept strictly confidential! Please kindly fill out the following questionnaire truthfully.

1. Company name _____.
2. Types of cargo are mainly _____.
3. How many platforms is your company usually using for vehicle searching and transaction?
4. Are your company using LHB platform for transaction?
5. Which transportation mode is used most often now when your company consign?
6. Which transportation mode is used most often now when your company consign from August 2014 to August 2015?
7. How much has been your company's monthly average consignment match rate over the past year (percentage)? (For example: There are 100 consignments every month, among which 85 can find vehicles as required at first time without waiting. Then the match rate is 85 %.)
8. During August 2014 to August 2015, the monthly average consignment match was _____ (percentage).

9. For the consignment demand of your company for the past year, could all trucks arrive in time? The in-time arrival rate was ____ (percentage).

10. For the consignment demand of your company from August 2014 to August 2015, could all trucks arrive in time; the in-time arrival rate was ____ (percentage).

11. Over the past year, your company's monthly average freight costs are ____ yuan, and the monthly average consignment size is ____ tons.

13. From August 2014 to August 2015, your company's monthly average freight costs were ____ yuan, and the monthly average consignment size was ____ tons.

Interview Questions (Truck owner)

Thank you for taking time from your busy schedule to finish this questionnaire. This is a study regarding to the logistic transaction situation of logistic platform users, aiming to improve your using experience of the logistic platform. We promise that all the contents you fill out will be kept strictly confidential! Please kindly fill out the following questionnaire truthfully.

1. Your name:_____ Age:_____

2. Up to now, you have been engaging in logistic industry for ____ years.

3. Your educational background.

A. Below middle school

B. High school

C. Associate degree

D. Bachelor or master

4. How many platforms are you usually using for vehicle searching and transaction?

Introduced by acquaintances, not by logistic platform

A. 1 pcs

B. 2-3 pcs

C. 3 pcs or more

5. Are you using Lahuobao platform for transaction?

A. Yes

B. No

6. Which type of vehicle are you using in the past year? The load is approximately ____ tons.

Trailer

A. High-sided truck

B. Low-sided truck

C. Semitrailer

D. Box car

E. Single axle truck

F. Double axle truck

G. Refrigerator car

H. Covered wagon

I. Container car

7. Which of following situations was more frequent for your hauling in the past year?

A. Short-distance hauling (less than 200km)

B. Middle-distance hauling (200km-500km)

C. Long-distance hauling (more than 500km)

8. Which of following situations was more frequent for your hauling in 2014?

A. Short-distance hauling (less than 200km)

B. Middle-distance hauling (200km-500km)

C. Long-distance hauling (more than 500km)

9. For the past year, you hauled goods for ____ times every month on average.
10. From August 2014 to August 2015, you hauled goods for ____ times every month on average.
11. How many days were you in transit every month in the past year?
12. From August 2014 to August 2015, how many days were you in transit every month on average?
13. For the past year, your average no-load rate for every month was at ____ (percentage).
14. From August 2014 to August 2015, your average no-load rate for every month was at ____ (percentage).
15. When you delivered the goods, if you chose receipt payment, the receipt time each time was approximately ____ days on average for the past year.
16. From August 2014 to August 2015, the receipt time each time was approximately ____ days.
17. For the past year, you monthly average logistic income was ____ yuan.
18. From August 2014 to August 2015, the logistics income for each month on average was ____ yuan approximately.
19. For the past year, the fixed expenditure you usually spent every month on vehicle maintenance including repairing and insurance was ____ yuan.
20. From August 2014 to August 2015, the fixed expenditure you usually spent every month on vehicle maintenance including repairing and insurance was ____ yuan.

21. Your monthly average fuel charges are approximately _____ yuan.
22. From August 2014 to August 2015, your monthly average fuel charges for each month on average were _____ yuan approximately.