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# Research on the Intergovernmental Fiscal Relations of China in the Past 70 Years: Fiscal Decentralization in Evolution

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Since the founding of the People's Republic of China, the Chinese scholars of finance theory have been sparing no effort on the theoretical research of intergovernmental fiscal relations in the past 70 years, with fiscal decentralization at the core. Although fiscal decentralization has a long history, the intergovernmental fiscal relations which use fiscal decentralization as the vehicle did not constitute an independent research topic in the early days of the People's Republic of China. Later, fiscal decentralization was adopted and gradually flourished in China, once systematically explained as the target mode of intergovernmental fiscal relations, and even took the form of tax sharing system. In the new era of socialism with Chinses characteristics, the booming research on intergovernmental fiscal relations, adapted to the theoretical innovation of modern fiscal system, has contributed to coping with the changes of international and domestic economic situation in the new normal and to the sustainable fiscal development of China.

**Keywords:** 70th anniversary of the founding of the People's Republic of China, intergovernmental fiscal relations, fiscal decentralization

## 1. Introduction

How to deal with the intergovernmental fiscal relations is an eternal topic. With the development of productivity, the relationship between government and market is constantly adjusted, and the scope of government function and fiscal function is in dynamic adjustment. For this reason, it is necessary to standardize and define each specific fiscal function, each revenue and each expenditure responsibility of the governments at different levels by stages. That is to say, the fiscal relations between governments are not fixed. In the 70 years since the founding of the People's Republic of China (PRC), under the background of market-oriented reform, China's intergovernmental fiscal relations have been adjusted dynamically, and are moving in a circuitous way in the direction of "centralization—decentralization—centralization—decentralization".

Theory originates from practice and guides practice. The dynamic adjustment in practice determines the continuous innovation of theoretical research. In the 70 years of

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reform practice from the beginning of the founding of PRC to the transition from planned economy to market economy, then to the establishment and development of socialist market economy system, till socialism with Chinese characteristics entering the new era, the intergovernmental fiscal relations have risen from an implicit clue to the main line of fiscal and tax reform. Accordingly, the research on intergovernmental fiscal relations in the fiscal academic circle of China has also evolved from scratch and increasingly deepened, making great contributions to the development of research on China's public finance. Therefore, on the 70th anniversary of the founding of PRC, it is of great theoretical and practical value to depict the main line of research on intergovernmental fiscal relations in the past 70 years, collect and analyze the important theoretical achievements in this field, and look to the future of the research in the new era on the basis of summarizing the laws.

Looking back on the 70 years of the study of intergovernmental fiscal relations in China, we can understand it from the following four historical stages (Table 1). It is evident that fiscal decentralization has always been the main line of the development of the theory and practice of intergovernmental fiscal relations in China, with the continuous enrichment of connotation and expansion of extension since its ideological germination.

Table 1. Background and Main Line of the Four Stages of the Study on the Intergovernmental Fiscal Relations in the 70 Years since the Founding of the PRC

| Stage | Background | Theoretical main line |
|---|---|---|
| Early days of the PRC | Establishment of "unified leadership and decentralized management", and the publishing of *On the Ten Major Relations* | Birth of fiscal decentralization |
| Transition period of economic system | The fiscal control system marked by "dividing revenue and expenditure between the central and local governments" experienced frequent adjustment | Fiscal decentralization was systematically interpreted to lay a solid theoretical foundation for the implementation of tax sharing system reform |
| The period of the establishment and construction of the socialist market economy system | The establishment of tax sharing system and the mainstream position of public finance | Fiscal decentralization was reflected by tax sharing system. Research on intergovernmental fiscal relations matching tax sharing system was conducted under the framework of public finance theory |
| Ever since socialism with Chinese characteristics entered the new era | Public finance is granted new position and the fiscal relations between the central and local governments become the top priority of modern fiscal system | Fiscal decentralization thrives. Intergovernmental fiscal relations, as the core of fiscal decentralization, gets unprecedented attention |

Source: Relevant data assembled by the authors.

In the early days of the founding of the PRC, with the completion of the socialist transformation and the establishment of socialist planned economy system, most of the fiscal administrative powers and fiscal rights were concentrated in the central government. In the theoretical research, although fiscal decentralization has a long history, in the early days of the founding of the PRC, the focus was to study the

essence of socialist finance with the aim of establishing a fiscal system suitable for the development of the socialist system, while the intergovernmental fiscal relations with fiscal decentralization as the carrier was not yet an independent research topic. With the thought of "unified leadership and decentralized management" taking root in the practice of the First Five-Year Plan, and the publishing of Mao Zedong's report *On the Ten Major Relations*, the academic circles gradually paid attention to the fiscal relations between the central and local governments under "unified leadership and decentralized management", and tried to analyze this problem from the perspective of history and comparison.

In the period of transition from planned economy to market economy, the fiscal management system marked by "dividing revenue and expenditure between the central and local governments" experienced frequent adjustment. The theoretical research focused on seeking the causes for the fiscal difficulties of the central government from the perspective of institutional change, and began to systematically explain "fiscal decentralization" as the target mode of fiscal system to straighten out the intergovernmental fiscal relations, which laid a solid theoretical foundation for the implementation of tax sharing system, thus the relevant historical research and international comparative research have also stepped up.

In the period of the establishment and construction of the socialist market economy system, fiscal decentralization was reflected by tax sharing system, the implementation of which highlighted the importance of intergovernmental fiscal relations. The focus of theoretical research was the division of various elements of intergovernmental fiscal relations under the framework of tax sharing system—the division of administrative powers, fiscal rights, fiscal resources, and expenditure responsibilities. At the same time, with the establishment of the mainstream position of public finance, more and more studies were conducted to explain Chinese intergovernmental fiscal relations with the help of western fiscal decentralization theory. In addition, there were breakthroughs in research methods, and relevant empirical studies increased rapidly.

After socialism with Chinese characteristics entered the new era, China established the modernization of state governance as the general goal of deepening reform, and put forward that "finance is the foundation and important pillar of state governance", fiscal decentralization must be committed to the realization of the new position of public finance and make a new institutional arrangement on the basis of the tax sharing system, and finally, together with the budget system and the tax system, it has been incorporated into the framework of the modern fiscal system, and has become the carrier for the modern fiscal system to give full play to the initiative of the central government and the local governments, thus attracting unprecedented attention and becoming the top priority of the reform. The theoretical research focuses on the intergovernmental fiscal relations that meets the requirements of the modern fiscal system, and studies the deepening reform of the intergovernmental fiscal relations with the reform of the division of fiscal administrative powers and expenditure responsibilities as the main starting point in view of the weak points on expenditure side.

## 2. Intergovernmental Fiscal Relations Drawing More Attention: The Birth of Fiscal Decentralization

Institutional change has a decisive influence on the development of public finance in the period of national economic recovery and planned economy in China. The introduction of the Soviet fiscal model and the criticism of the capitalist fiscal model served as the basis for re-understanding the essence of finance. As the intergovernmental fiscal relations was not in the scope of this discussion on the nature of finance, this issue was not of interest to the academic community at the beginning, but under the guidance of practice, the scattered views gradually became systematic research.

From the perspective of practice, the reform related to fiscal decentralization has started since the founding of PRC, and has been adjusted with the economic and social development. On March 29, 1951, the central government issued *The Decision on the Division of Fiscal Revenue and Expenditure System in 1951*, which divided the national fiscal revenue and expenditure management system into three levels: the central government, the major administrative regions and the provinces (cities); on November 14, 1957, the Standing Committee of the First National People's Congress approved and adopted *The Provisions on Improving the Fiscal Management System*, which was enforced in 1958 and defined the scope of the central and local fiscal revenue and expenditure. On August 8, 1958, the Ministry of Finance issued *Several Regulations on Further Improving the Fiscal Management System and the Corresponding Improvement of the Bank Credit Management System*, among which the main contents of the reform of the fiscal management system were "revenue and expenditure decentralization, plan contracting, regional adjustment, total amount sharing and change on one-year basis", which was implemented in 1959; since 1971, the state has implemented the method of fiscal revenue and expenditure contracting for provincial governments. The Ministry of Finance issued *The Notice on Implementing the Contracting of Fiscal Revenue and Expenditure*, the specific method being "fixing revenue and expenditure, revenue and expenditure contracting, guarantee the payment to the central government, keeping the balance, and fixing for one year". In 1972, the Ministry of Finance improved the method of fiscal revenue and expenditure contracting, and issued *The Notice on Improving Fiscal Revenue and Expenditure Contracting*.

In such a practical atmosphere, coupled with Mao Zedong's systematic exposition of the "Ten Relations" including the relations between the central and local governments in 1956, the fiscal academic circles paid more and more attention to the relations between the central and the local governments. At this stage, some theoretical research still has a strong guiding significance for the practice and theoretical research of today's intergovernmental fiscal relations reform. For example, in 1964, the Public Finance Teaching and Research Office of Renmin University of China compiled the first draft of Public Finance, which examined how the intergovernmental fiscal relations of China developed under the policy of "unified leadership and decentralized management" in the ten years after the

founding of PRC an carried out a special study on the fiscal relations between the central government and the local governments from the perspective of budget management system, which has a basic guiding significance for the current study in this field.

In addition, at this stage, scholars began to expand the research scope to foreign countries, introducing foreign economists' division principles and standards for intergovernmental fiscal revenue and expenditure, and inspecting the intergovernmental fiscal relations of major countries in the world. Qian (1949) found that the division of fiscal revenue and expenditure between the central and local governments in different countries varied due to different political systems, historical conditions and social environment. Yin (1953) made a comparative study of the intergovernmental fiscal relations in capitalist society and socialist society, and traced back to the primitive society, which provided a historical perspective for understanding this subject. These findings and multi-dimensional systematic discussions have laid a solid foundation for the rapid development of the study of intergovernmental fiscal relations in China.

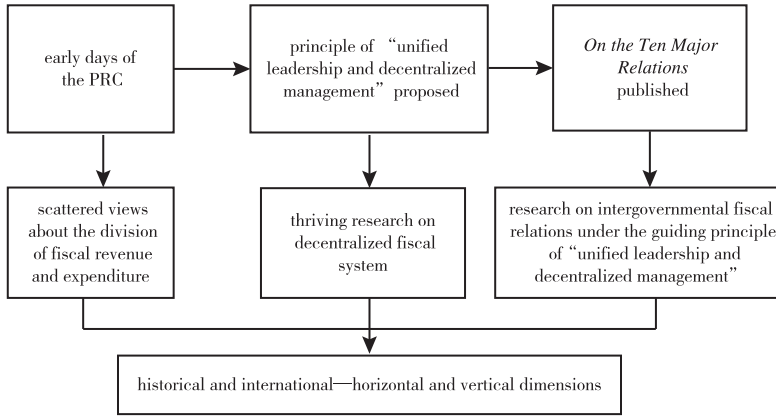


*Figure* 1. Budding Research on the Intergovernmental Fiscal Relations with Fiscal Decentralization as the Carrier

However, we still need to see that in the historical conditions at that time, it was more important to solve the fundamental theoretical problem of "what is public finance". The intergovernmental fiscal relations, as an implicit clue for the establishment of socialist finance, focusing on the theoretical interpretation of the practice of fiscal reform, received little attention while the "state distribution theory", "value distribution theory", "state capital movement theory", "surplus product value movement theory" formed at that time were mainstream theories.

## 3. Research on the Target Mode of Intergovernmental Fiscal Relations: A Systematic Interpretation of Fiscal Decentralization

In the period of economic transition, most of the studies focused on the institutional

causes of central fiscal difficulties, evaluated, analyzed, and proposed suggestions about the frequently adjusted fiscal management system of "dividing revenue and expenditure between the central and local governments", and began to systematically explain fiscal decentralization as the target mode of fiscal system reform to straighten out the fiscal relations between the central and local governments, studying the intervention of the central government on local finance and the effects of different ways of intervention. The academic research mainly reached the following consensus.

### *3.1. Fiscal Decentralization Was the Need of Developing Planned Commodity Economy and Solving Fiscal Difficulties*

Developing planned commodity economy was the main line of the economic system reform in this period, the reform of intergovernmental fiscal relations being no exception. Under such a realistic background, the relevant theoretical research was also greatly developed. Wang (1998) put forward that "the implementation of fiscal decentralization was the objective need of developing commodity economy and the only way to solve the fiscal difficulties at that time", thus finding the foundation for the development of the theory of intergovernmental fiscal relations then.

The reason why the development of intergovernmental fiscal relations theory finally fell to the clue of economic system reform is that, in the early stage of reform and opening-up, China's finance took a path of "delegation, tax reduction, interest concession, decentralized management", and when the fiscal situation was tightening, the public finance of both the central and local governments was tight as the "two proportions"[1] decreased. Subsequent research showed that at that time, the central government frequently drew funds from the local governments, introduced measures which increased local expenditure and reduced local revenue, resulting in instability of the contracting system and seriously dampening local enthusiasm. To cope with the central "borrowing", local governments converted the budget revenue to extra-budgetary revenue, and left wealth with the enterprises, which eventually led to the loss of central revenue (Yan, 1991).

It is for this reason that the academic community began to deal with the fiscal difficulties of this period, realizing that the reform of the fiscal system focused more on the speed than on the whole, that is to say, the reform was mostly bases on the finance itself, without serious consideration about the fiscal system needed for commodity economic development, which led to the passive reform and the conflict between the dual needs of decentralization of fiscal rights and centralization of fiscal resources. This conflict drove the frequent adjustment of the fiscal system: from "dividing revenue and expenditure, decentralized contracting" to "dividing taxes, approving revenue and expenditure, decentralized contracting", to various forms of local contracting

[1] "Two proportions" are the proportion of fiscal revenue to national income and the proportion of central fiscal revenue to national fiscal revenue.

system.[1] The above-mentioned fiscal system was not so much fiscal decentralization as fiscal contracting. Therefore, academic discussions about the contracting system yielded approval, neutral attitudes, but more criticism. Proponents believed that the fiscal contracting system improved the transparency of fiscal distribution between the central and local govemments, hardened the budget constraints, and expanded the autonomy of local finance. The neutrals analyzed the advantages and disadvantages of the contracting system, and thought that it adjusted interests in terms of distribution, but did not fundamentally straighten out the fiscal relations between the central and local governments. Critics argued that there were institutional defects in the contracting system, including the lack of legal form to protect and fix the distribution relationship between the central and local governments, the lack of objective scientific basis for the quantitative boundary of fiscal division, the prevalence of subjective randomness, and the phenomena of competing for base and proportion and bargaining, which weakened the material basis of macro-control. The sharpened conflict between the central and local finance and the friction of interests aggravated the deterioration of industrial structure and the regional blockade, preventing the formation of a unified national market. In the end, scholars realized that "dividing revenue and expenditure between the central and local governments" was merely a fix on the track of centralized revenue and expenditure, which limited the development of the commodity economy and needed to be reshaped to accommodate the principle of a planned commodity economy (Li, 1992).

So what is the fiscal system appropriate for the development of planned commodity economy? After the layer-by-layer research and analysis, the academic circles began to realize that it was fiscal decentralization, which could straighten out the intergovernmental fiscal relations at that time. Based on the early theoretical exploration, scholars systematically explained fiscal decentralization and gave a clear definition. [2]Jia (1986) proposed that the fiscal system should "develop towards a deeper economic decentralization and transmit to a thorough central and local tax sharing system and fiscal decentralization", and he further proposed the need to grasp the principles of transition in "various forms" and two sequences of space and time.

After clarifying what fiscal decentralization was, scholars carried out a comprehensive study on how to straighten out the intergovernmental fiscal relations under its framework. On the whole, to straighten out the fiscal relations between the central and local governments and re-shape the fiscal operation mechanism adapted to the development of commodity economy, is it to implement the fiscal decentralization that is managed independently by all levels of government and is based on the decentralized

[1] The local contracting system includes "revenue incremented contracting", "total sharing", "total sharing plus growth sharing", "payment incremented contracting", "quota payment", "quota subsidy" and other forms.

[2] Wang (1998) pointed out that "fiscal decentralization is the division of fiscal rights on the basis of the division of functions and responsibilities of the central and local governments, so that the local government has the constitutional fiscal legislative power, with independent fiscal resources and independent budget".

budget, or is it the decentralized management based on the passive implementation and "unitization" of all levels of government? After making a full comparative analysis of the two, the theoretical circles have been in favor of the former and put forward proposals for reform. For example, Guo (1991) defined fiscal decentralization as a "management system of revenue with tax sharing and expenditure responsibility".

### *3.2. Implementation of Tax Sharing System Was the Center of Establishing Fiscal Decentralization in China*

In accordance with the requirements proposed by the 7th Five-Year Plan that central and local fiscal revenues were divided according to tax categories to clarify the scope of central and local fiscal expenditure, the research on intergovernmental fiscal relations began to put forward the direction and ideas of tax sharing system reform to pave the way theoretically for tax sharing system. At that time, most views held that the establishment of tax sharing system was the central content of the reform of the fiscal system, because the fiscal system was a mixed tax sharing system that combined the tax division with the incomplete categories, which could not meet the development needs of planned commodity economic and needed reform.

The theoretical circle discussed the target mode of tax sharing system, mainly with the following six ideas: (1) Differential tax sharing system. Due to the differences in the economic development in each region, the forms of tax sharing system should be diversified, including both the tax system based and the tax-source based. (2) Tax sharing system with revenue sharing. It was characterized by not only retaining some advantages of the revenue sharing system, but also exerting the advantages of tax sharing system by combing the two. (3) Tax sharing contracting system. On the one hand, the tax sharing system was to be implemented in most parts of the country while in some areas the fiscal contracting system was still implemented, on the other hand, tax sharing system was implemented in provinces and regions where some elements of the fiscal contracting system were retained. (4) Flexible tax sharing system. This mode was characterized by the creation of a flexible pending tax instead of a shared tax. The pending tax was to be determined from a national perspective, but in the case of a certain area, it was either a central tax or a local tax. (5) Tax sharing system with assets distribution. At the same time as the central and local tax sharing system was implemented, the property rights of state-owned assets were divided accordingly. (6) Thorough tax sharing system. The basic framework was composed of the complete separation of taxes, legislation and administration.

After a series of discussions, the theoretical community basically reached a consensus of the thorough tax sharing system as the target mode of tax sharing system, and agreed that there should be a transition period to provide a good link and smooth transition between "dividing revenue and expenditure between the central and local governments" and thorough tax sharing system as the conditions were not ripe for implementation at one.

The reason for making such a judgment is that the realization of a thorough tax sharing system is conditional, first, administrative powers and fiscal rights of all governments at various levels should be clearly defined and reasonably divided, and second, the tax system was more sound and stable, the categories of main tax and auxiliary tax were complete, and the level of tax burden was relatively reasonable; third, the socio-economic development of the various regions of the country was relatively balanced. In fact, these three conditions have not been fully met to this day, so the current tax sharing system is still incomplete and the target mode of tax sharing system has not yet been achieved.

In addition, the theoretical circles also put forward some ideas of great value to the exploration of the reform path. First of all, on how to link the tax sharing system with the fiscal contracting. It was believed that the focus of the convergence between the two was how fiscal revenue should be distributed between the central and local governments. As the tax sharing system was the distribution of tax from the source according to the nature of tax, and the fiscal contracting was the distribution of tax revenue according to the proportion determined by the base, the task of the transition period was to bridge the two distribution methods. Second, on the timing of a thorough tax sharing system. There were two views, one that the sooner the better, thereby increasing the central fiscal rights and fiscal resources, and thus improving the central macro-control capacity. Another view was that it was not appropriate to implement prematurely, because "dividing revenue and expenditure between the central and local governments" could still be improved, and the other was that the conditions for implementing thorough tax sharing system had not been met. Finally, on the choice of transition plans. Some held that transition programmes should take into account the characteristics of interregional imbalances and highlight diversity. Others believed that the transition plans should create conditions for the step-by-step implementation of tax sharing system. Despite the wide differences of view, the core issue to be addressed remained the question of the degree of decentralized management under unified leadership.

During this period, China's fiscal system reform also received the attention of international institutions and foreign experts. In November 1991, the World Bank's Asia Region Study Mission, made an assessment of the state of China's fiscal system reform, and put forward some proposals[1] on the division of China's fiscal revenues and expenditures under the framework of fiscal decentralization under the title *China: Reforming the Intergovernmental Fiscal relations*. The practice of China's reform and development has shown that these proposals have a strong forward-looking, In October 1993, the Ministry of Finance, the International Monetary Fund and the World Bank jointly organized an international seminar on China's intergovernmental fiscal relations

[1] Specific proposals are that, in terms of fiscal revenues, the main taxes should be collected by the central government, so that the central fiscal revenue staked a larger proportion (initially at 60 per cent), and that in terms of fiscal expenditures, considering that the closer the beneficiaries were, the more conducive it was to improving efficiency, a considerable degree of decentralization should be carried out, with local expenditure accounting for a larger proportion, The central government subsidized the local area in some form.

in Shanghai, where experts discussed intergovernmental fiscal relations in China's fiscal reform and believed that China's intergovernmental fiscal relations urgently needed to be straightened out according to scientific procedures, to divide expenditure responsibilities according to scientific standards, to decentralize tax power according to fair efficiency trade-offs, and to correct vertical imbalance with transfer payments.[1] These international evaluations and views have been important references for China to deal with intergovernmental fiscal relations and promote the reform of the fiscal system.

### *3.3. The Development of the Theory of Intergovernmental Fiscal Relations, with Fiscal Decentralization as the Carrier, should Attach Importance to Thematic Research*

First, a special study on the quantitative relations between the quantities of the central and local finance. He (1987) limited the fiscal relations between the central and local governments in the framework of the relationships of responsibility, right and interest, and studied the degree and quantity of fiscal concentration and dispersion respectively based on the hierarchy of common social needs and the fiscal responsibility of the central and local governments, and his views and research paradigms have been used to this day.

Second, a special study on the impact of intergovernmental fiscal relations on economic development. During this period, theorists began to realize that "to improve economic efficiency needs to improve the fiscal relations between the central and local governments", "making the economic pie" and "cutting economic pie" linked.

Third, a special study on intergovernmental fiscal relations based on historical and comparative perspectives. Historical research included the study of intergovernmental fiscal relations in the Ming and Qing Dynasties and the review of the intergovernmental fiscal relations in the First Five-Year Plan period. During this period, Chinese scholars continued systematic research on the intergovernmental fiscal relations of the Soviet Union, while the scope of research was extended to other countries, including the United States, Japan, Britain, France, Canada, India and Australia. At the same time, the academic circle's study of the intergovernmental fiscal relations of capitalist countries shifted from focusing on criticism to relatively pure academic discussion.

## 4. Research on Intergovernmental Fiscal Relations and Tax Sharing System: The Manifestation of Fiscal Decentralization

During the construction period of socialist market economy, with the full implementation of the tax sharing system, fiscal decentralization was materialized

[1] The views of then-IMF Director of Fiscal Affairs Tantz, experts Amad, Juju Hu, and World Bank experts Ahmed, Agara, Hoffmann, Nurfarmer and Professor of Economics at the University of Turin, Mr. Brosio, were combined.

into a tax sharing system, and the intergovernmental fiscal relations was supported by the system, so the relevant research in this period was mainly carried out within the framework of tax sharing system. In addition, there was a theoretical background, that is, with the establishment of the market economy system, the research topic of China's fiscal circles shifted from the essence to the function of public finance, while the influence of western theory on finance expanded, and the three functions of finance proposed by Musgrave were also widely used in research on China's intergovernmental fiscal relations. Many scholars agreed that the allocation of resources should be mainly carried out by the local governments, and that the functions of income distribution and economic stability and growth should be assumed by the central government.

### *4.1. Tax Sharing System: Practical Basis for Research on Intergovernmental Fiscal Relations*

Theory comes from practice and guides practice. The implementation of tax sharing system was the practical basis of the research on intergovernmental fiscal relations at that time, and the relevant research was carried out from the following four levels.

Firstly, from the level of perfecting tax sharing system. The perspectives included the problem of dealing with intergovernmental fiscal relations and the imbalance of istitution supply in implementing tax sharing system. Jia and Bai (2002) put forward the principles of "seven ones" to improve the tax sharing system under the premise of appropriate simplification of the level of governments.[1]

Secondly, from the four elements of intergovernmental fiscal relations. The tax sharing system reform in 1994 took "matching fiscal rights with administrative powers" as the basic principle, but in practice, the division of fiscal rights was not as smooth as envisaged, and was subject to resistance from all sides. Therefore, scholars began to look for the system optimization program under this realistic condition, the focus diverted from the division of fiscal rights to the allocation of fiscal resources and administrative responsibilities (expenditure responsibilities). Liu (2008) believed that the principle of "matching fiscal resources with administrative powers" was more adaptable to the changing characteristics of the era of intergovernmental "incremental administrative powers". Hou (2009) held that the wording of "matching fiscal resources and administrative powers" was not exact, and there may be problems such as breakdown of policy design, misalignment of supervision mechanism, reversal of responsibility mechanism, and he also argued that the "administrative powers" were actually "expenditure responsibilities". The most comprehensive view was that when straightening out the intergovernmental fiscal relations, we should

[1] The principles of "seven ones" were: one-level regime, one-level administrative powers, one-level fiscal rights, one-level tax base, one-level budget, one-level property rights, and one-level right to borrow.

distinguish between the concepts of "administrative powers" and "administrative responsibilities", as fiscal rights match administrative powers, and the matching of administrative responsibilities is the fiscal resources (Ma *et al.*, 2013). In this way, the argument and exploration of theory promoted several adjustments and changes of the fiscal relations between the central and local governments which used the four elements of administrative powers, fiscal rights, expenditure responsibilities, and fiscal resources as the carrier.

Thirdly, from the division of administrative powers. Because the division of fiscal rights was not so easy, more research focused on the division of administrative powers. Gao (2010) proposed that the allocation of administrative powers should follow the principle of market priority, benefit scope and efficiency.

Finally, intergovernmental fiscal relations was studied at the sub-provincial levels. The tax sharing system reform in 1994 was mainly concentrated at the central and local levels, while the sub-provincial fiscal management system was not clearly defined, but mainly referred to the higher-level practices, resulting in revenue transferred upwards and expenditure transferred downwards, and finance at the levels of county and town becoming more and more difficult. Then there was the exploration of "placing county finances directly under the management of provincial govemments" and "township finances under the management of county governments" with the academic circles actively seeking theoretical basis for it.

### *4.2. Public Finance: Theoretical Basis for Research on Intergovernmental Fiscal Relations*

After Deng Xiaoping delivered the speech in South China in 1992, with the reform goal of socialist market economy established, China started the process of matching "fiscal publicization" with "economic marketization". Public finance became the mainstream, and the theory of western fiscal decentralization was widely used in the study of China's intergovernmental fiscal relations.

In terms of the basic logic, public finance is based on the theory of public goods, and analyzing intergovernmental fiscal relations under the framework of public finance should first pay attention to the levels of public goods and the efficiency of public goods supply at different levels, and realize the mechanism of separation of powers and checks and balances or the balance between centralization and decentralization to guarantee the efficiency of public goods. Lv (2005) showed that the difference in efficiency between the central and local public goods determined the concentration and decentralization of the fiscal system.

After the equalization of public services was put forward, the study of intergovernmental fiscal relations was further promoted. Scholars have found that there was a clear logical chain between the equalization of public services and

the intergovernmental fiscal relations: in market economy, in order to achieve the equalization of basic public services, vertical transfer payments were needed to balance the fiscal capabilities at all levels (Research group of *Public Services Equalization of Society of Public Finance of China*, 2007). In order to achieve the generally equal level of public services, we should seek to establish a horizontal transfer payment system. It can be seen that the realization of equalization of basic public services should not only optimize the fiscal relations between governments at all levels, but also optimize the fiscal relations between the governments at the same level.

### *4.3. Normative Analysis and Empirical Research: Breakthroughs in the Research Methodology of Intergovernmental Fiscal Relations*

Methods such as game theory were adopted in this period to study the fiscal relations between the central and local governments under the tax sharing system, to assess the realization of the objectives and internal stability of tax sharing system and the fairness and efficiency of intergovernmental fiscal relations, to identify problems and try to improve. On the whole, the empirical research on the intergovernmental fiscal relations made a breakthrough in the method and expanded in content, especially in the empirical research on the relationship between fiscal decentralization and economic growth, a large number of academic achievements emerged, but their results were quite different. Lin and Liu (2000), Zhang and Gong (2005), Zhou and Zhang (2008) believed that there was a positive correlation between the two, while Zhang and Zou (1998), Hu (2001), Chen *et al.* (2002) believed there was a negative correlation between the two. In addition, a number of results from other perspectives had been found, for example, regional differences in economic growth effects of fiscal decentralization, fiscal imbalance at all levels, the effect of transfer payment and its relationship with fiscal decentralization, and factors affecting the division of intergovernmental functions.

### *4.4. Thematic Research: Deepening Research on Intergovernmental Fiscal Relations under the Framework of Tax Sharing System*

Firstly, thematic studies on intergovernmental fiscal relations based on historical and comparative perspectives. In the field of historical research, the intergovernmental fiscal relations of various dynasties in China were included. In comparative research, the dimensions of the study shifted from specific countries to different levels, including Western countries, developing countries, unitary states, federal states and centralization, decentralization and subsidy models.

Secondly, thematic studies focusing on specific areas of intergovernmental fiscal relations in China. First of all, in the field of rural compulsory education, theorists

agreed that the function of rural compulsory education and the responsibility for expenditure should be borne solely by higher-level governments, with transfer payments and regional differences taken into account. Next, in the field of local government debt, many scholars analyzed the root causes of local government debt from the perspective of intergovernmental relations, and there were also causes including the dual political and economic role of government and the general soft budget constraints of the banking industry. In addition, the academic community were divided into the pre and the con on whether the central government's act of issuing local bonds meant fiscal decentralization. Furthermore, in the field of land finance, many scholars believed that the fiscal system with tax sharing had caused the upward transfer of fiscal rights, the downward transfer of administrative powers, the decrease of local fiscal revenue and the increase of local fisscal expenditure. Jia (2005) criticized this view, arguing that it was because the implementation of the tax sharing system was impeded at sub-provincial levels after 1994, the transition became revenue sharing or contracting system, only to trigger the short-term behavior of land finance, hidden debt, and grass-roots fiscal difficulties. Scholars held that, to change the status quo of land finance, we need to improve the tax sharing system, form a diversified urban public investment mechanism, build a more reasonable local tax system, speed up the construction of local debt system, strengthen budget constraints, and become more open and transparent in the budgets and final accounts. In addition, there was a study of the relations between the central and local finance in the field of rule of law (Figure 2).

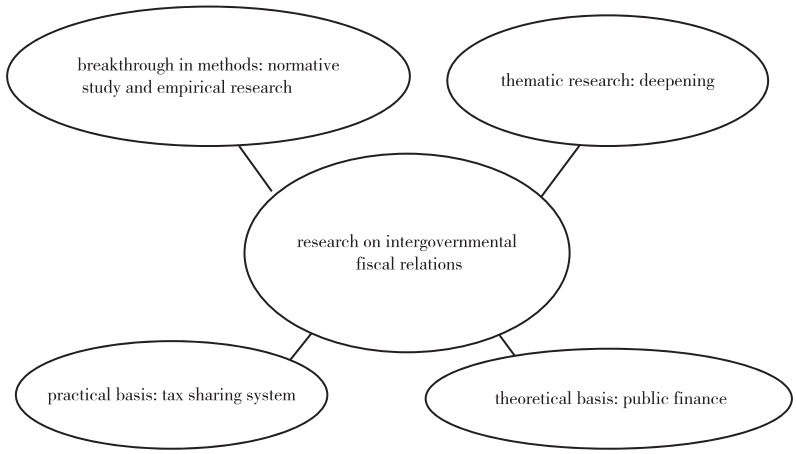


*Figure* 2. Research on Intergovernmental Fiscal Relations under the Framework of Tax Sharing System
Source: Relevant data assembled by the authors.

## 5. Research on Intergovernmental Fiscal Relations and Modernization of State Governance: The Prosperity of Fiscal Decentralization

As socialism with Chinese characteristics enters the new era, the Third Plenary Session of the 18th Central Committee of the Communist Party of China (CPC) issued *The Decision of the CPC Central Committee on Major Issues Concerning Comprehensively Deepening Reform*, which states that "finance is the foundation and important pillar of state governance" and "establishing a modern fiscal system to give full play to the central and local initiatives". Thus, the theoretical innovation of modern fiscal system to meet the needs of the modernization of state governance began to flourish. The report of the 19th National Congress of the Communist Party of China further proposed "accelerating the establishment of a modern fiscal system, the establishment of central and local fiscal relations with clearly defined powers and responsibilities, appropriate fiscal resources allocation and great balance between regions, and put the central and local fiscal relations before the reform requirements of budget system and tax system. In this way, the study of intergovernmental fiscal relations with fiscal decentralization as the carrier has become the focus, and fiscal decentralization has also flourished.

Firstly, the intergovernmental fiscal relations and stste governance are connected from multiple dimensions. The focus includes the relationship between the two, deepening the tax reform, deepening the fiscal system reform under the framework of state governance, and the theoretical framework of "fiscal governance in the whole area" based on the "five-sphere integrated plan". The innovation of intergovernmental fiscal relations theory began to flourish, and it was carried out in the logical chain of "modernization of state governance—modern fiscal system—intergovernmental fiscal relations—central and local initiatives—matching administrative powers and expenditure responsibilities".

Secondly, the intergovernmental fiscal relations are included in the framework of the modern fiscal system to study. On the one hand, the aim is to clarify the "two types of position"—the position of the modern fiscal system in the state governance and the position of the intergovernmental fiscal relations in the modern fiscal system. On the other hand, it aims to grasp the unique features of the development of fiscal relations between the central and local governments under the framework of modern fiscal system. It is believed that one of the fiscal paths to the modernization of the state governance system and governance capacity is to establish a modern fiscal system which includes the modern tax sharing system, but at present, the intergovernmental fiscal relations, as the "shortest board of the bucket" in the modern fiscal system, has become the key task of establishing the modern fiscal system (Yu, 2015).

Thirdly, the reform of the division of fiscal administrative powers and expenditure responsibilities serves as the focus to study the deepening reform of intergovernmental fiscal relations. Although the logical emphasis of fiscal and tax reform is different,

the current theoretical community agrees that the division of fiscal powers and expenditure responsibilities is the key to straightening out the intergovernmental fiscal relations. Gao (2018) believed that "the establishment of a system with compatible administrative powers and expenditure responsibilities" is proposed to stimulate the two initiatives by matching power and responsibility. As for the logic of the division of administrative powers and expenditure responsibilities, some scholars have proposed the vertical and horizontal dimensions,[1] some scholars emphasized the logical order of legal authorization, and some believed the correct logical starting point should be the division of intergovernmental expenditure responsibilities. In addition, the fiscal academic community has conducted two levels of research: One is to explore the principle of division. Lou (2013) put forward the three principles of division of administrative powers namely, externality, the complexity of information processing, and incentive compatibility, which has been widely recognized. In addition, scholars also discussed the principles of dividing administrative powers and expenditure responsibilities from the perspective of stability and certainty, as well as from formal statutory and substantive statutory perspective of division of administrative powers. The other is to explore the specific areas of fiscal administrative powers and expenditure responsibilities division, involving education, culture, science and technology, environmental protection, transportation, fiscal support for agriculture. In education, the six principles of the division of educational fiscal administrative powers and expenditure responsibilities, and the division mode of "legalized administrative powers, co-ordination by the governments at higher levels, upward transfer of overspending" have been put forward, and the relevant quantitative research is also increasing. In the field of culture, a structured theoretical model of the division of fiscal cultural administrative powers and expenditure responsibilities is formed. In the field of science and technology, the direction of change in the behavior pattern of fulfilling the scientific and technologieal administrative powers is proposed. In the field of environment, two basic paths to perfect the division of environmental administrative powers and expenditure responsibilities are put forward. In the field of transportation, it is proposed that the particularity of its public service be regarded as the basis of the division of administrative powers and expenditure responsibilities. In the field of fiscal support for agriculture, the key to the division of administrative powers and expenditure responsibilities is that the central government takes the initiative to assume the administrative powers and expenditure responsibilities.

From 2018 to 2019, China has successively introduced a reform plan for the division of central and local fiscal administrative powers and expenditure

[1] Ma (2013) proposed that, vertical division followed the government structure from the central to the local level, while horizontal division was based on the division of labor between the government, the market and the non-profit organizations in in the supply of public goods, and the path was also changed from the traditional path of "fiscal resources" to "administrative powers".

responsibilities in the four fields of health care, science and technology, education and transportation, and the reform of intergovernmental fiscal relations is further developing. It is because the researchers spare no effort to promote the innovation of the theory of intergovernmental fiscal relations, provide theoretical basis for decision-making and guide practice that the fruitful reform achievements emerge.

## 6. Prospect of Research on Intergovernmental Fiscal Relations: Providing System Guarantees for Sustainable Fiscal Development

Research on intergovernmental fiscal relations of China has thrived from scratch in the past 70 years, but we should be aware that the research is always on the way. At present, under the background of the new economic normal, with the need to continuously cut massive taxes and fees to support steady economic growth, and to deal with the escalating global economic and trade uncertainty, the pressure of finance at all levels is increasing, especially the sustainable development of local finance has been facing a severe test. Adjusting the fiscal relations between the central and local governments from the system perspective is the answer to the problem.

First of all, we should further work on the optimization scheme of the division of fiscal administrative powers and expenditure responsibilities with the goal of establishing the intergovernmental fiscal relations with clearly defined powers and responsibilities. The current division scheme is relatively extensive, and there is still room for further improvement in terms of the precision of the division. Therefore, on the basis of consolidating the reform achievements of the division of fiscal administrative powers and expenditure responsibilities, we can work on the division optimization scheme with fiscal decentralization as the carrier. “Up-to-down integration” should be achieved in the path, that is, after the division scheme is proposed from higher levels to lower levels, feedback is given from the bottom to the top level, and further discussions are needed in case of the lack of clear division, or unreasonable division of the administrative powers and expenditure responsibilities match each other at all levels of government. In addition, the division of fiscal administrative powers and expenditure responsibilities should also take full account of the special characteristics of various public services, and the division of public services of different nature should be different. A feasible and effective measure method should be proposed for the relevant indicators such as public service benefit, externality, cost-benefit and economies of scale, so as to make the division more scientific and accurate.

Secondly, we should study the scheme of adjusting the division of fiscal revenue between the central and local governments with the goal of establishing the intergovernmental fiscal relations of coordinated fiscal resources. It is necessary to follow the principle of “determining revenue based on expenditure”, and to form the idea of dividing revenue and perfecting the transfer payment system on the basis of

optimizing the division of administrative powers and expenditure responsibilities, so as to form a reasonable intergovernmental fiscal structure. The frame of reference can be the path of establishment of the scientific fiscal decentralization: dividing fiscal revenue among governments based on the clarified division of the administrative powers and expenditure responsibilities of government at all levels, filling the fiscal gap at all levels with general transfer payments, compensating for the fiscal resources required for the performance of entrusted administrative powers and expenditure responsibilities with special transfer payments and revenue handed to the higher governments, and exiting in due course after the performance of the duties. Although China's tax sharing system has been continuously improved since 1994, there is still a big gap with the scientific fiscal decentralization. As China is faced with the new economic normal and the changing world economic structure, which is a good opportunity to deepen the tax sharing system reform, the researchers in finance need to strengthen theoretical innovation and explore the reform from current tax sharing system to scientific fiscal decentralization by working on the establishment of intergovernmental fiscal relations of coordinated fiscal resources and ensuring sustainable fiscal development.

Thirdly, we should study the scheme to further improve the sub-provincial tax sharing system with the goal of establishing the intergovernmental fiscal relations of regional balance. Despite the remarkable achievements of the reform of the division of administrative powers and expenditure responsibilities, there are still many local governments (mainly grass-roots governments) in China, which are dealing with huge infrastructure expenditure with a small amount of fiscal revenue, forming a huge debt that cannot be repaid on their own. This phenomenon shows that sub-provincial government are still facing unequal intergovernmental administrative powers and expenditure responsibilities, and the goal of regional balance can only rely on large-scale transfer payments and borrowing. In other words, regionally balanced intergovernmental fiscal relations can hardly be established without fundamentally solving these problems, and the fundamental solution is to deepen the sub-provincial tax sharing system reform.

In addition, a key issue needs to be addressed, namely, how to establish a stable and sustainable local tax system as soon as possible. On the one hand, the establishment of local tax system is one of the basic conditions to consolidate the achievements of tax sharing system reform and promote the further deepening of tax sharing system reform; on the other hand, cultivating a stable tax source for the local govemments by granting local tax power is also one of the inherent requirements of fiscal decentralization. The basic idea of establishing the local tax system is to determine the taxes which are weak in liquidity and easy to collect and manage locally, and to redefine the proportion of the shared tax according to the principle of equal powers and responsibilities. In short, to establish the intergovernmental fiscal relations with clearly defined powers and responsibilities, appropriate fiscal resources allocation, and regional balance, it is

impossible to avoid the establishment of a sound local tax system, which is becoming increasingly important and urgent with the deepening of reform.

## References

Chen, K., Hillman, A. L., & Gu, Q. Y. (2002). Changes in Fiscal Centralization and Local Government Behaviour—From Helping Hand to Grabbing Hand. *Economics (Quarterly) (Jingjixue Jikan)*, 2 (1), 111-130.

Finance Teaching and Research Office of Renmin University of China. (1964). *Public Finance*. China Financial and Economic Publishing House.(in Chinese)

Gao, P. Y. (2010). *Fiscal and Tax Systems of Major Countries in the World: Comparisons and References*. China Financial and Economic Publishing House. (in Chinese)

Gao, P. Y. (2018). China's Forty Years of Fiscal and Tax Reform: The Main Path, Fundamental Experiences and Basic Laws. *Economic Research Journal (Jingji Yanjiu)*, 3, 4-20.

Guo, D. M. (1991). The Status and Prospects of the Relationship between Central and Local Fiscal Distribution. *Public Finance Research (Caizheng Yanjiu)*, 7, 26-30.

He, Z. Y. (1987). *Theoretical Finance*. China Financial and Economic Publishing House.(in Chinese)

Hou, Y. L. (2009). Government Functions, Responsibilities and Fiscal Resources. *Journal of Public Administration (Gonggong Xingzheng Pinglun)*, 2, 36-72.

Hu, S. D. (2001). *Central and Local Relations in Economic Development: A Study on the Change of China's Fiscal System*. Shanghai People's Publishing House.(in Chinese)

Jia, K., & Bai, J. M. (2002). County and Township Fiscal Relief and Innovation in the Fiscal System. *Economic Research Journal (Jingji Yanjiu)*, 2, 3-9.

Jia, K. (1986). The Vision of In-Depth Reform of the Fiscal System. *China Economic Systems Reform (Zhongguo Jingji Tizhi Gaige)*, 10, 16-18.

Jia, K. (1988). A Discussion on the Thinking of the Near-Medium-Term Fiscal Reform. *China Economic Systems Reform (Zhongguo Jingji Tizhi Gaige)*, 4, 33-37.

Jia, K. (2005). Correctly Promote the Tax Sharing System and Discussion with the Proposition of "Two Pieces Vertically, Two Parts Horizontally". *Journal of Central University of Finance & Economics (Zhongyang Caijing Daxue Xuebao)*, 12, 1-4.

Li, L. (1992). Several Issues on Reshaping the Relations between Central and Local Finance. *Journal of Jilin Institute of Finance and Trade (Jilin Caimao Xueyuan Xuebao)*, 1, 28-33.

Lin, Y. F., & Liu, Z. Q. (2000). China's Fiscal Decentralization and Economic Growth.

*Journal of Peking University (Philosophy and Social Sciences) (Beijing Daxue Xuebao, Zhexue Shehui Kexueban)*, 4, 5-17.

Liu, S. X. (2008). Principles in Perfecting the Fiscal System. *Chinese Cadres Tribune (Zhongguo Dangzheng Ganbu Luntan)*, 9, 1.

Lou, J. W. (2013). *Rethinking China's Intergovernmental Fiscal Relations*. China Financial and Economic Publishing House.(in Chinese)

Lv, W. (2005). *How Far We Are from Public Finance*. Economic Science Press.(in Chinese)

Ma, H. T., Ren, Q., & Cheng, L. (2013). The Desirability of the Division of the Central and Local Fiscal Resources in China. *Public Finance Research (Caizheng Yanjiu)*, 4, 2-6.

Ma, W. L. (2013). Intergovernmental Division of Fiscal Rights under the Governance of Multi-Centers. *Comparative Economic & Social Systems (Jingji Shehui Tizhi Bijiao)*, 6, 203-213.

Qian, J. J. (1949). *New Synopsis of Public Finance*. SDX Joint Publishing Company.(in Chinese)

Research Group of Public Goods Equalization, Society of Public Finance of China. (2007). Public Service Equalization (written by Yan Kun *et al*.). *Review of Economic Research (Jingji Yanjiu Cankao)*, 58, 2-36.

Sun, K. (1990). Reflections on Straightening out the Fiscal relations between the Central and Local Governments. *Research on Financial and Economic Issues (Caijing Wenti Yanjiu)*, 7, 33-37.

Wang, S. F. (1998). Target Mode of Central and Local Fiscal relations. *Finance & Trade Economics (Caimao Jingji)*, 6, 22-27.

Yan, B. (1991). The Key to Coping with Fiscal relations between the Central and Local Governments—Gradual Implementation of Tax Sharing System. *Journal of Finance and Economics (Caijing Yanjiu)*, 4, 3-10.

Yin, W. J. (1953). *National Finance*. Lixin Accounting Book Supplies Society.(in Chinese)

Yu, S. Y. (2015). Intergovernmental Fiscal Relations with Matching Fiscal Powers and Expenditure Responsibilities under the Framework of State Governance. *Sub National Fiscal Research (Difang Caizheng Yanjiu)*, 5, 11-16.

Zhang, T., & Zou, H. F. (1998) Fiscal Province, Public Spending and Economic Growth in China. *Journal of Public Economics*, 67 (2), 221-240.

Zhang, Y., & Gong, L. T. (2005). Tax Sharing System Reform, Fiscal Decentralization and China's Economic Growth. *Economics (Quarterly)(Jingjixue Jikan)*, 5 (1), 75-108.

Zhou, Y. A., & Zhang, Q. (2008). Fiscal Decentralization, Economic Growth and Volatility. *Management World (Guanli Shijie)*, 3, 6-15.

# Schooling and Income Effect of Education Development in China: Evidence from the National Compulsory Education Project in China's Poor Areas

Dehua Wang, Jie Zou, Zhonggen Mao*

Whether investing in hardware for basic education is conducive to the long-term development of school-age children is a controversial issue in academic literature. Based on the data from the 2013 Chinese Household Income Project (CHIP), this paper uses the difference-in-differences (DID) method with cross-sectional data to evaluate the policy effects of China's National Compulsory Education Project for Poor Areas launched in 12 central provinces in the mid-1990s. We find that through the construction, renovation, or expansion of primary and junior middle school buildings and purchase of teaching equipment, this project achieved on its goal of "raising education levels": the years of schooling of the beneficiaries after they reached adulthood increased significantly by roughly 0.7 years. However, the project was not found to have an "income effect", i.e., the income of the beneficiary children did not increase with the increase in schoolings. The econometric analysis shows that although the project could raise the income levels of the children in adulthood, it did not significantly increase the likelihood of the beneficiary groups moving to cities as migrant workers. Limited by the late development of secondary and tertiary industries in poor counties, the beneficiaries who stayed locally were less likely to engage in non-farm occupations, and thus their income did not significantly increase. This indicates that policies like the Compulsory Education Project designed to improve school hardware in a short period of time can effectively promote the development of basic education in poverty-stricken areas. Nonetheless, to achieve the fundamental goal of raising income while increasing schooling, it is also necessary to actively guide people moving to cities to work as migrant workers and bolster the development of local secondary and tertiary sectors.

**Keywords:** National Compulsory Education Project, poverty alleviation through education, difference-in-differences with cross-sectional data

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## I. Introduction

Over the past 70 years, China has spared no effort in developing education, especially basic education, in order to improve human capital, promote economic development and reduce poverty. Educational development has always been a basic national policy. Overall, China has made remarkable progress in this regard: the average years of education for the population aged 15 and above were merely 1.6 in 1949 (Zhai, 2009) and rose to 9.11 in 2011 (Department of Population and Employment Statistics of National Bureau of Statistics, 2013). As Li *et al*. (2017) concludes, the significantly improved human capital is an important reason for the boost in labor productivity since the launch of reform and opening up in 1978, which in turn has driven rapid economic growth.

China has a large population that needs access to compulsory education but lacks funds and proper educational infrastructure due to the relatively backward economic development; this is typical for a resource-constrained country aspiring to develop basic education (Zhai, 2009). How to retrofit shabby school buildings, increase teaching equipment, and rapidly improve the hardware of primary and secondary schools has been a long-standing challenge. In particular, given the regional development imbalances, the Chinese government has rolled out special support policies and leveraged external forces to improve school buildings, teaching equipment and other aspects of school hardware to propel the development of basic education in poverty-stricken areas. This type of policies designed for specific regions is referred to as "big push" policies in the field of social infrastructure by Atolia *et al*. (2017)[1] and as "fight against poverty in education" in this paper.[2] Such policies can have immediate effects such as more spacious and brighter classrooms and more teaching equipment and also lead to improvements in current educational indicators such as increased enrollment and reduced dropout. However, in the long run, how will the improved hardware influence the core indicators such as the increase in human capital and income of individual students? This is a topic rarely addressed in the existing literature.

Based on data from the 2013 Chinese Household Income Project (CHIP), this paper examines how the National Compulsory Education Project for Poor Areas ("Compulsory Education Project" for short), which was implemented in Category-

[1] The "big push" theory, proposed by British development economist Paul N. Rosenstein-Rodan in 1943, thinks that large investments should be made in various sectors concurrently in underdeveloped areas to promote balanced growth of these sectors, thereby promoting the rapid and comprehensive development of the entire economy. Atolia *et al.* (2017) focuses on comparing the advantages and disadvantages of "big push" policies in the fields of economic infrastructure and social infrastructure.

[2] A more general term is "poverty alleviation through education", i.e., taking various measures to develop education to help the poor get out of poverty. This paper proposes the concept of "fight against poverty in education", which refers to dedicated policies supporting the development of basic education in poverty-stricken areas. Obviously, the latter is part of the former.

II regions between the end of 1995 and the end of 1997, influenced the years of education ("schooling effect") and income ("income effect") of the children after they reached adulthood. In 1995, against the lagging basic education in the central and western regions and the difficulty to basically achieve universal coverage of the nine-year compulsory education and eradicate illiteracy among the middle-aged and young people on schedule, the Chinese government launched the Compulsory Education Project designed to improve the hardware of primary and junior middle schools in 852 poor counties of 22 central and western provincial administrative regions. It is China's largest basic education project for poverty alleviation with the widest coverage and most special investment from the central government and a typical policy for "fight against poverty in education". Whether individuals could benefit from the project depends on whether they received primary or junior middle school education in the project counties and whether they were at primary or junior middle school when the project was implemented. By matching the counties in the CHIP with the project counties in Category-II regions and combining the age information of the surveyed individuals in 1995, we used the difference-in-differences (DID) method with cross-sectional data to identify the project's long-term impacts on the increase in human capital and income of the children after they reached adulthood.

The empirical results show that the this project delivered on its goal of "raising education levels": the years of education of the participating children after reaching adulthood increased significantly by roughly 0.7 years. However, the project had quite limited effect on "raising income levels", i.e., the income of the participating children after they grew up was not noticeably higher. Econometric analysis shows that although the project could raise the income levels of the children in adulthood when they worked as migrant workers, the probability of them working as migrant workers did not increase, and the chance of staying in hometown doing non-agricultural work even dropped considerably, perhaps because of the lagging secondary and tertiary industries. In other words, policies like the Compulsory Education Project designed to improve the basic education hardware in poor areas in a short period of time have the schooling effect of improving human capital; however, to achieve the objective of raising income levels, it is also necessary to actively guide people to work as migrant workers and bolster the development of local secondary and tertiary industries.

The contributions of this paper mainly include two aspects.

First, the impact of hardware on student development is a highly controversial topic in educational economics and development economics. By evaluating a major and distinctive project aimed at improving the hardware of primary and secondary schools in impoverished areas, this paper provides empirical evidence from China for this topic. Based on the analysis of more than 600,000 students in the United States, the well-known Coleman Report (Coleman *et al.*, 1966) suggests that resources such as hardware have little effect on improving students' academic attainment and long-

term performance. Since then, a series of studies revolving this topic have been carried out in the fields of pedagogy and economics. While earlier research neglects the endogenous problem of hardware investment, some more recent studies by scholars such as Cellini *et al*. (2010), Neilson and Zimmerman (2014), Hong and Zimmer (2016), and Martorell *et al*. (2016) began to look at the exogenous impact of whether U.S. municipal bonds for education were approved. These studies focused on the impact of hardware construction in U.S. urban areas on student performance in the short to medium term. Although the relevant literature adopts a policy evaluation method with a greater emphasis on causality, there is lack of consensus in their conclusions.

Projects similar to the Compulsory Education Project include the school construction project launched by the Julius Rosenwald Fund to help rural black children in South America from the 1910s to the 1930s ("Rosenwald project") and the INPRES project for primary school development in rural impoverished areas implemented by Indonesia in the 1970s. Aaronson and Mazumder (2011) found that the enrollment rate, literacy rate, and years of schooling of rural black participants in the Rosenwald project grew significantly. Research by Duflo (2001, 2004) showed that the years of education and income of the children benefiting from the INPRES project increased by 1.5% and 2.7%, but this came at the cost of lower wages for older children not covered by the project. As can be seen, research based on historical events of school hardware investment in rural areas has drawn more consistent conclusions.

The Compulsory Education Project is unique in terms of organization and implementation. The Rosenwald project and the INPRES project both aimed to build more schools to improve access to education in addition to improving the quality of school hardware. By contrast, the Compulsory Education Project, implemented in combination with the policy of adjusting the layout of primary and secondary schools, in effect saw a decrease in the number of teaching sites and schools in the project counties instead of increasing access to education. For example, the number of primary schools declined from 125872 to 118524. Therefore, compared to the other two projects, it laid greater emphasis on school hardware construction.[1] Moreover, neither the Rosenwald nor INPRES project clearly designated the benefiting and non-benefiting areas. Duflo (2001, 2004) and Aaronson and Mazumder (2011) defined the treatment group and the control group by school density in each area. By contrast, funds of the Compulsory Education Project are earmarked for the project counties, which clearly distinguish the benefiting areas (project counties) and non-benefiting areas (non-project counties). These two characteristics of the Compulsory Education Project make it suitable to be used to evaluate the impact of school hardware construction. Different from the conclusions made by Duflo (2001, 2004) and other

[1] Despite the criticism for canceling teaching sites and merging schools in recent years, the decrease in the number of schools and the increase in average school size are considered achievements in the summary reports on the Compulsory Education Project.

studies, this paper finds that the income effect of the project is not significant; in view of this, a quantitative decomposition method is used to preliminarily discuss the reasons based on the actual conditions in China, leading to findings that carry policy implications.

Second, this paper evaluates the actual performance of China's major fiscal expenditures and special transfer payment projects from the micro-level perspective of beneficiaries. From the angle of public economics, performance evaluation of fiscal expenditures should be centered on their substantial impact on social production and people's wellbeing. For example, education expenditures should be evaluated from the perspective of human capital and labor productivity of the educated. In addition, the Compulsory Education Project was a large special transfer payment from a higher government to governments at lower levels. This paper also studies the substantial performance of large special transfer payments at the individual level.

The structure of this paper is as follows: the second part introduces relevant information about the project and puts forward the hypothesis; the third part describes the identification strategy, data, and preliminary descriptive statistical results; the fourth part is the empirical analysis of the project's schooling effect; the fifth part conducts an empirical analysis of the income effect and further examines the effect by using quantitative decomposition; and the last part discusses the policy implications of the empirical results.

## 2. Research Background and Hypothesis

Unbalanced regional development poses a major challenge for China to develop basic education and popularize nine-year compulsory education. In 1995, the Chinese government divided the country into three categories according to the levels of education and economic development and put forward different requirements for the popularization of nine-year compulsory education in different regions.[1] According to the analysis by Zhu Kaixuan, then director-general of China's National Education Commission, the most outstanding problem in the popularization of compulsory education facing poverty-stricken areas was the shortage of funding; without strong support from the central and local governments, these backward areas would have

[1] Category-I regions refer to 9 economically developed provinces and municipalities including Beijing, Tianjin, Shanghai, Liaoning, Jilin, Jiangsu, Zhejiang, Shandong, and Guangdong; Category-II regions refer to 12 provinces with moderate levels of economic development and key to the popularization of nine-year compulsory education, including Hebei, Shanxi, Heilongjiang, Anhui, Fujian, Jiangxi, Henan, Hubei, Hunan, Hainan, Sichuan, and Shaanxi; Category-III regions cover 9 economically underdeveloped provincial-level regions that pose the greatest difficulties in the popularization of compulsory education, including Inner Mongolia, Guangxi, Guizhou, Yunnan, Tibet, Gansu, Qinghai, Ningxia, and Xinjiang. See: Guidance on Categorization in the Popularization of Nine-year Compulsory Education, *China Education Yearbook 1996*, 133-144.

great difficulty in achieving the goal of universal access to nine-year compulsory education.[1] At the same time, these regions had great development potential, and achieving the goal on schedule would have strategic significance for reducing regional development gaps.

The Compulsory Education Project is the widest-ranging special project that supports the development of education in specific poverty-stricken areas with the largest amount of funding from the central government since 1949. Based on the project management methods and experience of international organizations such as the World Bank, this project was carried out in 852 counties in Category-II and Category-III regions, including 592 state-level and 260 provincial-level poor counties.[2] The total investments reached RMB 12.756 billion, of which RMB 3.9 billion came from the central government, RMB 6.27 billion from local governments, and RMB 2.585 billion from urban and rural surcharges and non-fiscal funds, accounting for about 2% of China's GDP in 1995.[3] All the funds were steered towards the project counties.

Given that two phases of the Compulsory Education Project were implemented in Category-III regions, in order to get clean estimates of the effects of the project, this paper looks at the project counties in Category-II regions where only the first phase of the project was carried out. The project in these regions lasted from the end 1995 to the end of 1997, and covered 383 counties a total population of 159 million in 13 provinces (municipalities) in Central China, including 262 state-level and 121 provincial-level poor counties. The total investments included RMB 1.5 billion from the central government, RMB 2.938 billion from provincial, municipal, and county-level governments, and RMB 2.131 billion from non-fiscal sources.[4] The central special funds were allocated to the provincial-level governments, which then allocated the funds to lower-level governments. According to the documents on the allocation of central and provincial funds for the Compulsory Education Project (Finance Department of Ministry of Education and Education and Culture Department of Ministry of Finance, 2002), the funds were generally allocated based on such factors as farmers' per capita net income, fiscal revenue, size of poor population, and whether a county is an ethnic county, with priority given to ethnic minority areas, old

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[1] Zhu, K.X. (1996). A Major Task in Accelerating the Popularization of Nine-Year Compulsory Education. *Ethnic Education of China* (*Zhongguo Minzu Jiaoyu*), 3, 3-4.

[2] *Analysis on Comprehensive Benefits of the National Compulsory Education Project for Poor Areas*. Beijing: Ocean Press, 4-5.

[3] Finance Department of Ministry of Education and Education and Culture Department of Ministry of Finance. (2002). *Analysis on Comprehensive Benefits of the National Compulsory Education Project for Poor Areas*. Beijing: Ocean Press, 304. In 1995, China posted GDP of RMB 6134 billion (National Bureau of Statistics).

[4] *Analysis on Comprehensive Benefits of the National Compulsory Education Project for Poor Areas*. Beijing: Ocean Press, 298. In 1997, Chongqing was separated from Sichuan Province and became a municipality directly under the administration of the central government, so the number of provincial regions covered by the project increased to 13.

revolutionary base areas, border areas, and large grain-producing counties.

The funds for the Compulsory Education Project in Category-II regions were mainly used for the construction of hardware for primary and junior middle schools such as the expansion and renovation of school buildings and purchase of teaching equipment, desks and chairs, with few spent on the purchase of books and principal and teacher training. Generally, more funds went to primary schools than junior middle schools in order to "satisfy the needs of primary schools first".[1] For example, the total funds of the project earmarked for Hebei Province were about RMB 490 million, of which 51.8% was used for the construction or renovation of primary schools, 21% for that of junior middle schools, 20% to purchase teaching equipment and desks, 4.4% to purchase books, and less than 4% for training principals and teachers.[2] Given that poor infrastructure such as school buildings was a major obstacle to the popularization of nine-year compulsory education in economically underdeveloped areas, such spending arrangements were in alignment with the development status of basic education in Category-II regions at that time.

At the end of 1998, the Ministry of Education and the Ministry of Finance evaluated the implementation of the Compulsory Education Project in each project county. According to the evaluation conclusions (2002), the project "greatly improved the conditions of primary and secondary schools in project counties", "increased access to compulsory education and accelerated the progress in 'two basics'." In terms of objective indicators such as school buildings, enrollment rate, and drop-out rate, the project helped promote educational development in the project counties. However, in economic literature, human capital measured by years of education and the future income growth of the educated are generally used as long-term performance indicators for education. By contrast, the evaluation results by the government (2002) are only about short-term impacts of the project through comparison with the past situations of the project counties, presenting insufficient evidence showing the project's effects on improving human capital. So, can the better hardware brought by the Compulsory Education Project in poverty-stricken counties in Category-II regions truly improve long-term educational performance?

## 3. Data and Evaluation Strategy

The data used in this paper is mainly rural household survey data from the 2013

[1] Announcement of Ministry of Education and Ministry of Finance on the Completion of the National Compulsory Education Project for Poor Areas in Category-II Regions. http://old.moe.gov.cn//publicfiles/business/htmlfiles/moe/moe_355/200409/3844.html.

[2] Finance Department of National Education Commission and Education and Culture Department of Ministry of Finance. (1997). *Guide on the Management of the National Compulsory Education Project for Poor Areas*. Beijing: Higher Education Press, 241-242. The rates for Hebei are calculated based on relevant information, and the situations of other provincial regions are similar.

China Household Income Project (CHIP). The main evaluation strategy is to use difference-in-differences (DID) with cross-sectional data.

The CHIP survey data is one of the most authoritative household survey data in China and has been widely used in research literature.[1] The CHIP has the following characteristics: it can meet the needs of mid- and long-term evaluations, incorporates long-term migrant workers, even if some have changed the nature of their household registration,[2] and contains information such as educational background, occupation, and income of all members in a rural household, as well as the administrative division code of the county of the surveyed households. By comparing these counties with the list of project counties in the Compulsory Education Project, it is easy to identify the beneficiaries.

Similar to other studies (Duflo, 2001; Aaronson and Mazumder, 2011), this paper uses DID with cross-sectional data. To use this method, the area where a child benefiting from the project is located needs to be accurately identified so as to define the treatment group and the control group. This paper matches the counties covered by the Compulsory Education Project with those of the surveyed rural households in CHIP, the lattering totaling 201 in the 2013 CHIP survey. After matching, it is found that 19 of them were project counties in Category-II regions, 10 in Category-III regions, and the remaining 172 were not covered by the project. As mentioned earlier, the 10 counties in Category-III regions are excluded. Therefore, the 19 project counties in Category-II regions are used as the treatment group, and 172 non-project counties as the control group.

For the DID method with cross-sectional data, dummy variables similar to those in ordinary DID before and after policy implementation also need to be constructed. Whether an individual could benefit from the project depends on their age. The Compulsory Education Project covered primary and junior middle schools, where students are generally aged 7 to 15 in China. Therefore, individuals who were aged 6 or below in 1995 were considered as the fully benefiting age group, while those aged 16 or above in 1995 had completed junior middle school education before the project was launched and therefore considered as non-benefiting age group. Like the method used by Duflo (2001), this paper sets a dummy variable—*young*, which is similar to ordinary DID before and after policy implementation. Its value is 1 when an individual was aged 2 to 6 in 1995, and 0 when they were aged 16 to 20.[3]

Therefore, a DID model with cross-sectional data can be set up as (1):

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[1] For the basic information on the CHIP data, please visit: http://ciid.bnu.edu.cn/CHIP/index.asp.

[2] According to the CHIP guide, rural households refer to households where the head has a rural *hukou* registered in the town (neighborhood) in which they are living; household members refer to all people that live in the same house or share all expenses and income. The samples include non-permanent population, including migrant workers, those going to school in other places, and people who have changed the nature of their household registration (from rural to urban). See: Wu (2007).

[3] The general practice is to ensure the age differences of the treatment group and the control group are the same. Therefore, the benefiting age group in this paper is 2-6 years of age instead of 0-6.

$$y_{ij} = a_j + \beta young_i + \lambda program_j \times young_i + X_{ij}\delta + \varepsilon_{ij} \quad (1)$$

In model (1), $y_{ij}$ represents the years of education or income of individual $i$ whose *hukou* (or residence) is in county $j$; project $j$ and young $i$ are dummy variables of whether the individual belongs to the specific project county and the benefiting age group, respectively. The coefficient $\lambda$ of the interaction term of the two dummy variables represents the effect of the project. $X_{ij}$ is a county-level characteristic variable. In order to control the unknown regional factors that may affect the years of education or income, the fixed effect $\alpha_j$ at the county level is controlled in model (1). At this point, project $j$ does not need to join the regression.

The ex-ante parallel trend between the treatment group and the control group is an important premise for applying the DID technique. However, the project counties of the Compulsory Education Project were not selected randomly: most of them were economically and socially underdeveloped. Given their systematic socioeconomic gap with non-project counties, there is a possibility that even if the Compulsory Education Project was not implemented, there may still be systematic differences in the years of education and income levels of residents between them. This paper uses two methods to mitigate this endogenous problem.

First, while controlling the fixed effect at the county level, some interaction terms between county-level regional variables in 1990 and whether they were 2~6 years old are added to control the ex-ante trend.[1] This approach essentially allows the ex-ante characteristic variables of each county to have varying effects on different age groups. We checked the factor variables the provincial-level governments considered when allocating the central government's grants for the Compulsory Education Project, such as farmers' per capita net income, per capita fiscal revenue, population density, and whether a county is an ethnic county, to determine the ex-ante county-level regional variables.[2] If the project was still found to have significant schooling and income effects after the ex-ante trend is controlled, the results will be highly robust.

Second, a placebo test is performed on the ex-ante parallel trend to verify whether there are significant differences in the increase of years of education or income of individuals in project and non-project counties who received compulsory education prior to the project. Similar to the method used by Duflo (2001), individuals aged 16 to 20 in 1995 are redefined as the treatment group and those aged 21 to 25 as the control group, and DID analysis with

[1] Moser and Voena (2009) provided the reasons and principle for using this method. To control the ex-ante trend, county-level variables of the year before the project was implemented should be used. In view of data availability, county-level regional variables in 1990 are selected in this paper.

[2] The Chinese government (2002) introduced the factors on which the provinces allocated funds for the project. Among them, the population density is mainly used to measure the topographic features. The terrain in the central region is increasing, the mountainous areas are sparsely populated, and the plains are more populated.

cross-sectional data is carried out. Since both groups had completed compulsory education by 1995, they were definitely not the beneficiaries of the Compulsory Education Project. Therefore, this is a placebo test.[1] If it is found that there are no systematic differences in years of education and income between the two age groups in the project and non-project counties, this can be used as evidence of a parallel trend.[2]

In addition, the decomposition method is used to examine why the project was found to have no income effect and analyze the impacts of the project on the children's probability of working as migrant workers and engaging in non-agricultural work, so as to explore the deep reason why the project could barely raise income levels.

The CHIP survey data records the years of education after an individual reached adulthood, which can be directly used to measure the level of education. In addition, this paper uses other information in CHIP to calculate the per capita income from agricultural operations and by adding it to income from wages or non-agricultural operations to get the total income of an individual.

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[1] Like the studies by Duflo (2001) and others, to find an age group that is not affected by the policy to conduct a placebo test is a common practice for parallel trend tests of DID with cross-sectional data. A reviewer argues that dividing into two groups alone is not sufficient to test the parallel trend and suggests that the 16~25 age bracket in 1995 be divided into multiple groups for verification. Following this suggestion, we divide the 16~25 age group into 10 groups for parallel trend tests of the schooling effect (using the 25-year-olds as the control group); it is found that while the interaction term coefficients is significantly positive for the 16-year-old group, the coefficients are not significant for the 17- to 24-year-old groups. The significance of the interaction term coefficient for the 16-year-old group can be explained by the fact that some children in rural areas went to school late. Duflo (2001) also gives yearly interactive term coefficient images of samples aged 0 to 24. The main purpose is to analyze the marginal effect of the benefit period, but objectively it can also provide evidence for the parallel trend test. We also replicate the approach of Duflo (2001) and get similar images. These two auxiliary tests can further verify the validity of the parallel trend test in this paper. Given that it is common to divide the 16-to-25 age group into two groups for the parallel trend test to be clearly contrasted with the principal component regression, this paper uses it as the main method of the parallel trend test. The results of the two parallel trend tests are not included herein due to length limitations. If you are interested, feel free to contact us.

[2] In the econometric analysis of this paper, family background information such as parents' occupations or income is not controlled. This is consistent with the approach used in long-term policy impact assessments by Duflo (2001). The reason is that the model needs to control family background information when the policy was implemented, i.e., in 1995 or before, but micro-level survey data generally only provides family background information at the time of the survey, and there are few retrospective surveys on family background information at long intervals. In the CHIP data, the level of education of parents can be matched by using the household code and the "relationship with the head of household" variable. If the level of education did not change much in 2013 compared with 1995, it could be used as a control variable. We successfully matched only 1201 individuals in this regard. Econometric analysis finds that after controlling parents' level of education and county-level fixed effects, interaction term coefficient of whether individuals were aged 2 to 6 and whether they were in project counties is 0.855, which is significantly positive at the 0.1 level. If the ex-ante trend is further controlled, the number of samples is reduced to 978, and the interaction term coefficient is 0.583, which is significant at the 0.1 level. We believe that the decline in significance here is mainly correlated with a notable decrease in the sample size. As DID with cross-sectional data is used herein, the systemic differences in family backgrounds by region and age group have been absorbed by other variables and will have little impact on the results if not controlled, in addition to the sample size limitations. Therefore, family background information is not controlled in all the analyses herein.

## 4. Schooling Effect of the Compulsory Education Project

Table 1(A) shows the basic regression results of the schooling effect obtained based on the econometric model (1). The explained variables in the table are years of education. The "project counties" dummy variable is added to column (1), which is a standard DID model with cross-sectional data. Column (2) controls county-level fixed effects to solve the problem of missing regional variables. In column (3), interaction terms between county-level characteristic variables such as net income of farmers, per capita fiscal revenue, and per capita industrial output in 1990, and whether an individual was aged 2 to 6 in 1990 are added to control the ex-ante trend. On the basis of column (3), columns (4) and (5) include interaction terms such as population density, whether a county was an ethnic county, and whether an individual was aged 2 to 6; the control variables in column (6) are the same as those in column (5), but the control group is restricted to Category-II regions. In all columns, the interaction term coefficients (*young* × *program*) of whether individuals were aged 2 to 6 and whether they were in project counties are significantly positive at the 0.05 significance level. These results show that the project has a significant schooling effect. The regression coefficients of the interaction terms in each column are relatively stable. The economic implication is that the project increased the average years of education of the beneficiaries by about 0.7 years.

Table 1. Basic Regression Results of the Schooling Effect

| | Years of education | | | | | |
|---|---|---|---|---|---|---|
| | Table 1(A) 2~6 years old/16~20 years old | | | | | |
| | (1) | (2) | (3) | (4) | (5) | Category-II regions |
| Interaction term | 0.693*** (3.23) | 0.753*** (3.51) | 0.694*** (2.86) | 0.679*** (2.79) | 0.625** (2.54) | 0.778*** (2.93) |
| Aged 2~6 | 2.402*** (29.00) | 2.495*** (31.42) | 2.747*** (12.46) | 2.720*** (12.35) | 2.788*** (12.23) | 2.662*** (7.14) |
| Project county | –0.936*** (-5.89) | | | | | |
| County-level fixed effect | No | Yes | Yes | Yes | Yes | Yes |
| Ex-ante trend interaction term | No | No | Yes | Yes | Yes | Yes |
| Constant term | 8.560*** (143.64) | 9.000*** (19.64) | 7.524*** (6.5) | 9.175*** (9.11) | 9.211*** (9.17) | 9.250*** (6.45) |
| N | 5200 | 5200 | 4107 | 4107 | 4043 | 2619 |
| $R^2$ | 0.1653 | 0.3188 | 0.3193 | 0.3214 | 0.3171 | 0.2725 |

Years of education

Table 1(B) 16~20 years old/21~25 years old

| | (1) | (2) | (3) | (4) | (5) | Category-II regions |
|---|---|---|---|---|---|---|
| Interaction term | –0.198<br>(–0.94) | 0.002<br>(0.01) | 0.196<br>(0.86) | 0.199<br>(0.87) | 0.257<br>(1.11) | 0.316<br>(1.25) |
| Aged 16~20 | 0.775***<br>(10.33) | 0.722***<br>(10.28) | 0.404**<br>(2.04) | 0.414**<br>(2.09) | 0.330<br>(1.64) | 0.035<br>(0.10) |
| Project county | –0.738***<br>(–5.35) | | | | | |
| County-level fixed effect | No | Yes | Yes | Yes | Yes | Yes |
| Ex-ante trend interaction term | No | No | Yes | Yes | Yes | Yes |
| N | 5047 | 5047 | 3995 | 3995 | 3940 | 2484 |
| $R^2$ | 0.0356 | 0.2217 | 0.1986 | 0.1991 | 0.1881 | 0.1372 |

Notes: (1) The values in parentheses are the *t*-statistics calculated by "robust" standard errors; (2) ***, **, and * indicate that the regression coefficients pass the significance tests at the 0.01, 0.05, and 0.1 levels, respectively.

Each column in Table 1(B) corresponds to that in Table 1(A). The control variables are the same, while the treatment group and the control group are replaced with the 16~20 and 21~25 age groups who had completed compulsory education before the project to conduct the placebo test. It can be seen that although the interaction term coefficients in Table 1(B) are mostly positive, they are much smaller than those in Table 1(A), and none of them is significant. This indicates that the parallel trend assumption is reasonable: despite the systematic differences between project and non-project counties, there will be no significant difference in the years of education between different age groups without the intervention of the Compulsory Education Project.

To examine the marginal schooling effect on the children benefiting from the project, the dummy variable "aged 2~6" in model (1) is replaced with the years that individuals aged 2~20 benefited from the project. The results are shown in Table 2. As can be seen, the interaction term coefficients of the benefit years and project counties are significantly positive and pass the significance test at the 0.01 level.[1] When the schooling that the children benefited from the project increased by one year, the average years of education after adulthood increased by about 0.07 to 0.09 years. If the samples are limited to Category-II regions, the coefficients will be a bit greater.

[1] Children aged 2 to 6 in 1995 benefited 9 years from the project; for children aged 10 or 15, the benefit years are 6 or 1, respectively.

Table 2. Impact of Benefit Years on Years of Education after Adulthood

| | Full sample | | | Category-II regions | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) | (3) |
| Interaction term | 0.0907*** (3.53) | 0.0874*** (3.49) | 0.0741*** (2.58) | 0.098*** (3.63) | 0.094*** (3.56) | 0.084*** (2.65) |
| Benefit year | 0.283*** (29.13) | 0.294*** (31.99) | 0.335*** (12.59) | 0.276*** (22.00) | 0.288*** (23.86) | 0.334*** (7.07) |
| Project county | −1.215*** (-6.40) | | | −0.875*** (−4.40) | | |
| County-level fixed effect | No | Yes | Yes | No | Yes | Yes |
| Ex-ante trend interaction term | No | No | Yes | No | No | Yes |
| N | 9649 | 9649 | 7444 | 6191 | 6191 | 4648 |
| $R^2$ | 0.0914 | 0.2510 | 0.2452 | 0.095 | 0.205 | 0.194 |

Notes: the values in parentheses are the *t*-statistics calculated by "robust" standard errors; *** indicates that the regression coefficients pass the significance tests at the 0.01 level.

## 5. Income Effect of the Compulsory Education Project and Quantitative Decomposition

### *5.1. Basic Results*

Children aged 2 to 6 in 1995 were 20 to 24 years old when the CHIP was conducted in 2013, whose employment was generally still unstable. Children aged 7 to 10 in 1995 in the project counties also benefited from the project and were aged 25 to 28 in 2013, when they should be stable forces in the labor market. In view of this, in the following analysis, the 7~10 age group in 1995 is defined as the benefiting age group, while the non-benefiting age group is still the 16~20 age group.[1] The benchmark regression results of the income effect are shown in Table 3. As can be seen from the first four columns in Table 3, no matter whether the logarithmic value of the explained variable "income" includes income from agricultural operations or whether the samples are restricted to Category-II regions, the interaction term coefficients are not significant. In other words, there is no indication that the project had an income effect. Given that per capita household expenditures are highly correlated with household income and are unlikely to be underreported, the last two columns in Table 3 will be replaced by

[1] We also conducted relevant analysis by using the 2~6 age group, and the basic conclusions are the same as in Table 5.

explanatory variables with household expenditures. It can be seen from the table that the interaction term coefficients are still not significant, that is, from the perspective of household consumption, the project was not found to have the effect of raising income levels.

Table 3. Benchmark Regression Results of the Income Effect on the 7~10 Age Group

| | Income (excluding income from agricultural operations) | | Total income | | Household expenditures | |
|---|---|---|---|---|---|---|
| | Full sample | Category-II regions | Full sample | Category-II regions | Full sample | Category-II regions |
| Interaction term | 0.096<br>(1.10) | 0.0869<br>(0.93) | 0.109<br>(1.26) | 0.104<br>(1.13) | –0.057<br>(–1.04) | –0.0258<br>(–0.44) |
| Project county | –0.028<br>(–0.43) | –0.0748<br>(–0.63) | 0.060<br>(0.87) | –0.00446<br>(–0.04) | 0.177***<br>(3.36) | 0.0417<br>(0.45) |
| County-level fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Ex-ante trend interaction term | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2583 | 1529 | 2449 | 1470 | 3308 | 2075 |
| $R^2$ | 0.1825 | 0.184 | 0.2156 | 0.231 | 0.3095 | 0.208 |

Notes: the values in parentheses are the *t*-statistics calculated by "robust" standard errors; *** indicates that the regression coefficients pass the significance tests at the 0.01 level.

Wu (2007) points out that rural residents with higher education and income levels are more likely to change their household registration (*hukou*) from "rural" to "urban", implicating a high degree of upward selectivity. The above econometric analysis finds that the project had no income effect, partly because some individuals who benefited from the project changed their *hukou* to "urban" in adulthood, resulting in a downward bias for the income effect. The CHIP rural household samples used in this paper include those who worked as migrant workers or changed their *hukou* from "rural" to "urban". Rural residents with higher levels of education are more likely to change their *hukou*, but this should have quite limited impact on the income effect evaluation results hereinof.

### *5.2. Decomposition Analysis*

Why did the project increase the years of education but play no role in raising the income levels of the beneficiaries as adults? To understand this is of great significance for poverty alleviation through education. In this paper, the quantitative decomposition method is used from the perspective of the income structure and employment

characteristics of the beneficiaries to shed light on this issue.

Generally, there are two main employment options for rural residents: to work as migrant workers or stay in their hometown engaging in agricultural or non-agricultural operations. The former means competing in the national labor market, while the latter means being restricted by the local labor market. These two groups of people vary greatly in terms of income structure and employment characteristics and therefore should be analyzed separately. According to the definition in the CHIP questionnaire, the sample individuals in Table 4(A) are people who left their counties to work as migrant workers in 2013. The regression results show that the interaction terms (aged 7 to 10 years project counties) are significantly positive at the 0.05 and 0.1 levels, and the income effect of the project should be about 20%. The samples of the treatment group and control group in Table 4(B) are those who did not work as migrant workers in 2013. The regression results show that whether the total income or income from non-agricultural operations is used as the only factor, the interaction term coefficients are negative but not significant.

Table 4. Regression Results of the Income Effect across Groups

| | (A) Income of migrant workers | | | | (B) Income of non-migrant workers | | | |
|---|---|---|---|---|---|---|---|---|
| | Income (excluding income from agricultural operations) | | Total income | | Income (excluding income from agricultural operations) | | Total income | |
| | Full sample | Category-II regions | Full sample | Category-II regions | Full sample | Category-II regions | Full sample | Category-II regions |
| Interaction term | 0.195** (2.06) | 0.187* (1.90) | 0.207** (2.35) | 0.194** (2.10) | –0.159 (–0.44) | –0.191 (–0.46) | –0.239 (–0.63) | –0.308 (–0.74) |
| Aged 7~10 | –0.053 (–0.64) | –0.131 (–0.87) | –0.056 (–0.70) | –0.103 (–0.71) | 0.024 (0.18) | 0.001 (0.00) | 0.030 (0.24) | 0.085 (0.23) |
| County-level fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Ex-ante trend interaction term | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1724 | 1147 | 1714 | 1141 | 834 | 564 | 825 | 525 |
| $R^2$ | 0.187 | 0.182 | 0.176 | 0.167 | 0.346 | 0.334 | 0.343 | 0.356 |

Note: the values in parentheses are the *t*-statistics calculated by "robust" standard errors; ** and * indicate that the regression coefficients pass the significance tests at the 0.05 and 0.1 levels, respectively.

By comparing the results of Tables 4(A) and 4(B), it can be found that as long as the beneficiaries left their hometown and participated in the national labor market,

more years of education indeed increased their income. However, for those who stayed in their hometown, the increase in years of education did not lead to higher income, indicating that the project was not found to have an income effect. Then, did the project increase the probability of working outside their hometown? Table 5 sets the dummy variable "whether to leave hometown to work or do business" as an explained variable. The results show that the interaction term coefficients (aged 7 to 10 × project county) are not significant no matter whether the samples are restricted to Category-II regions. This implies that compared with the control group, the beneficiaries did not choose to work outside their hometown even though they received more years of education.

Table 5. Impact on the Probability of Going out for Non-Farm Jobs

| | Table 5(A) Full sample | | | Table 5(B) Category-II regions | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) | (3) |
| Interaction term | –0.024<br>(–0.85) | 0.009<br>(0.30) | 0.040<br>(1.20) | –0.0138<br>(–0.46) | 0.0329<br>(1.08) | 0.0430<br>(1.23) |
| Project country | 0.127***<br>(8.69) | 0.107***<br>(7.92) | 0.019<br>(0.50) | 0.116***<br>(6.63) | 0.0830***<br>(4.96) | 0.0213<br>(0.35) |
| Item | 0.196***<br>(8.13) | | | 0.121***<br>(4.78) | | |
| County-level fixed effect | No | Yes | Yes | No | Yes | Yes |
| Ex-ante trend interaction term | No | No | Yes | No | No | Yes |
| N | 4484 | 4484 | 3449 | 2838 | 2838 | 2133 |
| $R^2$ | 0.0401 | 0.2747 | 0.2487 | 0.0350 | 0.214 | 0.162 |

Notes: (1) The values in parentheses are the *t*-statistics calculated by "robust" standard errors; (2) ***, **, and * indicate that the regression coefficients pass the significance tests at the 0.01, 0.05, and 0.1 levels, respectively.

We then analyze the employment choices of those who stayed in their hometown and were surveyed by the CHIP questionnaire. Non-agricultural occupations include occupations with wage income and non-agricultural businesses. Table 6 sets three dummy variables: "whether engaged in non-agricultural occupations", "whether engaged in non-agricultural occupations with wage income", and "whether engaged in non-agricultural production" as explanatory variables. The results show that the interaction term coefficients in the first four columns are all significantly negative at least at the 0.1 significance level. Although the interaction term coefficients in the last two columns are negative, they are not significant. This indicates that if the beneficiaries stayed in their hometown, the probability of engaging in non-agricultural occupations would be reduced. The main reason is that the opportunities for non-

agricultural occupations with wage income decreased, while whether they were employed in non-agricultural businesses had little impact.

Table 6. Impact on the Probability of Being Employed in Local Non-Agricultural Occupations

| | Whether engaged in non-agricultural occupations | | Whether engaged in non-agricultural occupations with wage income | | Whether engaged in non-agricultural production | |
|---|---|---|---|---|---|---|
| | Full sample | Category-II regions | Full sample | Category-II regions | Full sample | Category-II regions |
| Interaction term | –0.217** (–2.71) | –0.138* (–1.82) | –0.231*** (–2.79) | –0.176* (–1.88) | –0.110 (–1.23) | –0.013 (–0.13) |
| Aged 7~10 | –0.0463 (–0.79) | –0.195 (–1.61) | –0.00221 (–0.04) | –0.114 (–0.89) | –0.0634 (–0.73) | –0.325* (–1.83) |
| County-level fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Ex-ante trend interaction term | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 1769 | 1014 | 1512 | 861 | 976 | 650 |
| $R^2$ | 0.280 | 0.222 | 0.342 | 0.261 | 0.331 | 0.239 |

Notes: (1) The values in parentheses are the *t*-statistics calculated by "robust" standard errors; (2) ***, **, and * indicate that the regression coefficients pass the significance tests at the 0.01, 0.05, and 0.1 levels, respectively.

Zhao (2006) finds that the improvement in the return on education in rural areas mainly depends on the rapid development of the non-agricultural economy. Currently, in rural China, the income of non-agricultural jobs is relatively high, which is the main factor influencing the increase of rural residents' income. As can be seen from Table 6, although the project increased the years of education for the beneficiaries, it did not raise, but even reduced, their opportunities to engage in non-agricultural occupations, probably because of the lagging development of local secondary and tertiary sectors. The decrease in non-agricultural employment opportunities for children staying in their hometown is one of the reasons why the project did not have an income effect. Our findings are consistent with those of Zhao (2006).

As we see it, this can be attributed to the lagging development of non-agricultural sectors in the project counties, as shown in Figure 1 which compares the average added value of the three sectors in the 372 project counties with that in the 1207 non-project counties. As can be seen in Figure 3, the added value of the three sectors in project counties was lower than that of non-project counties. However, the gaps in added value of the secondary and tertiary sectors with non-project counties widened over time. Zhen and Ling (2017) pointed out that the development of non-agricultural sectors had a greater impact on the income of the younger generation (2~6 age group) than the older generation (16~20 age group). After 2000, the secondary and tertiary sectors of

the project counties fell behind, unable to provide sufficient non-agricultural jobs. Such impact was greater on the beneficiaries (2~6 age group) in the project counties. As a result, the project had the effect of increasing the levels of education but not income.[1]

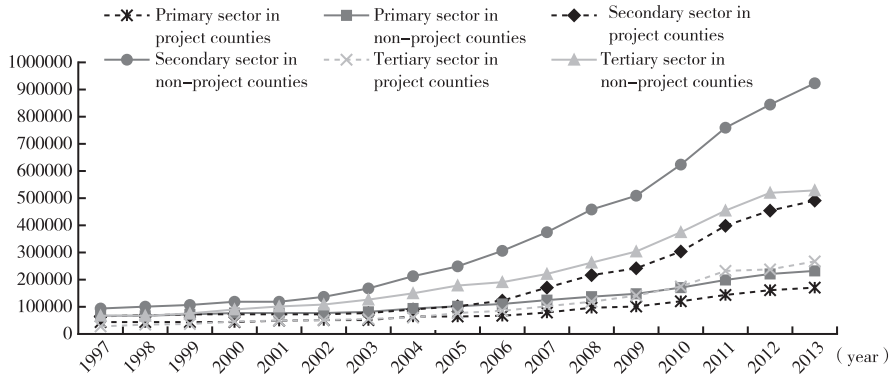


*Figure 1*. Trends of Added Value by Sector in Project Counties and Non-Project Counties (RMB 1000)
Notes: Data on the added value of the three sectors in each county comes from provincial statistical yearbooks and *China Statistical Yearbook for Regional Economy*; the project counties in the figure refer to the 372 counties in Category-II regions where the Compulsory Education Project was implemented, and there were 1207 non-project counties.

## 6. Conclusions and Policy Implications

In order to prop up the development of education in economically underdeveloped areas, developing countries often adopt the "big push" strategy of introducing special support policies and leveraging external forces to rapidly improve school buildings, teaching equipment and other hardware. However, the existing studies pay little attention to the long-term effects of such "big push" development strategy. The Compulsory Education Project in China carried out in the mid-1990s was a typical "big push" in the field of social infrastructure. Using data from the 2013 CHIP rural household survey, this paper analyzes the schooling and income effects of the project in an effort to examine the long-term effects of "big push" strategies, providing empirical evidence from China.

Quantitative analysis finds that the project had a significant schooling effect, increasing the level of education of the beneficiaries by about 0.7 years. However, the project was found to have no effect of raising their income levels. On the face of it, these findings run counter to the classic human capital theory. However, econometric analysis of those leaving their hometown for work finds that the project could indeed increase the income of the beneficiaries, which is consistent with the classic human

[1] Thanks to the reviewers for providing us with this perspective

capital theory. Generally, the project was not found to have the effect of raising income levels because it failed to increase the beneficiaries' probability of going out for work as adults; moreover, those who stayed in their hometown saw a significant decline in the probability of engaging in non-agricultural occupations. The possible reason is that the development of the secondary and tertiary sectors in the project counties was staggering over the years, unable to provide sufficient non-agricultural jobs for local residents. These results indicate that in China, the value of human capital improvements can only be reflected in non-agricultural secondary and tertiary labor markets. The finding that the project had income effect is not at odds with the classic human capital theory; the underlying reason is the lack of a labor market that can give full play to human capital.

This paper has obvious policy implications. Taking the "big push" strategy to promoting the development of education in poverty-stricken areas can have positive effects. However, poverty alleviation through education requires policy coordination to provide more non-agricultural jobs for people in poverty-stricken areas to bring into full play the improved human capital. The measures include actively guiding farmers to work as migrant workers and integrate into the market; promoting the development of the secondary and tertiary sectors in poor areas through industrial policies, combining poverty alleviation through education with industrial development, and providing more non-agricultural jobs for local residents.

## References

Aaronson, D., & Mazumder, B. (2011). The Impact of Rosenwald Schools on Black Achievement. *Journal of Political Economy*, 119 (5), 821-888.

Atolia, M., Li, B., Marto, R., & Melina, G. (2017). Investing in Public Infrastructure; Roads or Schools? IMF Working Papers 17.

Coleman, J., Campbell. E, *et al*. (1966). Equality of Educational Opportunity. Washington, DC: U.S. Government Printing Office.

Duflo, S. (2001). Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment. *The American Economic Review*, 91 (4), 795-813.

Duflo, S. (2004). The Medium Run Effects of Educational Expansion: Evidence from a Large School Construction Project in Indonesia. *Journal of Development Economics*, 74 (1), 163-197.

Finance Department of Ministry of Education, & Education and Culture Department of Ministry of Finance. (2002). *Analysis on Comprehensive Benefits of the National*

*Compulsory Education Project for Poor Areas*. Beijing: Ocean Press. (in Chinese)

Finance Department of National Education Commission, & Culture and Education Department of Ministry of Finance. (1997). *Guide on the Management of the National Compulsory Education Project for Poor Areas*. Beijing: Higher Education Press. (in Chinese)

Hong, K., & Zimmer, R. (2016). Does Investing in School Capital Infrastructure Improve Student Achievement? *Economics of Education Review*, 53,143-158.

Li, H. P., Loyalka, P., Rozelle, S., & Wu, B. (2017). Human Capital and China's Future Growth. *Journal of Economic Perspectives*, 31 (1), 25-48.

Martorell, P., Stange, K., & McFarlin, I. (2016). Investing in Schools: Capital Spending, Facility Conditions, and Student Achievement. *Journal of Public Economics*, 140, 13-29.

Moser, P., & Voena, A. (2009). Compulsory Licensing: Evidence from the Trading with the Enemy Act. *American Economic Review*, 102 (1), 396-427.

Neilson, C., & Zimmerman, S. (2014). The Effect of School Construction on Test Scores, School Enrollment, and Home Prices. *Journal of Public Economics*, 120, 18-31.

Rosenstein-Rodan, P. (1943). Problems of Industrialization of Eastern and Southeastern Europe. *Economic Journal*, 53 (210-211), 202-211.

Wu, X. G. (2007). China's Household Registration System and Intergenerational Occupational Mobility. *Sociological Studies* (*Shehuixue Yanjiu*), 6, 38-65.

Zhai, B. (2009). A Miracle in Human History: China's Endeavor to Promote Education for All in 30 Years of Reform and Opening Up. *Educational Research* (*Jiaoyu Yanjiu*), 1, 3-11.

Zhao, L. (2006). Research on Return on Education in Rural China. *Social Sciences in China* (*Zhongguo Shehui Kexue*), 3, 98-109.

Zhen, X., & Ling, C. (2017). Impact of Rural Labor Mobility on Rural Income and Income Gaps: From the Perspective of Labor Heterogeneity. *China Economic Quarterly* (*Jingjixue Jikan*), 16(3), 1073-1096.

# Employment Structure, Lewis Turning Point and the Labor Share of Income: Theoretical and Empirical Analysis

Jiajun Lan, Ying Fang, Tianping Ma*

In the context of the labor market segmentation in China and its reaching the Lewis turning point, this paper interprets the changing trend of the labor share of income in China from the changing perspective of the employment ownership structure. The theoretical analysis reveals that the labor share of income follows a U-shaped curve when the agricultural labor force gradually moves into the private and self-employed sectors. Using the Chinese provincial-level panel dataset between 1990 and 2016, our empirical study finds that there is a critical threshold. When the share of agricultural labor force is above this threshold value, the impact of the increase in the employment share of the urban private sector on the labor share of income is negative. In contrast, the impact becomes positive when the share of the agricultural labor force is less than or equal to this threshold value. Moreover, the impacts of other variables of employment ownership structure don't show this kind of feature on both sides of this threshold value. The increase in the employment share of the urban private sector accounted for about 29.37% of the growing labor share of income between 2007 and 2016. This paper provides policy implications in the following four areas: institutional guarantee improvement, harmonious labor relations establishment, redistribution policy imposition and economic development pattern transformation.

**Keywords:** labor share of income, employment ownership structure, Lewis turning point, urban private sector employment

## 1. Introduction

Changes with the labor share of income exert influence over a series of major

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economic issues. Its decrease not only restrains consumption power of citizens and negatively affects the expansion of consumer demand (Li *et al*., 2009), but also widens the income gap and therefore may induce social contradictions and undermine social stability and development (Cai, 2005). As the construction of socialism with Chinese characteristics enters a new era, it's important to increase the share of labor remuneration in primary distribution, ensure that people have a greater sense of gain in co-contribution and shared development, and develop a reasonable and orderly income distribution pattern, in order to complete the process of building a moderately prosperous society in all aspects. To this end, exploring the periodical features of changing labor share of income in China and its influential factors has important policy and realistic implications.

According to GDP data accounted with the income approach, the labor share of income in China declined from 53.42% in 1990 to 39.74% in 2007 and then climbed back gradually to 47.46% in 2016 (refer to Figure 1 for the "GDP approach"). Since the 1990s, decrease of the share attracted wide academic attention. However, increase of the share since 2007 has not been paid sufficient attention. This leads to the research contribution of the paper, which, based on the basic stylized fact of the labor market segmentation in China and its reaching the Lewis turning point, interprets the changing trend of decreasing first and then increasing of the labor share of income since 1990 from the changing perspective of the employment ownership structure.

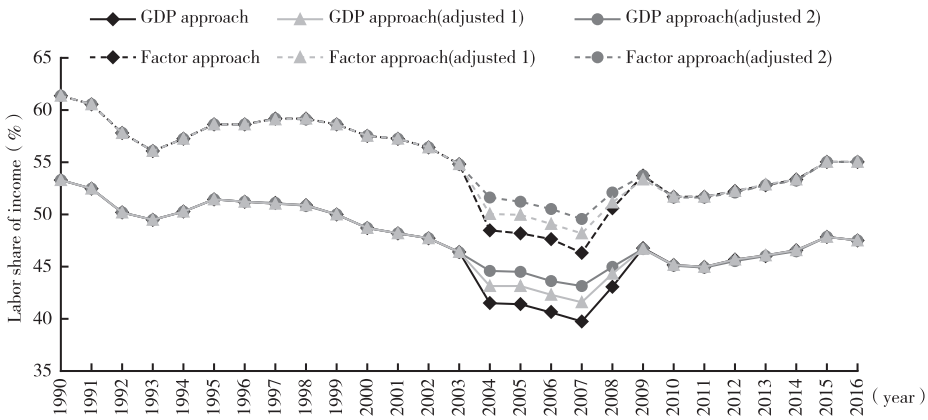


*Figure 1.* Changing Trend of the Labor Share of Income in China

Sources: *China Statistical Yearbooks*, *Data of Gross Domestic Product of China 1952—1995* and *Data of Gross Domestic Product of China 1952—2004*.

Due to the diversity of economic sectors, the employment ownership structure in China underwent tremendous changes (Cai and Wang, 2004). As shown in Figure 2, noticeable changes with the structure were rapid increase of the employment share of private and self-employed sectors, initial decline and then slow increase of the

employment share of urban units and continuous decrease of the share of agricultural labor force.[1] By 2016, self-employed and private economic sectors absorbed nearly 40% of national employed population and urban self-employed and private economic sectors even absorbed nearly half of urban employed population. As Chinese labor market is segmented into employment in urban formal sectors, urban informal sectors and rural employment sectors, agricultural labor force that has been transferred mostly moves into urban informal sectors. Therefore, changes with employment ownership structure can better reflect fundamental features of labor transfer in the context of Chinese dual economic structure and to this end, the paper takes the perspective of changing employment ownership structure to analyze the change with labor share of income.

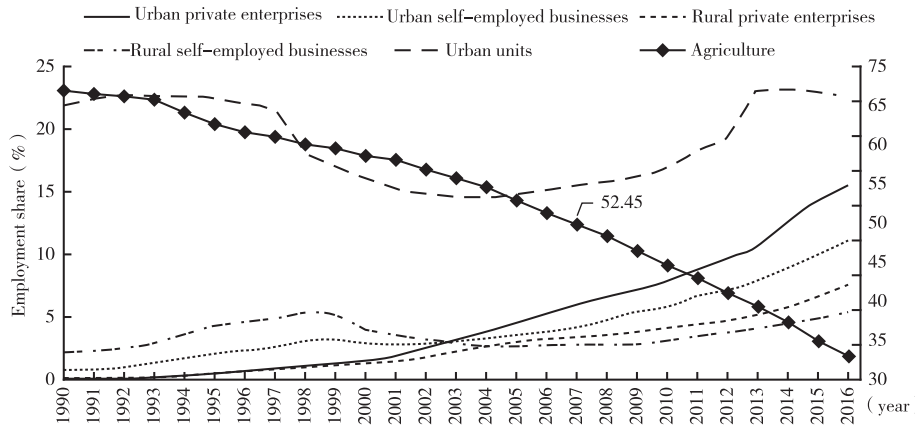


*Figure 2.* Changing Trend with Chinese Employment Ownership Structure

Note: "52.45" in the figure means that the share of agricultural labor force in 2007 was 52.45%.

Sources: *China Statistical Yearbook 2000* and *China Statistical Yearbook 2017*.

In the context of the labor market segmentation in China and its reaching the Lewis turning point, the paper constructs a theoretical model covering agricultural production sectors, self-employed and private sectors and urban units. The theoretical analysis reveals that the labor share of income follows a U-shaped curve when the agricultural labor force gradually moves into the private and self-employed sectors, and the wage of self-employed and private sectors and that of urban units will converge. Using the Chinese provincial-level panel dataset between 1990 and 2016, our empirical study finds that there is a critical threshold. When the share of agricultural labor force is above this threshold, the increase in the employment share of the urban private sector drives down the labor share of income; when the share of the agricultural labor force

[1] As defined in this paper, agricultural labor force = rural employed population–rural privately employed population–rural self-employed population.

is less than or equal to this threshold, the increase in the former will drive up the latter; moreover, the impacts of other variables of employment ownership structure don't show this kind of feature on both sides of this threshold. The increase in the employment share of the urban private sector contributed to about 29.37% of the growing labor share of income between 2007 and 2016 in China.

In the remaining parts of the paper, the second part is dedicated to literature review. The third part gives institutional background, theoretical analysis and hypothesis. The fourth part illustrates variables, data and descriptive statistics. The fifth part presents the empirical analysis and the last part is conclusions and provides some policy suggestions.

## 2. Literature Review

In the process of economic development, the factor share of income may remain constant, as indicated in one of Kaldor's stylized facts (Kaldor, 1961). However, since the 1980s, most countries worldwide experienced noticeable decrease of the labor share of income (Karabarbounis and Neiman, 2014) and hence sizeable literature on influential factors on the change of labor share of income was produced in the academic circle. Domestic and foreign studies were mainly conducted from the perspectives of technology bias (Karabarbounis and Neiman, 2014; Huang and Xu, 2009; Wen and Lu, 2018), adjustment of industrial structure (Luo and Zhang, 2009a; Bai and Qian, 2010), trade and globalization (Zhang *et al*., 2012), foreign direct investment (Luo and Zhang, 2009b; Shao and Huang, 2010) and transformation of labor relations (Wei *et al*., 2013).

Despite the immense literature on the influential factors on the change with Chinese labor share of income, they mostly focus on the decrease of the labor share of income, with little attention to the trend of decreasing first and then increasing. Kuznets' "inverted U curve" hypothesizes that economic inequality increases first and then decreases as economy develops (Kuznets, 1955). Theoretical analysis by Li *et al*. (2009) reveals that the labor share of income decreases first and then increases as labor force is continuously transferred from agricultural to industrial sectors and their empirical study based on transnational data also shows that labor share of income and per capita GDP display a U-shaped relationship. Unlike Li *et al.* (2009) that interprets from the general law of transfer from agriculture to industry, this paper innovatively explains the changing labor share of income that decreases first and then increases from the perspective of changing employment ownership structure, the fundamental feature of labor transfer, in the context of the labor market segmentation in China and its reaching the Lewis turning point. Some other literature indicates that along with industrialization and adjustment of industrial structure, the labor share of income may display the trend of decreasing and then increasing (Luo and Zhang, 2009a; Bai and Qian, 2010; Liu

*et al*., 2018). Such literature helps us understand the U-shaped trend of Chinese labor share of income from the perspective of industrial structure adjustment, but unlike them, we will interpret from the perspective of changing employment ownership structure.

## 3. Institutional Background, Theoretical Analysis and Hypothesis

### *3.1. Institutional Background*

#### 3.1.1. Reform of the Employment System and Evolvement of Labor Share Segmentation in China

Before the reform and opening up, the Chinese government implemented the strategy of prioritizing the heavy industry for development (Lin *et al*., 1994) and adopted policies discriminating against agriculture to transfer the surplus labor from agriculture to industry. In order to restrict the outflow of labor force from rural areas (Zhao, 2004) and secure the full employment and no welfare spillover for urban residents (Cai *et al*., 2001), the government promulgated the *Regulations of the People's Republic of China on Household Registration* in 1958, which marked the birth of the household registration system limiting free flow of population and directly caused serious segmentation in Chinese urban and rural labor markets.

After the reform and opening up, the household contract responsibility system improved the labor productivity of agriculture and also generated enormous agricultural surplus labor.[1] Meanwhile, the rapid economic development in urban areas and greater favor for labor-intensive industries in the development strategies stimulated urban needs for agricultural labor force. Subsequently, a large number of agricultural laborers entered the urban labor market. However, as local government practiced protective policies against migrant labor force in protection of interests of urban residents (Cai *et al*., 2001), Chinese urban and rural labor markets were still segmented and the massive agricultural labor force that had entered the urban labor market didn't have equal access to rights and security in employment with urban residents. Employment in urban informal sectors was featured by low wage, low requirements for skills and education background and predomination by agricultural labor force in its target of absorption (Wang *et al*., 2004). This contrasted sharply with employment of formal sectors. As sizeable agricultural labor force entered urban informal sectors and found it difficult to enter formal sectors, the urban labor market was also segmented into formal and informal sectors internally.

To sum up, as the employment system was reformed and the labor market

[1] As defined by Lewis (1954), surplus labor refers to labor force with insignificant marginal productivity of labor (zero and even negative). The definition is also adopted by Cai (2010) and Wang and Zhong (2011).

developed, Chinese labor market was segmented into employment in urban formal sectors, urban informal sectors and rural employment sectors. The majority of the agricultural labor force that had been transferred actually entered urban informal sectors.

#### 3.1.2. Lewis Turning Point and Wage Convergence

The reform and opening up has brought profound changes to Chinese demographic structure. The share of working-age population aged 15~64 reached the peak of 74.53% in 2010, but agricultural surplus labor had been nearly absorbed completely. Urban demand for labor force has outgrown the supply of labor (Cai and Wang, 2008), which means that China has reached the Lewis turning point in its economic development (Cai, 2010).

Under the joint impact of the advent of Lewis turning point and constant decrease of share of the employed with poor education background, the scarcity of regular workers with low education and low skills (mainly agricultural labor force) is considerably intensified, while the supply of proficient laborers with high education and high skills is relatively stable. The former is mainly employed in urban informal sectors, while the latter mainly in urban formal ones. According to the determination mechanism for wages based on supply and demand in the labor market, wage in urban informal sectors should outgrow that in urban formal sectors. Cai and Du (2011) found that systematic wage convergence had emerged in Chinese labor market.

### *3.2. Theoretical Analysis and Hypothesis*

Lewis (1954) divided an economy into the subsistence sector and the capitalist sector, with the former continuously providing surplus labor for the latter at a wage level only for subsistence and the latter constantly expanding with cheap labor force and capital accumulation. As the capitalist sector keeps expanding, it will take away all the surplus labor from the subsistence sector at some point. Afterwards, the wage of the labor force transferred from the subsistence sector to the capitalist sector is equal to its marginal productivity of labor and keeps rising, and this point is named Lewis turning point (Cai, 2010; Wang and Zhong, 2011).

In the context of the segmented Chinese labor market and its reaching Lewis turning point, this paper constructs a theoretical model on the basis of the study by Lewis (1954) and Li *et al*. (2009), with the purpose of establishing the relationship between employment ownership structure and labor share of income. With the transfer of agricultural labor force taken as the start of theoretical analysis, this paper focuses on the influence of the change with employment ownership structure on the labor share of income according to characteristics of the dual economic development in China and

its particular labor market segmentation.

According to the statistics provided by the National Bureau of Statistics, the employment ownership structure discussed herein includes employment in urban units (covering state-owned units, collective units, joint-stock cooperative units, associated units, limited liability companies, stock corporations, Hong Kong, Macao and Taiwan invested units, and foreign invested units), urban private enterprises, urban self-employed businesses, rural private enterprises, rural self-employed businesses and agriculture. In order to simplify the theoretical analysis, we combine employment in urban private enterprises, urban self-employed businesses, rural private enterprises and rural self-employment businesses into employment in self-employed and private sectors. Given that part of the transferred agricultural labor force has entered rural private enterprises and rural self-employed businesses as previously pointed out, it's reasonable to regard the segmentation of Chinese labor market as segmentation among agricultural production sectors, self-employed and private sectors and urban units. On such basis, we categorize the economy into the agricultural production sector, self-employed and private sectors and urban units. Suppose the following production functions for the three sectors respectively:

$$Y_1 = A_1 L_1^{a_1} M_1^{1-a_1} \tag{1}$$

$$Y_2 = A_2 L_2^{a_2} K_2^{1-a_2} \tag{2}$$

$$Y_3 = A_3 L_3^{a_3} K_3^{1-a_3} \tag{3}$$

To explain, $Y_j$ refers to output, $A_j$ (>0) technological coefficient, $L_j$ quantity of labor force, and $\alpha_j$ ($\epsilon$(0,1)) the coefficient of elasticity of labor output. $j$=1,2,3; $L=L_1+L_2+L_3$ is total quantity of labor force; $M_1$ refers to the land of agricultural production sector as a production factor, which puts marginal productivity of labor of the sector in degression; $K_2$ and $K_3$ respectively mean the capital of self-employed and private sectors and the urban unit sector. According to institutional background analysis, suppose the transferred agricultural labor force flows into the self-employed and private sectors, while labor force in the urban unit sector remains constant.[1] Consequently, make $\overline{L}=L_1+L_2$, with $\overline{L}$ meaning the sum of labor quantity in the agricultural production sector and the self-employed and private sectors and make $L_3$ constant, leaving aside the growth of population and labor force.

Before the advent of Lewis turning point, the agricultural production sector can provide surplus labor non-stop for the self-employed and private sector, and wage

[1] The hypothesis also complies with the feature of the changing employment ownership structure in China. Employment share of urban units in 1990–2016 changed only narrowly.

at this time is far lower than marginal productivity of labor in the latter. Given that marginal productivity of labor in the latter is greater than that in the former, total output will outgrow total labor remuneration. As agricultural surplus labor is constantly transferred, the latter keeps expanding and thus before the Lewis turning point, labor share of income will keep decreasing as the employment share of the self-employed and private sector increases. After reaching the point, agricultural surplus labor is completely absorbed. When the self-employed and private sector continues with demand for labor, wage ($w_2$) of the agricultural labor force further transferred from the agricultural production sector to the self-employed and private sector will equal marginal productivity of labor in the agricultural production sector ($w_1$). In this case,

$$w_2 = w_1 = a_1 A_1 L_1^{a_1 - 1} M_1^{1-a_1} \tag{4}$$

Wage of the urban unit sector ($w_3$) is its marginal productivity of labor:

$$w_3 = a_3 A_3 L_3^{a_3 - 1} K_3^{1-a_3} \tag{5}$$

Suppose that total labor remuneration of the economy is $W$ and total output $Y$, and then the labor share of income ($SH$) can be expressed as:

$$SH = \frac{W}{Y} = \frac{a_1 A_1 (\overline{L} - L_2)^{a_1 - 1} M_1^{1-a_1} \overline{L} + a_3 A_3 L_3^{a_3} K_3^{1-a_3}}{A_1 (\overline{L} - L_2)^{a_1} M_1^{1-a_3} + A_2 L_2^{a_2} K_2^{1-a_2} + A_3 L_3^{a_3} K_3^{1-a_3}} \tag{6}$$

Take natural logarithms on the both sides of formula (6) and seek partial derivative on self-employed and private employment ($L_2$):

$$\frac{\partial \ln(SH)}{\partial L_2} = \frac{\partial \ln(W)}{\partial L_2} - \frac{\partial \ln(Y)}{\partial L_2} = \frac{\partial W / \partial L_2}{W} - \frac{\partial Y / \partial L_2}{Y} \tag{7}$$

In the formula,

$$\frac{\partial W}{\partial L_2} = -a_1 A_1 (a_1 - 1)(\overline{L} - L_2)^{a_1 - 2} M_1^{1-a_1} \overline{L} \tag{8}$$

$$\frac{\partial Y}{\partial L_2} = a_1 A_1 (\overline{L} - L_2)^{a_1 - 1} M_1^{1-a_1} + a_2 A_2 L_2^{a_2 - 1} K_2^{1-a_2} \tag{9}$$

At the initial stage of agricultural labor force being further transferred, as labor marginal productivity of the self-employed and private sector is far higher than that of

the agricultural production sector, the transfer of agricultural labor force makes total output outgrow total labor remuneration and thus the labor share of income keeps declining. According to (8) and (9), $\partial W / \partial L_2 > 0$, $\partial Y / \partial L_2 > 0$, $\partial^2 W / \partial L_2^2 > 0$ and $\partial^2 Y / \partial L_2^2 < 0$. In other words, total labor remuneration and total output both increase as self-employed and private employment rises, but the acceleration of rising labor remuneration is greater than that of rising output. Therefore, when agricultural labor force is transferred to a certain degree, the increase of total output will be smaller than that of total labor remuneration and since then, labor share of income will start to keep climbing. When $\partial \ln(SH) / \partial L_2 = 0$, the share hits the bottom. Based on (7) ~ (9), when the labor share of income hits the bottom, the number of the employed in the self-employed and private sector ($L_2^{'}$) fits the following formula:

$$(a_1 - 1)\ln(\overline{L} - L_2') - (a_2 - 1)\ln(L_2') = \ln\left[\left(\frac{a_2 A_2 K_2^{1+a_2}}{a_1 A_1 M_1^{1+a_1}}\right) \Big/ \left(1 - \frac{(a_1 - 1)\overline{L}}{(\overline{L} - L_2')W/Y}\right)\right] \tag{10}$$

When the agricultural production sector and the self-employed and private sector have equal marginal productivity of labor, the transfer of labor force comes to an end. At this point, the number of the employed in the self-employed and private sector ($L_2^{''}$) fits the following formula:

$$(a_1 - 1)\ln(\overline{L} - L_2'') - (a_2 - 1)\ln(L_2'') = \ln\left(\frac{a_2 A_2 K_2^{1-a_2}}{a_1 A_1 M_1^{1-a_1}}\right) \tag{11}$$

In comparison between (10) and (11), we find that as the function $(a_1 - 1)\ln(\overline{L} - L_2) - (a_2 - 1)\ln(L_2)$ increases along with the growth of $L_2$ and $1 - \frac{(a_1 - 1)\overline{L}}{(\overline{L} - L_2')W/Y} > 1$, it's inferred that $L_2^{'} < L_2^{''}$. In other words, the bottom of labor share of income appears before the transfer of labor force stops.

Since after the advent of Lewis turning point, the wage of the self-employed and private sector will be equal to marginal productivity of labor in the agricultural production sector and keep rising and the wage in the urban unit sector is relatively stable, the self-employed and private sector and the urban unit sector will show the trend of wage convergence.

Based on the analysis, this paper comes to the following proposition:

**Proposition**: In the context of the segmented Chinese labor market and its reaching Lewis turning point, when agricultural labor force is continuously transferred to the self-employed and private sector, the labor share of income will display the trend of decreasing first and then increasing and the bottom of the share appears before the

labor force stops transferring. Moreover, the self-employed and private sector and the urban unit sector will experience wage convergence. On such basis, we propose the following hypothesis that remains to be tested:

**Hypothesis**: There exists a critical threshold. When the share of agricultural labor force is above the threshold, the increase of the employment share in the self-employed and private sector will cause the labor share of income to drop. When the share of agricultural labor force is below or on the threshold, the increase of the employment share of the self-employed and private sector will drive the labor share of income to rise.

## 4. Variables, Data and Descriptive Statistics

### *4.1. Labor Share of Income and Its Changing Trend*

According to currently available literature (Luo and Zhang, 2009b), labor share of income in primary distribution of national income can be calculated with the GDP approach or the factor approach. Also, GDP accounting with the income approach in China was changed in two areas in 2004—2007. First, income of the employed in the self-employed sector was changed from labor income to operating surplus; second, operating surplus was no longer accounted for agriculture. The changes with the statistical coverage caused the labor share of income in 2004—2007 to plunge. The paper adjusts the labor share of income in 2004—2007 based on the method proposed by Zhou *et al*. (2010) and Zou and Yuan (2018) and marks the two adjustment methods as "adjusted 1" and "adjusted 2". We will take labor share of income ($SH_1$) with the "GDP approach" as the benchmark for empirical analysis and use another five indicators for prudence analysis. As revealed in Figure 1, no matter which method is used for adjusting the labor share of income in 2004—2007, the share shows the trend of decreasing first and then increasing in 1990—2016 and hitting the bottom in 2007.

### *4.2. Employment Ownership Structure and Other Control Variables*

In this paper, variables of the employment ownership structure include the employment share of urban units, urban private enterprises, urban self-employed businesses, rural private enterprises and rural self-employed businesses and the share of agricultural labor force. Besides, based on existing literature, this paper selects the following control variables, including per capita GDP (at constant price of 1990, taking the natural logarithm), capital-output ratio (at constant price of 1990), share of public finance expenditure in GDP, share of import/export in GDP, share of FDI in GDP, average schooling years and proportion of working-age population.

### *4.3. Data Source and Descriptive Statistics*

We get access to data on these variables from *China Statistical Yearbooks*, *China Compendium of Statistics 1949—2008*, *Data of Gross Domestic Product of China 1952—1995*, *Data of Gross Domestic Product of China 1952—2004*, *China Population and Employment Statistics Yearbook* and provincial statistical yearbooks. As some data is not available, the paper eventually adopts the panel dataset of 29 provinces, autonomous regions and municipalities directly under the central government in China in 1990—2016. Table 1 lists descriptive statistics on all the variables and regarding the variable of labor share of income with GDP approach, the mean value is 0.486 and standard deviation 0.072. Besides, variables of the employment ownership structure show strong variability, satisfying the regular requirements for empirical analysis.

Table 1. Descriptive Statistics on the Variables

| Variable | Definition | Observed | Mean | SD | Min | Max |
|---|---|---|---|---|---|---|
| $SH_1$ | Labor share of income with GDP approach | 783 | 0.486 | 0.072 | 0.315 | 0.681 |
| $SH_2$ | Labor share of income with factor approach | 783 | 0.565 | 0.082 | 0.368 | 0.797 |
| $SH_1\_adj_1$ | GDP approach (adjusted 1) | 783 | 0.489 | 0.070 | 0.323 | 0.681 |
| $SH_2\_adj_1$ | Factor approach (adjusted 1) | 783 | 0.567 | 0.080 | 0.379 | 0.797 |
| $SH_1\_adj_2$ | GDP approach (adjusted 2) | 783 | 0.491 | 0.068 | 0.323 | 0.681 |
| $SH_2\_adj_2$ | Factor approach (adjusted 2) | 783 | 0.569 | 0.078 | 0.390 | 0.797 |
| *Priv_U* | Employment share of urban private enterprises | 783 | 0.050 | 0.061 | 0.000 | 0.442 |
| *Self_U* | Employment share of urban self-employed business | 783 | 0.046 | 0.032 | 0.002 | 0.178 |
| *Priv_R* | Employment share of rural private enterprises | 783 | 0.026 | 0.031 | 0.000 | 0.165 |
| *Self_R* | Employment share of rural self-employed business | 783 | 0.035 | 0.021 | 0.001 | 0.170 |
| *Formal* | Employment share of urban units | 783 | 0.240 | 0.139 | 0.087 | 0.736 |
| *Agri* | Share of agricultural labor force | 783 | 0.570 | 0.184 | 0.001 | 0.866 |
| *PGDP* | Per capita GDP (at constant price of 1990) | 783 | 8184 | 8048 | 779 | 52874 |
| *K/Y* | Capital-output ratio (at constant price of 1990) | 783 | 2.525 | 0.904 | 1.199 | 8.533 |
| *Gov* | Share of public finance expenditure in GDP | 783 | 0.166 | 0.086 | 0.049 | 0.627 |
| *Open* | Share of import/export in GDP | 783 | 0.303 | 0.398 | 0.032 | 2.258 |

| Variable | Definition | Observed | Mean | SD | Min | Max |
|---|---|---|---|---|---|---|
| *FDI* | Share of FDI in GDP | 783 | 0.033 | 0.035 | 0.000 | 0.243 |
| *Edu* | Average schooling years | 783 | 7.855 | 1.316 | 4.608 | 12.304 |
| *L_prop* | Proportion of working-age population | 783 | 0.708 | 0.046 | 0.602 | 0.838 |
| $TP_1$ | Whether *Agri* ≤0.56 or not; 1 if yes | 783 | 0.398 | 0.490 | 0 | 1 |
| $TP_2$ | Whether *Agri* ≤0.53 or not; 1 if yes | 783 | 0.354 | 0.478 | 0 | 1 |
| *East* | Whether in East China or not; 1 if yes | 783 | 0.345 | 0.476 | 0 | 1 |

## 5. Empirical Analysis

In this part of empirical analysis, the paper first studies the overall impact of the variables of employment ownership structure on the labor share of income, produces a critical threshold in the share of agricultural labor force through threshold regression, and then constructs dummy variables with the threshold to analyze if the impact of the variables on the labor share of income changes on both sides of the threshold.

### *5.1. Basic Estimation Results*

In order to study the overall impact of the variables of employment ownership structure on the labor share of income, this paper sets the following estimating equation:

$$SH_{it} = \alpha + \beta' X_{it} + \gamma' Z_{it} + u_i + u_t + \varepsilon_{it} \tag{12}$$

In the equation, $i$ and $t$ respectively refer to area and year, $u_i$ and $u_t$ fixed effects of area and year, and $\varepsilon_{it}$ a stochastic disturbance term. $SH_{it}$ is labor share of income; $X_{it}$ means a column vector of employment ownership structure, including the employment share of urban private enterprises (*Priv_U*), that of urban self-employed business (*Self_U*), that of rural private enterprises (*Priv_R*), that of rural self-employed business (*Self_R*) and that of urban units (*Formal*); $Z_{it}$ represents a column vector including a series of control variables.

Table 2 lists the basic estimation results. The coefficient estimate of the variable of employment share of urban private enterprises is significantly positive; the estimate of employment share of urban self-employed business and that of rural private enterprises are positive, but not highly significant; the estimate of employment share of rural self-employed business and that of urban units are both negative. As the purpose of this paper is to study whether the variables of employment ownership structure can explain the decrease-and-then-increase changing trend of Chinese labor share of income, these estimation results are only for reference.

Table 2. Basic Estimation Results

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Explained variable | $SH_1$ | $SH_2$ | $SH_1\_adj_1$ | $SH_2\_adj_1$ | $SH_1\_adj_2$ | $SH_2\_adj_2$ |
| *Priv_U* | 0.241** | 0.231* | 0.240** | 0.231* | 0.240** | 0.230* |
| | (0.113) | (0.129) | (0.114) | (0.130) | (0.115) | (0.131) |
| *Self_U* | 0.014 | 0.227 | 0.021 | 0.233 | 0.024 | 0.235 |
| | (0.148) | (0.176) | (0.152) | (0.179) | (0.154) | (0.182) |
| *Priv_R* | 0.290* | 0.326 | 0.296* | 0.333* | 0.301* | 0.338* |
| | (0.170) | (0.193) | (0.170) | (0.193) | (0.171) | (0.193) |
| *Self_R* | –0.150 | –0.273 | –0.148 | –0.272 | –0.148 | –0.273* |
| | (0.132) | (0.161) | (0.133) | (0.161) | (0.133) | (0.160) |
| *Formal* | –0.059 | –0.055 | –0.064 | –0.061 | –0.069 | –0.065 |
| | (0.069) | (0.080) | (0.070) | (0.081) | (0.070) | (0.081) |
| Observed value | 783 | 783 | 783 | 783 | 783 | 783 |
| Inner-group $R^2$ | 0.597 | 0.558 | 0.552 | 0.518 | 0.516 | 0.485 |

Notes: Those in brackets are heteroskedasticity-robust standard error of coefficient estimates. In the regression equations, provincial/regional fixed effect, fixed effect of year and control variables (including ln*PGDP*, *K/Y*, *Gov*, *Open*, *FDI*, *Edu* and *L_prop*) are all controlled, and due to limited space, coefficient estimation results of control variables and constant terms are not reported. *, ** and *** respectively stand for the level of significance at 10%, 5% and 1%. Hereinafter it is the same.

### *5.2. Interpretation with the Variables of Employment Ownership Structure for the Decrease and then Increase of Labor Share of Income*

According to the hypothesis in the theoretical analysis, on the both sides of the threshold share of agricultural labor force, the coefficient symbol for the influence of employment share in self-employed and private sectors on labor share of income has changed. Besides, since various employment ownership sectors within self-employed and private sectors are affected by the changing supply of labor to different extents, it's necessary to analyze the variables of employment ownership structure within self-employed and private sectors. In the paper, a threshold regressive model (Hansen, 1999 and 2000) on panel data is constructed as follows to estimate the threshold of share of agricultural labor force.

$$SH_{it} = \alpha + \beta_1' X_{it} I(Agri_{it} \le \theta) + \beta_2' X_{it} I(Agri_{it} > \theta) + \gamma' Z_{it} + u_i + u_t + \varepsilon_{it} \quad (13)$$

Here, the threshold variable is the share of agricultural labor force (*Agri*). $I(Agri_{it} \le \theta)$ is an indicative function and it is valued 1 when *Agri* is below or equal to the threshold value ($\theta$) and valued 0 otherwise. Similarly, the indicative function $I(Agri_{it} > \theta)$ is defined. Others are set in the same way as in (12).

Table 3 lists the estimation results of the threshold model. The critical value of the

share of agricultural labor force is 0.53 when only fixed effects of area are added, and 0.56 when fixed effects of both area and year are added. When the share of agricultural labor force is above the critical value, the increase of the employment share of urban private enterprises exerts negative impact on the labor share of income; when the share of agricultural labor force is below or equal to the critical value, the increase exerts positive influence in a significant way. However, other variables of employment ownership structure don't exhibit similar characteristics on both sides of the critical value.

The labor share of income in China displayed the trend of decreasing first and then increasing in 1990—2016 and hit the bottom in 2007, which was perfectly matched by the critical value of the share of agricultural labor force estimated in the threshold model. Based on the critical value, we develop two dummy variables ($TP_1$ and $TP_2$). (1) When the share of agricultural labor force is lower than or equal to 0.56, $TP_1$ is valued 1; otherwise, it is valued 0. (2) When the share is lower than or equal to 0.53, $TP_2$ is valued 1; otherwise, it is valued 0. On the basis of the estimation equation (12), we add interaction terms of the employment ownership structure variables and the dummy variables and the estimation results are shown in Table 4.

Take the column (1) in Table 4 for example. The variable of employment share of urban private enterprises (*Priv_U*) has a coefficient estimate of -0.171, while its interaction term ($Priv\_U \times TP_1$) with dummy variable of the critical value has an coefficient estimate of 0.468, significant at the level of 10%. This indicates that when the share of agricultural labor force is above the critical value, the increase by one percentage point of the employment share of urban private enterprises will cause the labor share of income to drop by 0.171 percentage point; when the share of agricultural labor force is below or equal to the critical value, it will cause the labor share of income to rise by 0.297 percentage point. Interaction terms of the employment share of urban self-employed business, rural private enterprises and rural self-employed business and the dummy variable of the critical value all have negative coefficient estimates and therefore none of the three variables can explain the U-shaped change of the labor share of income. Though the interaction term of the employment share of urban units and dummy variable of the critical value has a positive coefficient estimate, it's found in calculation that after the share of agricultural labor force is below or equal to the critical value, the coefficient estimate of influence of the employment share of urban units on the labor share of income is –0.050. Therefore, the variable of the employment share of urban units cannot explain the U-shaped trend of the labor share of income. In the column (2) with another dummy variable of the critical value ($TP_2$) used for interaction, the estimation results are consistent with those in the column (1), meaning that the results are robust. The analysis reveals that among all the variables of employment ownership structure, only the change of employment share of urban private enterprises is able to explain the changing trend of Chinese labor share of income in decreasing first and then increasing.

Table 3. Estimation Results of the Threshold Model

| Explained variable | | (1) $SH_1$ | (2) $SH_1$ |
|---|---|---|---|
| Critical value of threshold variable (*Agri*) | | 0.53 | 0.56 |
| *Priv_U* | *Agri* ≤ critical value | 0.577*** (0.093) | 0.296*** (0.098) |
| | *Agri* > critical value | –0.490** (0.211) | –0.171 (0.248) |
| *Self_U* | *Agri* ≤ critical value | 0.121 (0.262) | –0.018 (0.203) |
| | *Agri* > critical value | 1.254*** (0.341) | 0.807** (0.333) |
| *Priv_R* | *Agri* ≤ critical value | –0.145 (0.185) | 0.259 (0.172) |
| | *Agri* > critical value | 0.006 (0.292) | 0.447* (0.259) |
| *Self_R* | *Agri* ≤critical value | 0.694** (0.258) | –0.174 (0.233) |
| | *Agri* > critical value | 0.243 (0.181) | –0.112 (0.172) |
| *Formal* | *Agri* ≤critical value | 0.020 (0.072) | –0.061 (0.058) |
| | *Agri* > critical value | 0.122 (0.092) | –0.147* (0.086) |
| Fixed effect of province/area | | Controlled | Controlled |
| Fixed effect of year | | Un–controlled | Controlled |
| Observed value | | 783 | 783 |
| Inner-group $R^2$ | | 0.445 | 0.614 |

According to the law of economic development, East China absorbs agricultural labor force faster than Central and West China. Given so, after the share of agricultural labor force is below or equal to the critical value, the wage in the urban private sector in East China will outgrow that in Central and West China and the increase of employment share of urban private enterprises in the east may drive the labor share of income to increase by a greater margin than in the central and western regions. In order to test the difference, on the basis of Table 4, we add an interaction term of three variables, namely the employment share of urban private enterprises, the dummy variable of the critical value ($TP_1$) and eastern regions (*East*). As found in the result, the interaction term ($Priv\_U \times TP_1 \times East$) of the three variables has a coefficient estimate that is significantly positive. It illustrates that after the share of agricultural labor force is below or equal to the critical value, compared with that in central and

western regions, the increase of the employment share of urban private enterprises in the east causes the labor share of income to rise by a greater margin.[1]

Table 4. Heterogeneity of the Influence of Employment Ownership Structure

| | (1) | (2) |
|---|---|---|
| Explained variable | $SH_1$ | $SH_1$ |
| Dummy variable of critical value | $TP_1$ | $TP_2$ |
| *Priv_U* | –0.171<br>(0.259) | –0.209<br>(0.186) |
| *Self_U* | 0.762**<br>(0.360) | 0.725**<br>(0.291) |
| *Priv_R* | 0.476*<br>(0.265) | 0.467<br>(0.305) |
| *Self_R* | –0.122<br>(0.177) | –0.156<br>(0.177) |
| *Formal* | –0.143<br>(0.126) | –0.064<br>(0.080) |
| *Priv_U×TP* | 0.468*<br>(0.273) | 0.544***<br>(0.185) |
| *Self_U×TP* | –0.751*<br>(0.415) | –0.788*<br>(0.431) |
| *Priv_R×TP* | –0.215<br>(0.245) | –0.292<br>(0.257) |
| *Self_R×TP* | –0.047<br>(0.283) | 0.087<br>(0.267) |
| *Formal×TP* | 0.093<br>(0.113) | 0.010<br>(0.081) |
| *TP* | –0.008<br>(0.033) | 0.009<br>(0.030) |
| Observed value | 783 | 783 |
| Inner-group $R^2$ | 0.613 | 0.613 |

Note: *TP* in column (1) refers to $TP_1$ and *TP* in column (2) refers to $TP_2$. Hereinafter it is the same.

Development of the focus of the industrial structure from the primary sector to the secondary and then to the tertiary sector also causes the labor share of income to drop first and then climb. In order to test whether the industrial structure poses any influence, we add in the equation several variables related to the industrial structure, namely the share of output value of the secondary and tertiary sectors in GDP ($GDP\_Ind_2$, $GDP\_Ind_3$) and the share of employed population in the secondary and tertiary

[1] Due to limited space, estimated result of the regression is not reported. Please contact the author if needed.

sectors in total employed population ($L\_Ind_2$, $L\_Ind_3$). The estimation results are consistent with the previous analysis.[1]

### *5.3. Relationship between the Change in the Employment Share of Urban Private Enterprises and the Change in the Labor Share of Income*

By combing the variable regression coefficient and its margin of change in corresponding time periods (Wen and Lu, 2018), we use the estimate result in column (1) in Table 4 to explain the influence of the changing employment share of urban private enterprises on the changing labor share of income. Chinese labor share of income ($SH_1$) dropped by 12.81 percentage points in 1990—2006 and rose by 7.72 percentage points in 2007—2016; the employment share of urban private enterprises increased by 5.18 percentage points in 1990—2006 and climbed by 9.49 percentage points in 2007—2016. Based on the coefficient estimate of the employment share of urban private enterprises on both sides of the critical value of the share of agricultural labor force, it's calculated that the employment share of urban private enterprises contributed to 6.92% of the change of labor share of income in 1990—2006 and 36.50% in 2007—2016.

Table 5. Contribution of the Changing Employment Share of Urban Private Enterprises to the Changing Labor Share of Income

| Critical value | Time period | Benchmark(%) | Share of output value of the secondary and tertiary sectors added(%) | Share of employment in the secondary and tertiary sectors added(%) |
|---|---|---|---|---|
| $TP_1$ | 1990—2006 | 6.92 | 4.49 | 10.60 |
| | 2007—2016 | 36.50 | 32.32 | 25.19 |
| $TP_2$ | 1990—2006 | 8.46 | 7.00 | 12.38 |
| | 2007—2016 | 41.17 | 36.50 | 29.37 |

Following this method, we calculate the contribution of the changing employment share of urban private enterprises to the changing labor share of income when using different dummy variables of the critical value and adding the industrial structure variables, with the results shown in Table 5. The critical value of the agricultural labor force share used as the basis for constructing the critical value dummy variable ($TP_2$) is exactly the agricultural labor force share in 2007 and when the share of employment in the secondary and tertiary sectors is added, the contribution of the employment share of urban private enterprises is the lowest. Hence it's conservatively estimated that the increase of the employment share of urban private enterprises roughly contributed to 29.37% of the increase of Chinese labor share of income in 2007—2016.

[1] Same as above.

## 6. Conclusions and Policy Suggestions

In the context of the segmented Chinese labor market and its reaching Lewis turning point, this paper interprets the changing trend of labor share of income that decreases first and then increases from the perspective of changing employment ownership structure. First, by constructing a theoretical model covering the agricultural production sector, self-employed and private sector and urban unit sector, the paper shows that when agricultural labor force is constantly transferred to the self-employed and private sector, labor share of income will display the trend of decreasing first and then increasing. Second, empirical study based on provincial-level panel data in 1990—2016 indicates that within the self-employed and private sector, only the employment share of urban private enterprises exerts influence on labor share of income, which complies with the theoretical hypothesis and in other words, there exists a critical threshold value. When the share of agricultural labor force is above the threshold, the increase of the employment share of urban private enterprises will cause the labor share of income to decrease; when the share of agricultural labor force is below or equal to the threshold, it will drive the labor share of income to increase; other variables of employment ownership structure don't show similar characteristics on both sides of the threshold value. Besides, after the agricultural labor force share is below or equal to the threshold value, compared with central and western areas, the increase of the employment share of urban private enterprises in eastern areas drives up the labor share of income by a greater margin. The increase of the employment share of urban private enterprises roughly contributed 29.37% to the increase of labor share of income in China in 2007—2016.

Based on the conclusions, this paper proposes the following policy suggestions. (1) Institutional guarantee should be provided. It's important to persist with employment priority strategies and proactive employment policies and reform the household registration system and policies to help the transferred agricultural labor force to settle in cities, avoid their return to countryside for policy reasons and ensure the continuity and stability of such transfer. (2) Harmonious labor relationships should be constructed. It's necessary to put into better play the role of labor unions, increase the labor contract signing rate, reasonably increase the minimum wage level, safeguard legitimate rights and interests of laborers (especially transferred agricultural labor force) and improve employment quality. (3) Redistribution adjustment should be enhanced. When setting the individual income tax threshold, the average income taken as basis should allocate greater weight to non-private sectors to lower tax payable for laborers in the private sector. Individual income and financial information systems should be established to prevent high income earners from evading tax in various ways and the implementation effect of the progressive rate of individual income tax should be intensified. (4) Economic development mode should be transformed. The advent of

the Lewis turning point means that population dividend in China is diminishing and the traditional mode dependent on high savings and high investment won't be able to sustain economic development. China should shift to technological advance and higher total factor productivity to drive economic development and stimulate the vitality and boost labor productivity of the self-employed and private sector.

## References

Bai, C., & Qian, Z. (2010). The Determinants of Labor Share of Income—Evidence from China's Provincial-Level Panel Data. *The Journal of World Economy (Shijie Jingji)*, 12, 3-27.

Cai, F. (2005). Exploration of A Fair Distribution Mechanism in Compliance with Economic Development. *People's Tribune (Renmin Luntan)*, 10, 30-31.

Cai, F. (2010). Demographic Transition, Demographic Dividend, and Lewis Turning Point in China. *Economic Research Journal (Jingji Yanjiu)*, 4, 4-13.

Cai, F., & Du, Y. (2011). Wage Growth, Wage Convergence and Lewis Turning Point. *Economic Perspectives (Jingjixue Dongtai)*, 9, 9-16.

Cai, F., Du, Y., & Wang, M. Y. (2001). Household Registration System and Labor Market Protection. *Economic Research Journal (Jingji Yanjiu)*, 12, 41-49.

Cai, F., & Wang, M. (2008). A Counterfactual Analysis on Unlimited Surplus Labor in Rural China. *China & World Economy*, 16 (1), 51-65.

Cai, F., & Wang, M. (2004). Informal Employment and Labor Market Growth: An Interpretation of Urban Employment Growth in China. *Economic Perspectives (Jingjixue Dongtai)*, 2, 24-28.

Hansen, B. E. (1999). Threshold Effects in Non-Dynamic Panels: Estimation, Testing, and Inference. *Journal of Econometrics*, 93 (2), 345-368.

Hansen, B. E. (2000). Sample Splitting and Threshold Estimation. *Econometrica*, 68 (3), 575-603.

Huang, X. H., & Xu, Sh. (2009). Reasons for the Decline of Labor Share—From the Angle of Labor-Saving Technical Progress. *Economic Research Journal (Jingji Yanjiu)*, 7, 34-44.

Kaldor, N. (1961). Capital Accumulation and Economic Growth. In Hague, D. C., (ed.), *The Theory of Capital*. London: International Economic Association Series, Palgrave Macmillan.

Karabarbounis, L., & Neiman, B. (2014). The Global Decline of the Labor Share. *Quarterly Journal of Economics*, 129 (1), 61-103.

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic*

*Review*, 45 (1), 1-28.

Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labor. *The Manchester School*, 22 (2), 139-191.

Li, D., Liu, L., & Wang, H. (2009). The U Curve of Labor Share in GDP during Economic Development. *Economic Research Journal (Jingji Yanjiu)*, 1, 70-82

Lin, Y., Cai, F., & Li, Z. (1994). *The China Miracle: Development Strategy and Economic Reform*. Shanghai: Truth & Wisdom Press. (in Chinese)

Liu, Y., Mao, R., & Yao, Y. (2018). Structural Transformation, Financial Crisis and China's Labor Share. *China Economic Quarterly (Jingjixue Jikan)*, 2, 609-632.

Luo, C, & Zhang, J. (2009a). Labor Income Share and Economic Development: An Empirical Study Based on Chinese Industry-Level Data. *Social Sciences in China (Zhongguo Shehui Kexue)*, 4, 65-79.

Luo, C, & Zhang, J. (2009b). The Declining Share of Income from Labor in China: An Explanation from the Angle of Economics. *Management World (Guanli Shijie)*, 5, 25-35.

Shao, M., & Huang, J. (2010). Foreign Investment and the Labor Share in China: An Empirical Study Based on Industrial Level Panel Data. *China Economic Quarterly (Jingjixue Jikan)*, 4, 1189-1210.

Wang, D., Wu, Y., & Cai, F. (2004). Migration, Unemployment and Urban Labor Market Segmentation. *World Economic Papers (Shijie Jingji Wenhui)*, 1, 37-52.

Wang, J., & Zhong, X. (2011). Has the Lewis Turning Point Arrived in China?—Theoretical Analysis and International Experience. *Social Sciences in China (Zhongguo Shehui Kexue)*, 5, 22-37.

Wei, X., Dong, Z., & Huang, J. (2013). Do Labor Unions Improve the Labor Share of Income?—Theoretical Analysis and Empirical Evidence from Chinese Private Enterprises. *Economic Research Journal (Jingji Yanjiu)*, 8, 16-28.

Wen, Y., & Lu, X. (2018). The Determination Mechanism of Changes in China's Labor Income Share: Based on the Double Perspectives of Market Competition and Institutional Quality. *Economic Research Journal (Jingji Yanjiu)*, 9, 83-98.

Zhang, L., Li, J., & Xu, X. (2012). Globalization, Biased Technological Change and Factor Shares. *China Economic Quarterly (Jingjixue Jikan)*, 2, 409-428.

Zhao, Z. (2004). Rural-Urban Migration in China—What Do We Know and What Do We Need to Know? *China Economic Quarterly (Jingjixue Jikan)*, 3, 517-536.

Zhou, M., Xiao, W., & Yao, X. (2010). China's Unbalanced Economic Growth and National Income Distribution. *China Industrial Economics (Zhongguo Gongye Jingji)*, 6, 35-45.

Zou, W., & Yuan, F. (2018). Labor Income Share, Aggregate Demand and Productivity. *China Industrial Economics (Zhongguo Gongye Jingji)*, 2, 5-23.

# Funding Liquidity and Bank Risk-Taking: Empirical Evidence from China

Yong Ma, Zhen Li*

Liquidity risk has a significant impact on the prudent operation of financial institutions and the stability of financial system. Funding liquidity risk has played an important role in banking crises in history. This paper uses the data of 338 commercial banks in China from 2002 to 2016 to analyze the relationship between funding liquidity and bank risk-taking. The findings show that: (1) Banks with lower funding liquidity risk take more risks, which is evidenced by lower Z-score and capital adequacy ratio, as well as higher risk-weighted asset ratio and liquidity creation. (2) Funding liquidity risk has an impact on the factors of bank risks. Lower funding liquidity risk increases bank profitability and reduces capital level. (3) Funding liquidity risk can affect bank risk-taking behavior through the intermediary effect of bank loans. (4) With a lower funding liquidity risk, larger asset and higher leverage ratio can restrain banks from taking more risks, and the banks can take less risks during the international financial crisis or higher economic risk periods.

**Keywords:** funding liquidity, bank risk, intermediary effect, heterogeneity

## 1. Introduction and Literature Review

Liquidity risk has an important impact on the prudent operation of financial institutions and the stability of the financial system. Lack of sufficient liquidity may plunge financial institutions into difficulties, and in serious cases may lead to liquidity crisis. Factors such as maturity mismatch of commercial banks' assets and liabilities, sensitivity to changes in interest rates, etc., will cause serious liquidity risk exposure (Rose and Hudgins, 2012). Before the international financial crisis in 2008, there was no globally unified liquidity regulatory framework, and the contagion of liquidity risk among banks became an important inducement of systemic risk. In view of this, all countries in the world viewed strengthening liquidity regulation as an important part

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of financial regulatory reform after the crisis. In December 2010, the Basel Committee on Banking Supervision issued *Basel III*, which introduced two liquidity supervision standards, liquidity coverage ratio (LCR) and net stable funding ratio (NSFR), to measure the liquidity risk of banks in the short term and long term respectively. In January 2014, China Banking Regulatory Commission promulgated *The Measures for Liquidity Risk Management of Commercial Banks (for Trial Implementation)*. Since then, China's banking industry has gradually adjusted its asset liability business structure to meet the regulatory standards of liquidity risk and enhance its ability to resist liquidity risk. As an important manifestation of liquidity risk, funding liquidity risk plays an important role in all previous banking crises (Drehmann and Nikolaou, 2013). As whether the latest requirements of *Basel III* on funding liquidity will reduce the risk-taking of commercial banks and improve the stability of the whole banking system is still unclear, further study is needed.

In order to study the relationship between funding liquidity and bank risk-taking, this paper first defines funding liquidity and funding liquidity risk. According to previous studies, funding liquidity is usually defined as the ability to raise cash by selling assets or borrowing new money in the short term (Brunermeier and Pedersen, 2009).The International Monetary Fund (IMF, 2008) defines funding liquidity as the ability of solvent institutions to pay agreed amounts in a timely manner. The Basel Committee on Banking Supervision (BCBS, 2008) believes that liquidity is the ability to finance increased assets and meet obligations at maturity without incurring unacceptable losses. Referring to Drehmann and Nikolaou (2013), this paper defines funding liquidity as the ability to pay off debts immediately, and defines funding liquidity risk as the possibility that banks cannot pay off debts immediately in a specific period. The central banks of eurozone member countries conduct short-term main refinancing operations (MROs) in the form of standard bidding to provide liquidity to the banking system. Although the commercial banks' offer will expose the banks' liquidity risk (Drehmann and Nikolaou, 2013), the short-term MROs data are internal confidential data and not available, and the People's Bank of China does not include this policy tool in its open market operation. Consistent with Acharya and Naqvi (2012), Khan *et al.* (2017), this paper regards investors' deposits as bank funding liquidity, which can protect banks from operational risk. The increase of deposits means the improvement of funding liquidity, or the reduction of funding liquidity risk.

This paper mainly uses the theoretical prediction of Acharya and Naqvi (2012) to provide theoretical evidence support for banks to absorb a large number of deposits, reduce funding liquidity risk, and encourage them to take more risks. Acharya and Naqvi (2012) put forward a theory of bank loan, that is, to study how the internal agency problem affects the loan pricing. In practice, bank executives and managers are motivated to make too many loans because their pay increases with the increase of loans. Acharya and Naqvi (2012) prove that when the behavior or hard work of bank

executives and managers is not visible, the incentive linked with the amount of loans can be regarded as the optimal contract result of principal-agent problem to some extent, however, it will also cause banks to take too many risks. It is assumed that the client can conduct a costly audit afterwards to verify whether the bank manager has taken excessive radical actions such as reducing loan interest rate and approving excessive loan. Acharya and Naqvi (2012) show that, although the client may wish to implement strict audit policy in advance, the cost of audit means that the bank audit is the best choice after the event only when the liquidity shortage suffered by the bank is large enough. All in all, the ideal compensation for managers is to increase the number of loans to make them work hard, but if the bank manager underestimates the risk of investment (approves too many loans), then when the bank faces a serious liquidity shortage, the bank manager will face the risk of being punished. Therefore, when the bank liquidity is sufficient, the managers will reasonably expect that there will be loose audit policy, thus ignoring that the bank may face insufficient liquidity afterwards. That is to say, too many deposits make bank managers overconfident, relax loan standards, increase the number of loans to take too many risks, and lay a hidden danger for the bank's possible future crisis.

In addition, there are some studies that provide direct or indirect evidence for this paper. Myers and Rajan (1998), for example, find that for financial institutions, although more liquid assets improve their ability to raise cash in the short term, they may also reduce the ability of management to make credible commitments to protect investors' investment strategies. That is to say, banks must hold enough current assets to meet the needs of borrowers for cash, but more asset liquidity will reduce the ability of banks to raise external funds, which may increase the risk-taking of banks. Allen and Gale (2000) argue that asset bubbles are caused by agency relationships in the banking sector. Investors use funds borrowed from banks to invest in risky assets, which are relatively attractive because they can avoid losses in low yields by defaulting on loans. This kind of risk transfer causes investors to raise asset prices. When the positive credit expansion is not enough to prevent the crisis, financial vulnerability will appear. Gatev and Strahan (2006) find that banks have unique ability to hedge against market liquidity shocks. The inflow of deposits provides funds for the impact of loan demand after the decrease of market liquidity. When liquidity dries up and commercial paper spreads expand, banks will face capital inflow, which enables banks to meet the needs of lenders without reducing the current assets held by banks. That is to say, with the expansion of market interest margin, the loan growth rate and current assets of banks will rise. Berger and Bouwman (2009) test the theory of Acharya and Naqvi (2012) and verify the results, and find that high liquidity creation is accompanied by high risk. The focus of our study is not the behavior of lenders, but the behavior of bank executives and managers. Cheng *et al.* (2015) provide relevant evidence for this study. Based on the traditional principal-agent theory, risk-averse managers need higher pay

when they work in high-risk financial institutions, in order to compensate for the extra risks they take in equity. As a result, in order to achieve the higher compensation needed by managers to work in banks with higher risks, they may implement more radical loan strategies when there is sufficient liquidity (Cheng *et al.*, 2015).

It can be seen from Figure 1 that in the Asian financial crisis, the international financial crisis and their subsequent impact periods (2002—2004, 2007—2010), compared with the high-risk direct investment, investors prefer bank deposits, which drives the deposit asset ratio of China's banking industry significantly higher. In 2015, the deposit asset ratio of China's banking industry increased slightly, which may be the short-term effect of China's formal introduction of explicit deposit insurance system. The better protection of depositors' interests led to a small increase in bank deposits. Deposit insurance can be regarded as a put option on bank assets (Merton, 1977). Due to the existence of explicit or implicit deposit insurance system, excessive risk-taking by banks will make deposit insurance face moral hazard (Keeley, 1990), which is particularly obvious for developing countries like China (Duan *et al.*, 2018). Guo and Zhao (2017) find that after the introduction of explicit deposit insurance system, China's large non-state-owned commercial banks take more risks by increasing leverage and shadow banking business. Although deposits can protect banks from operational risks, with the increase of deposits, banks are motivated to overloan to take more risks, which is at the cost of deposit insurance, i.e. the lower funding liquidity risk provides banks with more motivation to take more risks (Khan *et al.*, 2017).

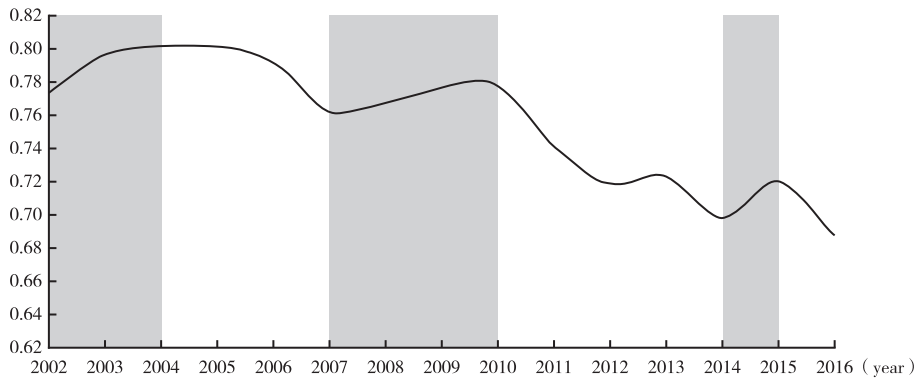


*Figure 1*. Deposit Asset Ratio of China's Banking Industry from 2002 to 2016
Source: Wind database and the authors' calculation.

Based on the data of 338 commercial banks in China from 2002 to 2016, this paper empirically analyzes the relationship between funding liquidity risk and bank risk-taking. In order to enhance the robustness of the benchmark model results, this paper tests the robustness based on different bank risk-taking proxy variables, not adding macro-control variables, not controlling the fixed effect of time. At the same time,

the methods of instrumental variable 2SLS estimation, propensity score matching estimation, system GMM estimation, one phase lag of independent variable and potential missing variable control are used to alleviate the endogeneity of benchmark model. In this paper, the above regression results are further discussed from three aspects. First of all, this paper analyzes the influence of funding liquidity risk on the factors of bank risk (Z-score), and finds that the decrease of funding liquidity risk will improve profitability, reduce bank risk, but also reduce capital level and improve bank risk, which is generally manifested as the increase of bank risk. Secondly, this paper studies whether the funding liquidity risk affects the risk-taking behavior of banks through loans. The results show that there is an intermediary effect with bank loans as the intermediary variable. The decrease of funding liquidity risk will lead to the increase of bank loans, and then improve the risk-taking level of banks. Finally, this paper further investigates whether there is heterogeneity in the impact of funding liquidity risk on bank risk-taking. The results show that when the funding liquidity risk is low, the overall stability and capital adequacy level of large banks are higher, and their risk of financial intermediation is lower, while the capital adequacy level of banks with high leverage is higher and their risk of financial intermediation is lower, and asset risk and financial intermediary risk are lower during financial crises while, the capital adequacy level of banks is higher and the risk of financial intermediary is lower during the periods of high economic risk.

Compared with the existing research, this paper makes useful exploration and innovation in four aspects. Firstly, in terms of literature, there are few studies on the relationship between funding liquidity risk and bank risk-taking, especially on the empirical analysis of China's banking industry. Based on the data of China's banking industry, this paper systematically examines the impact of funding liquidity risk on bank risk-taking, and measures bank risk-taking from the perspectives of banks' overall stability, capital adequacy level, asset risk, financial intermediary risk, etc. Therefore, while enriching bank liquidity risk management research, we also provide an important supplement for bank risk-taking behavior analysis. Secondly, in terms of risk composition, this paper makes an important expansion of the existing research. We use the factors such as the return on equity, equity to asset ratio and the volatility of return on equity as the components of bank Z-score to test the impact of funding liquidity risk on the components of bank risk. Thirdly, in the aspect of intermediary effect, this paper attempts to compensate for the lack of intermediary influence mechanism in the existing empirical literature. By using the intermediary effect test procedure proposed by Baron and Kenny (1986) and Wen *et al.* (2004), we investigate whether the funding liquidity risk affects the bank's risk-taking behavior through loans. Fourthly, in terms of heterogeneity analysis, this paper further analyzes whether there is asymmetry in the impact of funding liquidity risk on bank risk-taking in terms of bank size, leverage ratio, financial crisis or high-risk economic period. The analysis of perspectives such

as high leverage and high economic risk further enriches the empirical evidence of Khan *et al.* (2017).

The structure of the rest of this paper is as follows: the second part is research design, including the description of main variables, model setting and sample selection; the third part is empirical analysis and test, including benchmark model regression, robustness test and endogeneity treatment; the fourth part is expanded discussion, including risk composition analysis, intermediary effect test and heterogeneity impact; the fifth part is conclusions and policy recommendations.

## 2. Research Design

### *2.1. Description of Main Variables*

#### 2.1.1. Proxy Variables of Bank Risks

Based on the practice of Laevene and Levine (2009), this paper uses Z-score to measure the overall stability of commercial banks. The formula is as follows:

$$Z\text{-}score = (ROE + EquityToAsset)/\sigma(ROE) \tag{1}$$

where, *ROE* is the return on equity, *EquityToAsset* is the equity to asset ratio, $\sigma(ROE)$ is the 3-year moving standard deviation of the return on equity. To avoid the influence of the peak and fat tail of *Z-score*, this paper takes the natural logarithm of *Z-score*. The greater the value of *Z-score*, the smaller the total default risk and the stronger the stability of commercial banks. In addition, this paper uses the 2-year, 4-year and 5-year moving standard deviation of *ROE* to calculate *Z-score*, and the regression results are consistent with the 3-year moving standard deviation of *ROE*. At the same time, in the stability test, referring to the practice of Zhang and Wang (2012), this paper uses capital adequacy ratio (*CapitalRatio*) instead of the equity to asset ratio (*EquityToAsset*) for calculation of *Z-score* to measure the overall stability of commercial banks.

Capital adequacy can capture important aspects of bank risks (Zhu and Yang, 2016) and help banks increase their probability of survival to assess the extent to which they absorb potential losses (Berger and Roman, 2013).This paper uses the capital adequacy ratio to measure the capital adequacy level of banks, and uses the ratio of net capital of banks to risk-weighted assets, which includes credit risk-weighted assets, market risk-weighted assets, operational risk-weighted assets and capital bottom line adjustment. Commercial banks have a high negative capital effect on risk. The higher the capital adequacy ratio, the lower the risk of banks (Lee and Hsieh, 2013). The negative correlation between bank capital and risk can be explained by the "moral hazard

hypothesis", that is, due to the existence of explicit or implicit deposit insurance system, banks with insufficient capital bear excessive risk (Demirgüç-kunt and Kane, 2002). In the stability test, this paper uses core capital adequacy ratio (*Tier1Ratio*) to replace capital adequacy ratio (*CapitalRatio*) to measure the capital adequacy level of banks.

In the existing literature, risk-weighted asset ratio is widely used to measure the quality of bank assets, and non-performing loan ratio is often used to measure bank credit risk. Both risk-weighted assets ratio and non-performing loan ratio can measure the risk of bank assets. The former is expressed by the ratio of risk-weighted assets to total assets, which measures the bank's active asset risk-taking, and the latter is expressed by the ratio of non-performing loans to total loans, which measures the bank's passive asset risk-taking. Risk-weighted assets are calculated according to the Basel capital regulatory rules and can be determined when loans are issued. The higher the ratio of risk weighted assets, the stronger the willingness of banks to purchase high-risk assets. Non-performing loans are the number of loans identified as possible default problems after the issuance of loans. The higher the non-performing loan ratio, the more risk assets the bank may default. In this paper, risk-weighted asset ratio (*RWAToAsset*) is used as the main risk proxy variable of bank assets, and non-performing loan ratio (*NPLRatio*) is used for robustness test.

Financial intermediztion is used to realize the conversion of term and liquidity, non-current long-term assets are financed by current short-term liabilities. Although the unique intermediary role of liquidity supply of commercial banks is conducive to their daily business activities, there are also inherent vulnerabilities (Xin and Tao, 2018). The maturity mismatch between assets and liabilities of commercial banks aggravates the financial intermediary risk faced by banks (Khan *et al.*, 2017). Berger and Bouwman (2009) propose a comprehensive index to calculate liquidity creation, which comprehensively reflects the liquidity maturity mismatch of commercial banks.[1] The more liquidity creation of commercial banks, the higher the risk of financial intermediation. Referring to Berger and Bouwman (2009), Xin and Tao (2018), and excluding the ones with poor data availability, we divide the bank's balance sheet items into three categories of liquidity, quasi liquidity and illiquidity according to the liquidity size and give them different weights respectively. According to the classification of balance sheet items and their corresponding weights, the total amount of liquidity creation of the bank is obtained after weighted sum, and then the liquidity creation index is obtained by dividing the total assets of the bank. In this paper, liquidity creation (*LCToAsset*) is used as the proxy variable of financial intermediary risk. In the robustness test, asset liquidity creation (*ALCToAsset*) and liability liquidity creation (*LLCToAsset*) are used as the proxy variables of financial intermediary risk.

[1] Due to space limitations, detailed liquidity categories and weights of banking activities are omitted here, which are available upon request.

2.1.2. Proxy Variable of Funding Liquidity Risk

Acharya and Naqvi (2012) try to explain that sufficient liquidity may aggravate the risk-taking behavior of bank executives, resulting in excessive loans and asset price bubbles. They regard investors' deposits as bank liquidity, because in order to protect banks from run risk, banks need to take a certain proportion of deposits as liquidity reserve. Therefore, deposits are the main determinant of bank reserve, so they can choose deposits as bank liquidity. With reference to Acharya and Naqvi (2012), Khan, *et al.* (2017), this paper selects deposit asset ratio (*DepositToAsset*) as the proxy variable of funding liquidity risk. The higher the deposit asset ratio, the higher the funding liquidity of the bank and the lower the funding liquidity risk. More reliance on deposits to fund long-term assets will reduce the risk of bank runs in the short term. In the case of explicit or implicit deposit insurance, deposit can protect banks from operational risks. Deposit insurance can be regarded as the put option of bank assets. Due to the existence of deposit insurance, banks will be motivated to take more risks with the increase of deposits (Khan *et al.*, 2017). Table 1 shows the symbols and definitions of variables used in this paper.

Table 1. Definition of Main Variables

| Variable | Description |
|---|---|
| *Z-score* | ln [(return on equity + capital asset ratio) / 3-year moving standard deviation of the return on equity] |
| *Z-value* | ln [(return on equity + capital adequacy ratio) / 3-year moving standard deviation of the return on equity] |
| *CapitalRatio* | Capital adequacy ratio = net capital / risk-weighted assets |
| *Tier1Ratio* | Core capital adequacy ratio = net core capital / risk-weighted assets |
| *RWAToAsset* | Risk-weighted assets ratio = risk-weighted assets / total assets |
| *NPLRatio* | NPL ratio = NPL / total loan |
| *LCToAsset* | Liquidity creation = [0.5 ×∑ (non-current assets + current liabilities)–0.5 ×∑ (current assets + non-current liabilities + owners' equity)] / total assets |
| *ALCToAsset* | Asset-side liquidity creation = (0.5 ×∑ non-current assets–0.5 ×∑ current assets) / total assets |
| *LLCToAsset* | Liability-side liquidity creation = [0.5 ×∑ current liabilities–0.5 ×∑ (non-current liabilities + owners' equity)] / total assets |
| *DepositToAsset* | Deposit asset ratio = total deposits / total assets |
| *TotalAssets* | Capital scale = ln (total assets (yuan)) |
| *ROA* | Return on assets = net profit / average value of total assets at the beginning and end of the year |
| *NIIToIncome* | Proportion of non-interest income = non-interest income / operating income |
| *IncomeDiversity* | Income diversification = 1–[net interest income – non-interest income) / operating income] |

| Variable | Description |
|---|---|
| *IsListed* | Dummy variable of whether it is a listed bank or not |
| *HHI* | The competitiveness of the bank's location is obtained by summing up the square of the number of branches in the bank's location to obtain the Herfindahl-Hirschman Index (HHI). National banks use national data, and local banks use prefecture-level city data. |
| *GDPPerCapital* | ln (GDP per capita of bank location). National banks use national data, and local banks use prefecture-level city data. |
| *DepositToAssetOther* | Average value of deposit asset ratio of other banks of the same type in the current year |
| *LoanToAsset* | Loan to asset ratio = total loans / total assets |
| *ROE* | Return on equity = net profit / average value of owners' equity at the beginning and end of the year |
| *EquityToAsset* | Equity asset ratio = owners' equity / total assets |
| *SDROE* | Volatility of return on equity = 3-year moving standard deviation of return on equity |
| *IsBig* | Dummy variable of whether it is a large bank. If the total assets of the bank throughout all the years are greater than the quarter of the sample space, the value is 1. Otherwise, the value is 0. |
| *IsHighLeverage* | Dummy variable of whether it is a bank with high leverage. If the leverage ratio (debt to total assets) of the bank in all years is greater than one quarter of the sample space, the value is 1, otherwise the value is 0. |
| *IsCrisis* | Dummy variable of whether it is in the international financial crisis. The value from 2008 to 2009 is 1, otherwise it is 0. |
| *IsMacRisk* | Referring to Chen *et al.* (2016), this paper divides the economic cycle into three specific categories: the upsurge period, the recession period and the normal period. *IsMacRisk* is the dummy variable of whether it is in the period of high economic risk, that is, when the economy is in the period of upsurge or recession, the value is 1; otherwise, the value is 0. National banks use national data, local banks use prefecture-level city data. |

### *2.2. Model Settings*

To analyze the impact of liquidity risk on the risk-taking of commercial banks, this paper uses the Ordinary Least Squares (OLS) estimation method to establish a benchmark model:

$$BankRisk_{bt} = \alpha + \beta Liquidity_{bt} + \gamma Controls_{bt} + \theta_t + \varepsilon_{bt} \quad (2)$$

where, the explained variable $BankRisk_{bt}$ represents the risk-taking of the bank $b$ in the period $t$. In the model, we use the Z-score of natural logarithm to measure the overall risk of the bank, the capital adequacy ratio (*CapitalRatio*) to measure the capital adequacy level of the bank, use the risk-weighted asset ratio (*RWAToAsset*) to measure the asset risk of the bank, and use the liquidity creation (*LCToAsset*) to

measure the financial intermediary risk. Core explanatory variable $Liquidity_{bt}$ represents liquidity risk. Referring to Acharya and Naqvi (2012), Khan *et al.* (2017), this paper uses deposit asset ratio (*DepositToAsset*) as the proxy variable of liquidity risk. The larger the deposit asset ratio is, the greater the bank's funding liquidity and the smaller the funding liquidity risk. Control variable $Controls_{bt}$ includes bank-level asset scale (*TotalAssets*), return on assets (*ROA*), non-interest income ratio (*NIIToIncome*), income diversity (*IncomeDiversity*), dummy variable of whether it is a listed Bank (*IsListed*). Macro environment variables include competitiveness (*HHI*) and per capita GDP (*GDPPerCapital*). $\alpha$ is the intercept term, $\theta_t$ is the time effect of commercial banks, $\varepsilon_{bt}$ is a residual term. In order to solve the possible problem of sequence correlation, this paper uses heteroscedasticity robust standard error to cluster at the bank level.

In order to analyze whether the change of funding liquidity risk affects the banks' risk-taking through loans, this paper uses the intermediary effect test procedure proposed by Baron and Kenny (1986), Wen *et al.* (2004) to test the intermediary effect of bank loans as the mediator. The specific regression model is shown in equation (2) and equations (3) and (4).

$$Loan_{bt} = \alpha + \delta Liquidity_{bt} + \gamma Controls_{bt} + \theta_t + \varepsilon_{bt} \tag{3}$$

$$BankRisk_{bt} = \alpha + \beta' Liquidity_{bt} + \beta_1 Loan_{bt} + \gamma Controls_{bt} + \theta_t + \varepsilon_{bt} \tag{4}$$

where, $Loan_{bt}$ represents bank loans, with the ratio of loans to assets (*LoanToAsset*) as the proxy variable. Figure 2 provides details of the intermediary effect test procedure of bank loans.

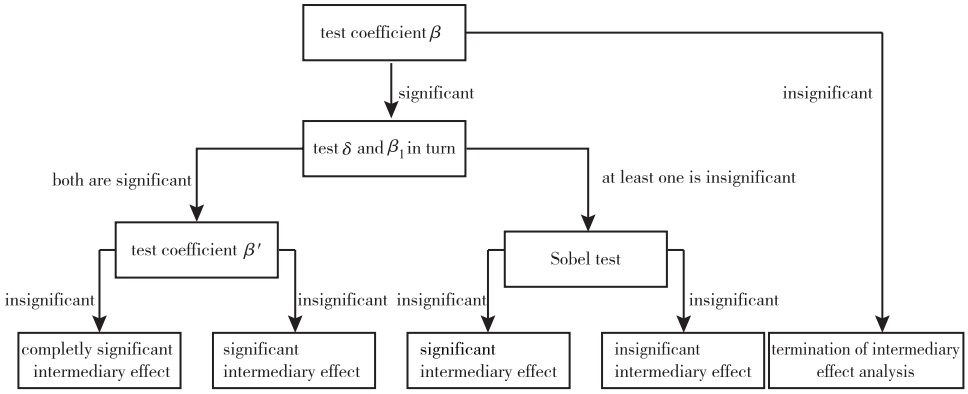


*Figure* 2. Test Procedure of Intermediary Effect

In order to further study whether the impact of funding liquidity risk on the risk-taking of different types of banks in different periods is different, this paper adds into the benchmark model dummy variables such as whether it is a large bank, whether it is

a bank with high leverage, whether it is in the international financial crisis, whether it is in the period of high economic risk and their cross terms with liquidity variables to build the extended model:

$$BankRisk_{bt} = \alpha + \beta Liquidity_{bt} + \beta_1 Dum_{bt} + \beta_2 Liquidity_{bt} \times Dum_{bt} + \gamma Controls_{bt} + \theta_t + \varepsilon_{bt} \quad (5)$$

where, $Dum_{bt}$ represents the heterogeneity of various banks' risk-taking in different periods, $Liquidity_{bt} \times Dum_{bt}$ is used to analyze whether the impact of funding liquidity risk on the risk-taking of different banks in different periods is asymmetric. In terms of different types of commercial banks, the dummy variable of whether it is a large bank (*IsBig*) is used first: if the total assets of the bank throughout all those years are greater than the quarter of the sample space, the value is 1, otherwise the value is 0; next the dummy variable of whether it is a bank with high leverage (*IsHighLeverage*) is used: if the leverage ratio (debt to total assets) of the bank throughout all the years is greater than the quarter of the sample space, the value of one quantile is 1, otherwise it is 0. In terms of commercial banks in different periods, the dummy variable of whether they are in the international financial crisis (*IsCrisis*) is first used: the value for 2008—2009 is 1, otherwise the value is 0; the dummy variable of whether they are in the period of high economic risk (*IsMacRisk*) is used next, when the economy is in the period of high risk (upsurge or recession), value is 1, otherwise the value is 0. This paper also control the year offect, and in order to solve the problem of sequence correlation, we use heteroscedasticity robust standard error and cluster at the bank level.

### *2.3. Sample Selection*

This paper selects the data of the unbalanced panel of 338 commercial banks in China from 2002 to 2016 as the research sample. All the data are from Wind database, BankScope, and annual reports of commercial banks in China. We treated the initial samples as follows: (1) considering the object of this study, we excluded China Post Savings Bank and policy banks; (2) for the purpose of calculating the Z-score of bank risk-taking index, we excluded banks with data less than three consecutive years of return on equity (*ROE*), equity asset ratio (*EquityToAsset*), and capital adequacy ratio (*CapitalRatio*); (3) we excluded samples which have selected variables with missing values; (4) to eliminate the influence of outliers on the regression results, the variables selected were winsorized at the upper and lower 1% quantiles. According to the classification criteria of CBIRC at the end of 2018, 338 sample commercial banks include 5 large state-owned commercial banks, 12 joint-stock commercial banks, 120 urban commercial banks, 164 rural commercial banks and 37 foreign-funded corporate banks. By the end of 2016, the total assets of the banks selected accounted for 76.33%

of the total assets of financial institutions in the banking industry and 97.67% of the total assets of commercial banks. Therefore, the research sample used in this paper covers major commercial banks in China and is a particularly representative bank sample. Since the average age of the study sample is 7 years, in order to avoid potential sample selection problems, this paper tests the bank samples with the variables removed for less than 5 and 7 consecutive years respectively, and finds that the main conclusions remain stable. In addition, the regression results are consistent with the main conclusions of this paper.

## 3. Empirical Analysis and Test

### *3.1. Benchmark Model Regression*

Table 2 reports the regression results of the benchmark model based on equation (2). In all the models, we use heteroscedasticity robust standard errors and cluster them at the bank level, include bank characteristic variables and macro environment variables, and control the time fixed effect to avoid the impact of other unobservable factors on bank risk-taking. It can be concluded that there is no multicollinearity problem as the value of variance inflation factor (VIF) of every model is less than 10. The results show that there is a significant negative correlation between funding liquidity risk and bank risk-taking, that is, the smaller the funding liquidity risk (the greater the deposit asset ratio, the greater the funding liquidity), the greater the risk-taking of commercial banks, which is consistent with the analysis of Acharya and Naqvi (2012), Khan *et al.* (2017). Specifically, there is a significant positive correlation between funding liquidity risk and the overall stability and capital adequacy level of banks, and a significant negative correlation between funding liquidity risk and bank asset risk, financial intermediary risk.

Table 2. Funding Liquidity and Bank Risk-Taking

| Model | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Explained variable | *Z-score* | *CapitalRatio* | *RWAToAsset* | *LCToAsset* |
| *DepositToAsset* | –0.665**<br>(0.312) | –0.388***<br>(0.064) | 0.177***<br>(0.046) | 0.430***<br>(0.052) |
| Control variable | control | control | control | control |
| Time fixed effect | control | control | control | control |
| Adjust $R^2$ | 0.154 | 0.403 | 0.199 | 0.373 |
| Sample size | 1690 | 2249 | 2092 | 2346 |
| Number of banks | 333 | 336 | 330 | 338 |

Notes: OLS estimation is used in this table. The number in the table is the regression coefficient of the variable, and in the corresponding bracket is the clustering robust standard error at the bank level.

### *3.2. Robustness Test and Endogeneity Treatment*[1]

In this paper, we use different bank risk-taking proxy variables, do not add macro-control variables and do not control the fixed effect of time to test the robustness, and find that there is still a significant negative correlation between funding liquidity risk and bank risk-taking. At the same time, we use two-stage least squares (2SLS) of instrumental variables, propensity score matching (PSM), system GMM, one-stage lag of independent variables and controlling potential missing variables to analyze the endogeneity, and find that the regression results are consistent with the benchmark model.

## 4. Extended Discussions

### *4.1. Analysis of Risk Composition*

In Table 3, we use *ROE* as a component of *Z-score* to measure the bank's profitability, *EquityToAsset* to measure the bank's capital level, and *SDROE* to measure the bank's profitability volatility. The explanatory and control variables are still consistent with the benchmark model. In column (1), there is a significant negative correlation between funding liquidity risk and bank profitability. The possible reason is that with the increase of deposit funds, bank loans increase with the decrease of lending standards (Acharya and Naqvi, 2012), which will improve the profitability of banks (Köhler, 2012). In column (2), there is a significant positive correlation between funding liquidity risk and bank capital level, which is consistent with the result when the explanatory variable is capital adequacy ratio in the benchmark model. The results of columns (1) and (2) show that the funding liquidity risk has different effects on the profitability and capital level in the factors of bank risk (Z-score), which ultimately affects the overall stability of the bank. Specifically, the reduction of funding liquidity risk will improve profitability and reduce bank risk, but it will also reduce capital level and improve bank risk, which is generally reflected in the increase of bank risk (the sum of the coefficients of the components of Z-score, *ROE* and *EquityToAsset,* equals –0.105). In addition, in column (3), the volatility of return on equity (*SDROE*) as the denominator of Z-score is often used to measure the bank's risk-taking (Zhu and Yang, 2016). Although the coefficient of funding liquidity (*DepositToAsset*) is not significant, the sign of coefficient is positive, which indicates that there may be a positive correlation between the volatility of profitability and the risk-taking of banks.

[1] Due to space limitations, detailed regression results are omitted here, which are available upon request.

Table 3. Funding Liquidity and Bank Risk-Taking: Analysis of Z-score Components

| Model | (1) | (2) | (3) |
|---|---|---|---|
| Explained variable | Z-score components | | |
| | *ROE* | *EquityToAsset* | *SDROE* |
| *DepositToAsset* | 0.084***<br>(0.012) | –0.189***<br>(0.022) | 0.011<br>(0.008) |
| Control variable | control | control | control |
| Time fixed effect | control | control | control |
| Adjust $R^2$ | 0.656 | 0.441 | 0.152 |
| Sample size | 2350 | 2350 | 1693 |
| Number of banks | 338 | 338 | 333 |

### *4.2. Intermediary Effect Test*

In order to investigate whether the risk of funding liquidity affects the risk-taking of banks through loans, this paper uses loan to asset ratio (*LoanToAsset*) as an intermediary variable to test the intermediary effect. First of all, it can be seen from the above that there is a significant negative correlation between funding liquidity risk and bank risk-taking. In column (1) of Table 4, the results show that there is a significant negative correlation between funding liquidity risk and bank loans, that is, the smaller the funding liquidity risk, the larger the loan scale of commercial banks. This is consistent with the results of Brunermeier and Pedersen (2009), Drehmann and Nikolaou (2013), Chung *et al.* (2018), Wang and Yang (2014). In column (2), Sobel test statistic is 1.477, which is greater than the critical value of 0.97 at the 0.05 significance level. According to the intermediary effect test procedure in Figure 2, there is a significant intermediary effect with loan asset ratio (*LoanToAsset*) as the intermediary variable; in columns (3) and (5), there is a significant intermediary effect with loan asset ratio (*LoanToAsset*) as the intermediary variable; in column (4), there is a significant complete intermediary effect with loan asset ratio (*LoanToAsset*) as the intermediary variable. Therefore, there is an intermediary effect of taking bank loans as intermediary variables, and funding liquidity risk affects bank risk-taking through loans.

Table 4. Funding Liquidity and Bank Risk-Taking: Based on the Intermediary Effect of Bank Loans

| Model | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Explained variable | *LoanToAsset* | *Z-score* | *CapitalRatio* | *RWAToAsset* | *LCToAsset* |
| *DepositToAsset* | 0.394***<br>(0.035) | –0.903***<br>(0.334) | –0.326***<br>(0.051) | –0.059<br>(0.047) | 0.145***<br>(0.041) |
| *LoanToAsset* | | 0.485<br>(0.327) | –0.143***<br>(0.052) | 0.513***<br>(0.055) | 0.723***<br>(0.042) |

| Model | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Control variable | control | control | control | control | control |
| Time fixed effect | control | control | control | control | control |
| Adjust $R^2$ | 0.414 | 0.155 | 0.416 | 0.339 | 0.561 |
| Sample size | 2349 | 1690 | 2249 | 2092 | 2345 |
| Number of banks | 338 | 333 | 336 | 330 | 338 |

### *4.3. Heterogeneity Impact*[1]

#### 4.3.1. The Impact of Bank Size

This paper finds that when the funding liquidity risk is low, the overall stability and capital adequacy level of large banks are higher than that of small and medium banks, and the risk of financial intermediation is lower, which can be proved by high Z-score, capital adequacy ratio and low liquidity creation. Therefore, these results are similar to the findings of Khan *et al.* (2017), that is, in order to deal with the lower funding liquidity risk, the asset risk and overall risk of large banks are generally lower than that of small banks. Large banks take less risk in response to lower funding liquidity risk. It can be seen from the benchmark model that the improvement of income diversity will reduce the risk-taking level of banks. Due to the more diversified business model of large banks, as well as more stringent prudential supervision and regulatory constraints (Khan *et al.*, 2017), large banks may take less risk to cope with the lower funding liquidity risk. As to the robustness test, based on the perspective of the bank's business scope, we analyze whether the national banks have an impact on the relationship between funding liquidity risk and bank risk-taking, and find that the conclusions are basically consistent with the perspective based on bank size.

#### 4.3.2. The Impact of High Leverage

This paper finds that when the funding liquidity risk is low, the capital adequacy level of highly-leveraged banks is higher, and the risk of financial intermediation is lower, which can be proved by high capital adequacy ratio and low liquidity creation. These results are consistent with the existing literature, that is, as excessive leverage enlarges potential investment losses (Tasca *et al.*, 2014), shareholders will also suffer losses in the case of bank bankruptcy (Repullo, 2004), and banks with higher leverage

[1] Due to space limitations, detailed regression results are omitted here, which are available upon request.

will take less risk when they have more deposits. Therefore, highly-leveraged banks take less risk in response to lower funding liquidity risk.

#### 4.3.3. The Impact of Financial Crisis

This paper finds that during the financial crisis, when the funding liquidity risk is low, the asset risk and financial intermediary risk of banks are lower, which can be proved by the lower risk-weighted asset ratio and liquidity creation. These results are consistent with the conclusions of Acharya and Mora (2015), Khan *et al.* (2017). Before the financial crisis, bank deposits were in a weaker position because investors believed that the risk of bank deposits was greater than that of financial instruments (Acharya and Mora, 2015). At the beginning of the crisis, due to the decrease of deposit inflow, banks would reduce new credit, and their future operating performance would deteriorate (Cohen *et al.*, 2014). After the outbreak of the crisis, investors became highly risk averse, while the government explicitly supported deposit insurance, and investors were more inclined to deposit funds in the bank (Acharya and Mora, 2015). Therefore, during the international financial crisis, bank risk decreases with the decrease of funding liquidity risk.

#### 4.3.4. The Impact of Macroeconomic Risks

This paper finds that in the period of high economic risk, when the risk of funding liquidity is low, the capital adequacy level of banks is higher and the risk of financial intermediation is lower, which can be proved by high capital adequacy ratio and low liquidity creation. When the macroeconomic risk is high, investors cannot control the increase of enterprises or enterprise moral risk well, bank deposits are considered to be safer, and investors will reduce direct investment and hold more bank deposits (Acharya and Naqvi, 2012). However, when the economic risk is high, the sensitivity of bank managers to the repayment of economic risk is improved, the loan behavior may become more conservative, the loan standard is improved, the credit is tightened, the level of capital adequacy is improved, and the risk bearing of banks is reduced. Therefore, in the period of high economic risk, bank risk decreases with the decrease of funding liquidity risk.

## 5. Conclusions and Policy Suggestions

This paper uses the data of 338 commercial banks in China from 2002 to 2016 to study the impact of funding liquidity risk on bank risk-taking. The empirical results show that banks with lower funding liquidity risk will take more risks, while banks with higher deposits will have lower funding liquidity risk, because deposits can protect banks from operational risks in the presence of explicit or implicit deposit

insurance. In addition, sufficient liquidity can help banks avoid capital shortage, which may stimulate banks' risk-taking tendency and thus take higher risks. Further analysis shows that: (1) deposit growth will improve profitability and reduce bank risk, but it will also reduce capital level and improve bank risk, which is generally reflected in the rise of bank risk; (2) there is an intermediary effect that takes bank loan as an intermediary variable, that is, the decrease of funding liquidity risk will lead to the increase of bank loan, which will further increase bank risk; (3) when the risk of capital liquidity is low, the capital adequacy level of large banks and highly-leveraged banks is higher, and the risk of financial intermediation is lower; (4) during the financial crisis, the risk of assets and financial intermediation of banks is lower; at the same time, in the period of high economic risk, the capital adequacy level of banks is higher, and the risk of financial intermediation is lower.

The conclusion of this paper has a clear enlightenment to bank operators and government supervision departments. Firstly, because the lower funding liquidity risk may promote banks to take more risks, banks should avoid the excessive growth of short-term funding liquidity, maintain a moderate level of capital, and control the excessive risk-taking; secondly, because the funding liquidity risk may affect the risk-taking behavior of banks through loans, banks should better regulate the credit release and management, and reasonably control credit scale; thirdly, because large banks and highly leveraged banks usually face higher risk-taking, the government should strengthen the risk supervision of large banks and highly leveraged banks to avoid the systemic risk caused by excessive risk-taking of these banks; fourthly, the counter cyclical financial supervision still needs to be strengthened and improved as the external financial and economic impact is still likely to greatly affect the stability of banks although banks could actively reduce risk-taking in the international financial crisis or high-risk economic period. In summary, in order to deal with the potential funding liquidity risk, commercial banks should maintain long-term, stable and diverse capital sources, and at the same time, effectively control the excessive risk-taking by better regulating credit supply and loan management; and the government supervision departments should further improve the macro prudential policy tools under the framework of *Basel III*, and take various measures to strengthen the supervision of banks' liquidity and leverage ratio, so as to ensure that the overall risk of financial institutions can be controlled.

## References

Acharya, V., & Naqvi, H. (2012). The Seeds of a Crisis: A Theory of Bank Liquidity

and Risk Taking over the Business Cycle. *Journal of Financial Economics*, 106 (2), 349-366.

Acharya, V. V., & Mora, N. (2015). A Crisis of Banks as Liquidity Providers. *Journal of Finance*, 70 (1), 1-43.

Allen, F., & Gale, D. (2000). Bubbles and Crises. *The Economic Journal*, 110 (460), 236-255.

Baron, R. M., & Kenny, D. A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology*, 51 (6), 1173-1182.

Basel Committee on Banking Supervision (BCBS). (2008). *Principles for Sound Liquidity Risk Management and Supervision*. Bank for International Settlements, Basel.

Berger, A. N., & Bouwman, C. H. S. (2009). Bank Liquidity Creation. *Review of Financial Studies*, 22 (9), 3779-3837.

Berger, A. N., & Bouwman, C. H. S. (2017). Bank Liquidity Creation, Monetary Policy, and Financial Crises. *Journal of Financial Stability*, 30 (6), 139-155.

Berger, A. N., & Roman, R. A. (2015). Did TARP Banks Get Competitive Advantages? *Journal of Financial and Quantitative Analysis*, 50 (6), 1199-1236.

Brunnermeier, M. K., & Pedersen, L. H. (2009). Market Liquidity and Funding Liquidity. *Review of Financial Studies*, 22 (6), 2201-2238.

Chen, Y. L., Ma, Y., & Ruan, Z. Y. (2016). How Does Financial Cycle and Financial Fluctuation Affect Economic Growth and Financial Stability? *Journal of Financial Research (Jinrong Yanjiu)*, 2, 1-22.

Cheng, I. H., Hong, H., & Scheinkman, J. A. (2015). Yesterday's Heroes: Compensation and Risk at Financial Firms. *Journal of Finance*, 70 (2), 839-879.

Chung, J. Y., Ahn, D. H., Baek, I. S., & Kang, K. H. (2018). An Empirical Investigation on Funding Liquidity and Market Liquidity. *Review of Finance*, 22 (3), 1213-1247.

Cohen, L. J., Cornett, M. M., Marcus, A. J., & Tehranian, H. (2014). Bank Earnings Management and Tail Risk during the Financial Crisis. *Journal of Money Credit and Banking*, 46 (1), 171-197.

Demirgüç-Kunt, A., & Kane, E. (2002). Deposit Insurance around the World: Where Does It Work? *Journal of Economic Perspectives*, 16 (2), 175-195.

Drehmann, M., & Nikolaou, K. (2013). Funding Liquidity Risk: Definition and Measurement. *Journal of Banking & Finance*, 37 (7), 2173-2182.

Duan, J. S., Yang, F., & Gao, H. M. (2018). Deposit Insurance, Institutional Environment and Risk Taking of Commercial Banks: Empirical Evidence Based on Global Samples. *Nankai Economic Studies (Nankai Jingji Yanjiu)*, 3, 136-156.

Gatev, E., & Strahan, P. E. (2006). Banks' Advantage in Hedging Liquidity Risk: Theory and Evidence from the Commercial Paper Market. *Journal of Finance*, 61(2), 867-892.

Guo, Y., & Zhao, J. (2017). Deposit Insurance System, Bank Heterogeneity and Bank Individual Risk. *Economic Research Journal (Jingji Yanjiu)*, 12, 134-148.

International Monetary Fund (IMF). (2008). *Global Financial Stability Report*. Washington, April.

Keeley, M. C. (1990). Deposit Insurance, Risk, and Market Power in Banking. *American Economic Review*, 8 (5), 1183-1200.

Khan, M. S., Scheule, H., & Wu, E. (2017). Funding Liquidity and Bank Risk Taking. *Journal of Banking & Finance*, 82, 203-216.

Köhler, M. (2012). Which Banks Are More Risky? The Impact of Loan Growth and Business Model on Bank Risk-taking. Bundesbank Discussion Paper, No.33/2012.

Laeven, L., & Levine, R. (2009). Bank Governance, Regulation and Risk Taking. *Journal of Financial Economics*, 93 (2), 259-275.

Lee, C. C., & Hsieh, M. F. (2013). The Impact of Bank Capital on Profitability and Risk in Asian Banking. *Journal of International Money and Finance*, 32 (2), 251-281.

Merton, R. C. (1977). An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees: An Application of Modern Option Pricing Theory. *Journal of Banking & Finance*, 1 (1), 3-11.

Myers, S. C., & Rajan, R. G. (1998). The Paradox of Liquidity. *The Quarterly Journal of Economics*, 113 (3), 733-771.

Repullo, R. (2004). Capital Requirements, Market Power, and Risk-Taking in Banking. J*ournal of Financial Intermediation*, 13 (2), 156-182.

Rose, P. S., & Hudgins, S. C. (2012). *Bank Management & Financial Services*. McGraw-Hill Education.

Tasca, P., Mavrodiev, P., & Schweitzer, F. (2014). Quantifying the Impact of Leveraging and Diversification on Systemic Risk. *Journal of Financial Stability*, 15 (12), 43-52.

Wang, X. H., & Yang, C. J. (2014). Research on Market liquidity, Financing Liquidity and Bank Risk. *Review of Investment Studies (Touzi Yanjiu)*, 7, 13-25.

Wen, Z. L., Zhang, L., Hou, J. T., & Liu, H. Y. (2004). Test Procedure and Application of Intermediary Effect. *Acta Psychologica Sinica (Xinli Xuebao)*, 5, 614-620.

Xin, B. H., & Tao, J. (2018). Does Liquidity Risk Management of Commercial Banks Have the Same Group Effect? *Finance & Trade Economics (Caimao Jingji)*, 4, 67-81.

Zhang, J. H., & Wang, P. (2012). Bank Risk, Loan Scale and Legal Protection Level. *Economic Research Journal (Jingji Yanjiu)*, 12, 18-30.

Zhu, W. Y., & Yang, J. W. (2016). State Ownership, Cross-Border Acquisition, and Risk-Taking: Evidence from China's Banking Industry. *Journal of Banking & Finance*, 71 (10), 133-153.

# Research on Measurement of China's Inter-Provincial Trade, International Trade and Low-Carbon Trade Competitiveness

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In this paper, Embodied carbon emission competitiveness in international trade and inter-provincial trade is measured and comparative analysis is conducted. Specifically the non-competitive input-output model and low-carbon trade competitiveness index are constructed to study the embodied carbon emission competitiveness of 31 Chinese provinces in international trade and inter-provincial trade from the perspectives of the whole, three industries and product sectors. We find that Shanghai is the most competitive in low-carbon trade, while Qinghai is the least; carbon leakage in international trade is severe; the performance of different product sectors differ widely in embodied carbon emission competitiveness in international trade and inter-provincial trade; the primary and secondary industries are competitive in low-carbon inter-provincial trade and the tertiary industry is competitive in low-carbon international trade. The innovations of this paper is as follows: methodology in low-carbon trade competitiveness index is innovated; macro, meso and micro perspectives are taken; factors in international trade and inter-provincial trade are combined in content. In the end, development of low-carbon trade is promoted and references for policy are provided for a new round of trade competition.

**Keywords:** international trade, inter-provincial trade, low-carbon trade competitiveness index, embodied carbon emissions, input-output model

## 1. Introduction

Since 1990s, foreign trade grew rapidly along with economic globalization, but ecological degradation was worsened as economic development was promoted. The relationship between trade and the environment attracted wide attention. China actively performed the responsibility of a major power. The Report to the 19th

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National Congress of the CPC attached great importance to ecological civilization and green development and identified the building of an ecological civilization as vital to sustain the Chinese development, which indicated China's resolution in addressing environmental pollution and climate change and defined our direction in developing low-carbon trade and taking the path of low-carbon economy.

Meanwhile, trade liberalization and economic globalization drove Chinese economy to grow rapidly, but subsequently, environmental problems were increasingly severe. In 2016, Global Carbon Project (GCP) issued the *Global Carbon Budget 2016* and pointed out that China emitted 10.4 billion tons of carbon annually, 29% of the world's total and 4% higher than the sum of the United States and EU. According to statistics of the World Bank (WB), if carbon tariffs are carried out comprehensively, export of China will plunge by nearly 21%. This implies that global climate change rules exert impact that cannot be underestimated on China's foreign trade and carbon emissions will become an important indicator for measuring a country's foreign trade competitiveness. In an open economic system, foreign trade intensifies the flow of carbon emissions globally and production and consumption of products in a country (region) are gradually separated. In this context, "low-carbon trade competitiveness" is born as an index for measuring international competitiveness of products of a country (region) in the era of low-carbon economy and it reflects both emission reduction effect of trade-engaged product sectors and their level of trade competitiveness (Zheng *et al*., 2015). At the same time, in China, the largest developing country, due to breadth of its territory, different areas differ widely in low-carbon trade competitiveness. Given so, what impact is exerted on low-carbon trade competitiveness in different areas by international trade and inter-provincial trade and what trend of changes is displayed are worth further analysis and research. On this basis, this paper constructs the environmentally non-competitive input-output model, develops the low-carbon trade competitiveness index based on the traditional trade competitiveness index and carbon productivity index, measures the embodied carbon emission competitiveness index in international trade, inter-provincial trade and general trade of 31 Chinese provincial-level administrative regions and analyzes their difference from the panoramic view, the three industries and product sectors, with the hope of offering empirical supports and reference for different areas in improving low-carbon trade competitiveness in the low-carbon economy.

## 2. Theoretical Basis and Literature Review

In the international division of labor and engagement in trade activities, traditional

theories, such as the theory of comparative advantage and the theory of factor endowment, take the environmental factor in trade growth as an exogenous variable. In fact, however, trade grows at the cost of massive consumption of energy and resources and environmental pollution. In the context of economic globalization, a country cannot develop without contribution of other countries or regions and environmental pollution generated by trade should be taken into re-consideration. This paper aims to enrich and develop theories on international trade and environment, identify China's level of low-carbon trade competitiveness and effectively avoid low-carbon trade barriers. In the meantime, based on the pollution haven hypothesis, the paper measures China's embodied carbon emissions in international trade and inter-provincial trade, analyzes if pollution havens exit in China and validates them, if any. According to the environmental Kuznets theory, it verifies whether the inverted U-curve proposed in the theory exists in China.

Trade and the environment have always been the focus of attention of domestic and foreign scholars. As researchers probe deeper into the issue, many scholars gradually integrate the factor of environment into traditional trade competitiveness and combine environmental changes and trade competitiveness in study. Their perspectives of study can be categorized into relationships of environmental regulation, efficiency of carbon emission reduction and carbon productivity with trade competitiveness. The first is the influence of environmental regulation on trade competitiveness. Scholars mainly take the angles of pollution haven hypothesis, factor endowment hypothesis and Porter hypothesis and they have different views. Some believe environmental regulation can improve resource utilization and trade competitiveness (Porter and Lindo, 1995; Song and Wang, 2013; Wang and Liu, 2014), while some others hold that environmental regulation can narrow down trade circulation and reduce trade competitiveness (Jaffe and Palmer, 1997; Li *et al*., 2014; Ren and Huang, 2015). The second is the relationship between efficiency of carbon emission reduction and trade competitiveness in the context of low-carbon economy differs in different product sectors due to impact of the efficiency on trade competitiveness (Kuik and Hofkes, 2010; Zhou and Yu, 2014; Zhang *et al*., 2016). The third is the relationship between carbon productivity and trade competitiveness. Trade of a country (region) affects carbon productivity mainly through technology effect and structure effect and further affects its trade competitiveness (Zheng *et al*., 2015; Zhao and Zhang, 2016).

Compared with previous research findings, this paper contributes in the following areas. First, having excluded factors of import and inflow from other provincial regions, it resorts to the non-competitive input-output model and measures embodied carbon emissions in international trade and inter-provincial trade in 31 Chinese provincial-level administrative regions. Also, it integrates carbon productivity and traditional trade competitiveness index and constructs a low-carbon trade competitiveness index

to measure embodied carbon emission competitiveness in international trade, inter-provincial trade and general trade of the 31 Chinese provincial-level administrative regions and make comparative analysis. Second, on the basis of the traditional trade competitiveness evaluation standard, the paper refers to the practice of scholars such as Huang (2006) in segmenting the trade competitiveness index and introduces it into the low-carbon trade competitiveness evaluation standard for better accuracy. Third, in measuring carbon emissions of product sectors in each provincial-level administrative region, the paper takes into full consideration the difference in technology. It not only analyzes the embodied carbon emission competitiveness of the 31 provincial-level administrative regions in international trade, inter-provincial trade and general trade from the panoramic view and product sectors, but also introduces the three industries to study their low-carbon trade competitiveness in the three industries from a meso perspective.

## 3. Measuring Methodology and Modeling

### *3.1. Input-Output Analysis*

The paper measures embodied carbon emissions of Chinese product sectors in international trade and inter-provincial trade and on this basis, the low-carbon trade competitiveness index of 31 Chinese provinces. Based on the *Input-output Tables of Provinces in China in 2012*, it takes 31 Chinese provinces as object of study and refers to methodology of some scholars (Yan and Zhao, 2012; Nie and Li, 2016; Pan, 2017) to study the relationship between international trade, inter-provincial trade and low-carbon trade competitiveness in China. The measurement is as follows:

$$X = AX + Y + T^{e} + T^{ep} - T^{m} - T^{mp} \tag{1}$$

It can be further written as:

$$X = (I - A)^{-1}(Y + T^{e} + T^{ep} - T^{m} - T^{mp}) \tag{2}$$

In the formula, $(I - A)^{-1}$ is a Leontief inverse matrix; $X$ and $Y$ respectively refer to column vector of total output and final consumption of each provincial region; $A$ represents a direct intermediate input coefficient matrix of each provincial-level region; $T^{e}$ and $T^{ep}$respectively refer to each provincial-level region's export column vector and column vector of outflow from other provinces in China; $T^{m}$ and $T^{mp}$ respectively refer to each provincial-level region's import column vector and column vector of inflow from others in China.

### *3.2. Non-Competitive Input-Output Modeling*

With the input-output model applied into the environmental sector, according to theoretical analysis, direct intermediate input coefficient matrix of each provincial region is $A_i=A_i^d+A_i^m(i=1,2,3)$. $A_i^d$ is direct intermediate input coefficient matrix in the country or provincial-level regions and $A_i^m$ is direct intermediate input coefficient matrix of product sectors imported or flowed from other provincial regions. By referring to the method of Li and Lu (2010) in excluding intermediate input of import $A_i^m$, we set $A_i^m = M_i \times A_i$ and $M_i$ is coefficient matrix of import or inflow from other provincial regions, representing the proportion of intermediate inputs into products imported or flowed from other provincial regions in the overall intermediate inputs. Suppose the proportion of intermediate inputs imported or flowed from other provincial regions remains the same in the input of product sector *i* into another product sector *j*, and then

$$M_i = \begin{bmatrix} m_{11} & 0 & \cdots & 0 \\ 0 & m_{22} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & m_{nn} \end{bmatrix}$$ is a diagonal matrix. Direct intermediate input coefficient matrix in China and 31 provincial-level regions is $A_i^d = (I - M_i)A_i(i = 1,2,3)$.

Total carbon emission coefficient (intensity) matrix of each product sector is:

$$F_i = E_i(I - A_i^d)^{-1} \tag{8}$$

### *3.3 Modeling for the Measurement of Embodied Carbon Emissions Exported and Flowed from Provincial-Level Regions*

According to the non-competitive I-O model and the total carbon emission coefficient matrix, the measurement formula for embodied carbon emissions in export of China can be attained as:

$$C_e = E_1(I - A_1^d)^{-1}T^e \tag{9}$$

In the formula, $C_e$ is embodied carbon emissions in export; $(I\text{-}A_1^d)^{-1}$ is Leontief inverse matrix with import and inflow from other provincial regions excluded; $E_1$ is direct carbon emission coefficient matrix exported and flowed out from provincial regions of product sectors; $T^e$ is column vector of product value in export.

Similarly, embodied carbon emissions caused by outflow from provincial regions can be measured with the formula:

$$C_{ep} = E_1(I - A_1^d)^{-1}T^{ep} \tag{10}$$

$C_{ep}$ is embodied carbon emissions flowed out from provincial regions and $T^{ep}$ is column vector of product value flowed out from them.

### *3.4. Modeling for the Measurement of Embodied Carbon Emissions Imported and Flowed in from Other Provincial Regions*

China imports products to meet its domestic demand and carbon dioxide embodied in the imported products saves carbon dioxide generated in domestic production for the country. According to the non-competitive I-O model and the total carbon emission coefficient matrix, the measurement model for embodied carbon emissions in import is attained as followed:

$$C_m = E_2(I - A_2^d)^{-1}\left[A_2^m(I - A_2^d)^{-1}Y + Y^{m1}\right] \tag{11}$$

In the formula, $C_m$ is embodied carbon emission in import; $A^d{}_2$ is the intermediate input matrix with input inflows from other provinces excluded; $E_2$ is direct carbon emission coefficient matrix of product sectors in import; $Y$ is the sum of final consumption.

Similarly, the measurement model for embodied carbon emissions caused by inflow from other provincial regions in the country is:

$$C_{mp} = E_3(I - A_3^d)^{-1}\left[A_3^m(I - A_3^d)^{-1}Y + Y^{m2}\right] \tag{12}$$

$C_{mp}$ is embodied carbon emission flowed in from other provincial regions in the country; $A^d{}_3$ is the intermediate input matrix with imported inputs excluded; $E_3$ is direct carbon emission coefficient matrix flowed in from other provincial regions in product sectors; $Y$ is the sum of final consumption.

### *3.5. Construction of Low-Carbon Trade Competitiveness Index*

Before measuring the low-carbon trade competitiveness, it's necessary to understand the meaning of trade competitiveness. Trade competitiveness refers to the proportion of foreign trade balance in total foreign trade of a country (region) and is a common indicator for analyzing a country (region)'s international competitiveness. The trade competitiveness index (*TC*), compared with other methods such as international market share and index of revealed comparative advantage, better reflects if a country (region) enjoys competitive advantage in foreign trade and is more representative in reflecting trade competitiveness of product sectors (Greenaway and Milner, 1993). The formula is as follows:

$$TC = \frac{T^{ex} - T^{im}}{T^{ex} + T^{im}} \tag{13}$$

In the formula, $TC$ means trade competitiveness; $T^{ex}$ is the column vector of exported product value; $T^{im}$ the column vector of imported product value. According to the formula (13), trade competitiveness index is valued between [–1,1].

By referring to Pan and Zhang (2001) and Huang (2006) for segmenting the trade competitiveness index, this paper develops the following evaluation standard and introduces it to the evaluation of low-carbon trade competitiveness.

Table 1. Trade Competitiveness Evaluation Standard

| *TC* | *TC* Rating |
|---|---|
| 0.8~1.0 | High comparative advantage |
| 0.5~0.8 | Relatively high comparative advantage |
| 0~0.5 | Low comparative advantage |
| –0.5~0 | Low comparative disadvantage |
| –0.8~–0.5 | Relatively high comparative disadvantage |
| –1.0~–0.8 | High comparative disadvantage |

Besides, it's important to understand the meaning of carbon productivity which refers to economic value per unit of carbon dioxide emission, measures the GDP level per unit of carbon emission in a country (region) and mainly reflects the impact of carbon emission permits on the economy and society (Zhou and Yu, 2014; Zheng *et al*., 2015). The measurement formula is as follows:

$$CP_{ik} = \frac{Y_{ik}}{C_{ik}} \tag{14}$$

In the formula, $CP_{ik}$ refers to carbon productivity of product sector $k$ in the country (region) $i$; $Y_{ik}$ is value added of product sector $k$ in the country (region) $i$; $C_{ik}$ is carbon dioxide emission of product sector $k$ in the country (region) $i$. On such basis, the paper develops the low-carbon trade competitiveness index (*CTC*) model and in the model, the embodied carbon emission competitiveness index in international trade is calculated as follows:

$$CTC_f = \frac{\frac{T^e}{C_e} - \frac{T^m}{C_m}}{\frac{T^e}{C_e} + \frac{T^m}{C_m}} = 1 - \frac{2\frac{T^m}{C_m}}{\frac{T^e}{C_e} + \frac{T^m}{C_m}} = 1 - \frac{2T^m}{C_m \frac{T^e}{C_e} + T^m} \tag{15}$$

Similarly, the embodied carbon emission competitiveness index in inter-provincial trade is calculated as follows:

$$CTC_p = \frac{\frac{T^{ep}}{C_{ep}} - \frac{T^{mp}}{C_{mp}}}{\frac{T^{ep}}{C_{ep}} + \frac{T^{mp}}{C_{mp}}} = 1 - \frac{2\frac{T^{mp}}{C_{mp}}}{\frac{T^{ep}}{C_{ep}} + \frac{T^{mp}}{C_{mp}}} = 1 - \frac{2T^{mp}}{C_{mp} \frac{T^{ep}}{C_{ep}} + T^{mp}} \tag{16}$$

The embodied carbon emission competitiveness index in general trade is calculated as follows:

$$\begin{aligned} CTC &= \frac{\frac{T^e + T^{ep}}{C_e + C_{ep}} - \frac{T^m + T^{mp}}{C_m + C_{mp}}}{\frac{T^e + T^{ep}}{C_e + C_{ep}} + \frac{T^m + T^{mp}}{C_m + C_{mp}}} = 1 - \frac{2\frac{T^m + T^{mp}}{C_m + C_{mp}}}{\frac{T^e + T^{ep}}{C_e + C_{ep}} + \frac{T^m + T^{mp}}{C_m + C_{mp}}} \\ &= 1 - \frac{2(T^m + T^{mp})}{(C_m + C_{mp})\frac{T^e + T^{ep}}{C_e + C_{ep}} + (T^m + T^{mp})} \end{aligned} \tag{17}$$

It's inferred from the model that the low-carbon trade competitiveness index is similarly between [–1,1]. In the evaluation of low-carbon trade competitiveness of product sectors, the evaluation standard in Table 1 is equally applicable.

## 4. Data Source and Processing

In order to ensure reliability, thoroughness and accuracy of research materials, the paper adopts statistics mainly from the *Input-Output Tables of Provinces in China in 2012*, *China Energy Statistical Yearbook* and statistical yearbooks of all the provincial-level administrative regions. Besides, according to *Industrial Classification Standard for National Economic Activities (GB/T4754-2017)* and consolidated classification of input and output sectors in the *Input-Output Tables of Provinces in China in 2012*, the paper categorizes input and output sectors in 31 Chinese provincial-level administrative regions in 2012 into 28 types (Table 2~Table 7).

Table 2. Embodied Carbon Competitiveness Index in International Trade of 28 Product Sectors in 31 Chinese Provincial-Level Administrative Regions in 2012 (Top 14 Product Sectors)

| Provincial-level Administrative Region | Agriculture | Coal Mining, Washing and Dressing | Oil and Gas Extraction | Metallic Ore Mining and Dressing | Nonmetallic Ore and other Ore Mining and Dressing | Food Manufacturing and Tobacco Processing | Textile |
|---|---|---|---|---|---|---|---|
| Beijing | 0.58 | 0.75 | –0.53 | 0.78 | 0.44 | 0.73 | 0.41 |
| Tianjin | –0.27 | –0.72 | 0.94 | –0.48 | 0.45 | 0.06 | 0.20 |
| Hebei | –0.90 | –0.89 | –1.00 | –1.00 | –0.47 | –0.32 | –0.50 |
| Shanxi | –0.49 | 1.00 | 0.00 | –1.00 | 0.00 | –0.50 | –0.57 |
| Inner Mongolia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liaoning | –0.59 | –1.00 | –0.93 | –0.80 | 0.04 | –0.12 | –0.38 |
| Jilin | –0.54 | –0.98 | 0.00 | –0.89 | 0.26 | 0.27 | –0.29 |
| Heilongjiang | –0.23 | –0.99 | –1.00 | –0.93 | 1.00 | 0.74 | 0.62 |
| Shanghai | –0.16 | –0.37 | –1.00 | –0.90 | –0.45 | 0.24 | –0.62 |
| Jiangsu | –0.84 | –0.94 | 0.74 | –0.92 | –0.39 | 0.05 | –0.07 |
| Zhejiang | –0.83 | –1.00 | 0.84 | –1.00 | –0.34 | 0.07 | 0.08 |
| Anhui | –0.55 | –1.00 | 1.00 | –1.00 | –0.06 | –0.10 | –0.28 |
| Fujian | 0.74 | –0.84 | –1.00 | 0.76 | –0.32 | 0.07 | –0.50 |
| Jiangxi | –0.79 | –1.00 | 1.00 | –1.00 | –0.78 | 0.35 | –0.45 |
| Shandong | –0.88 | –0.96 | –0.99 | –1.00 | –0.41 | 0.94 | 0.64 |
| Henan | –0.64 | –1.00 | –1.00 | –0.99 | –0.18 | 0.21 | 0.44 |
| Hubei | 0.86 | –0.98 | –0.76 | –0.83 | 0.93 | –0.06 | 0.81 |
| Hunan | –0.37 | –1.00 | 0.00 | –0.99 | 0.41 | 0.11 | –0.19 |
| Guangdong | –0.56 | –1.00 | –0.76 | –0.78 | –0.43 | 0.06 | –0.23 |
| Guangxi | –0.70 | –0.99 | 0.00 | –1.00 | 1.00 | 0.33 | –0.06 |
| Hainan | 0.20 | 0.00 | –0.34 | –1.00 | 0.32 | 0.28 | –0.10 |
| Chongqing | –0.76 | –1.00 | 1.00 | 0.26 | –0.82 | 0.20 | 0.09 |
| Sichuan | –0.58 | –1.00 | –0.48 | –1.00 | –0.87 | 0.11 | 0.29 |
| Guizhou | –0.77 | –1.00 | 1.00 | –0.99 | –0.68 | 0.43 | 0.15 |
| Yunnan | –0.37 | –1.00 | 0.00 | –1.00 | –1.00 | –0.22 | 0.75 |
| Shaanxi | –0.33 | 0.00 | 1.00 | –0.77 | 0.60 | 0.69 | 0.47 |
| Gansu | –0.22 | 0.00 | –1.00 | –1.00 | 0.74 | 0.58 | 0.84 |
| Qinghai | –0.30 | –0.85 | 0.82 | 0.21 | –0.92 | –0.68 | –0.65 |
| Ningxia | –0.08 | 1.00 | 0.00 | –0.73 | –0.99 | 0.63 | –0.40 |
| Xinjiang | –0.92 | –1.00 | –1.00 | –1.00 | –0.94 | –0.09 | –0.23 |
| Tibet | –0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.99 |

| Provincial-level Administrative Region | Manufacturing of Clothes, Leather, Down and others | Wood Processing and Furniture Manufacturing | Papermaking, Printing and Manufacturing of Stationery and Sporting Goods | Petroleum Processing, Coking and Nuclear Fuel Processing | Chemical Industry | Nonmetallic Mineral Products | Metal Smelting, Calendering and Processing |
|---|---|---|---|---|---|---|---|
| Beijing | 0.63 | 0.80 | 0.60 | 0.97 | 0.87 | 0.56 | 0.25 |
| Tianjin | 0.54 | 0.57 | 0.42 | –0.49 | –0.13 | 0.42 | 0.18 |
| Hebei | –0.02 | 0.55 | –0.23 | 0.37 | –0.23 | –0.16 | –0.03 |
| Shanxi | –0.10 | –1.00 | –0.53 | 1.00 | –0.24 | 0.18 | –0.22 |
| Inner Mongolia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liaoning | 0.41 | 0.34 | 0.45 | –0.47 | –0.31 | 0.14 | –0.28 |
| Jilin | 0.59 | 0.37 | 0.72 | –0.57 | 0.03 | 0.15 | 0.19 |
| Heilongjiang | 0.62 | 0.32 | 0.12 | –0.84 | 0.20 | 0.91 | 0.62 |
| Shanghai | 0.41 | 0.52 | 0.07 | –0.03 | 0.06 | 0.16 | –0.13 |
| Jiangsu | 0.50 | 0.57 | 0.10 | –0.64 | –0.23 | 0.19 | –0.16 |
| Zhejiang | 0.58 | 0.38 | 0.06 | –0.51 | –0.21 | 0.37 | –0.30 |
| Anhui | 0.84 | 0.58 | 0.15 | –0.89 | 0.04 | –0.23 | 0.21 |
| Fujian | 0.51 | 0.61 | 0.47 | –0.89 | –0.08 | 0.15 | –0.04 |
| Jiangxi | 0.87 | 0.92 | 0.34 | –1.00 | 0.33 | 0.75 | –0.56 |
| Shandong | 0.90 | 0.90 | 0.73 | 0.60 | 0.71 | 0.70 | –0.87 |
| Henan | 0.88 | 0.93 | 0.17 | –0.78 | 0.47 | 0.44 | 0.27 |
| Hubei | –0.05 | 0.96 | –0.47 | –0.74 | –0.15 | –0.71 | –0.70 |
| Hunan | 0.54 | 0.54 | –0.16 | 0.65 | 0.24 | –0.28 | 0.06 |
| Guangdong | 0.53 | 0.52 | 0.30 | –0.17 | –0.13 | 0.02 | –0.57 |
| Guangxi | 0.43 | 0.98 | 0.02 | –0.60 | 0.51 | 0.99 | 0.61 |
| Hainan | 1.82 | 0.24 | 0.53 | 0.17 | 0.22 | –0.07 | –0.01 |
| Chongqing | 0.15 | 0.42 | 0.28 | –0.96 | –0.06 | 0.10 | 0.18 |
| Sichuan | 0.56 | 0.70 | 0.22 | –1.00 | –0.14 | 0.07 | –0.39 |
| Guizhou | 0.79 | 0.92 | 0.42 | –0.99 | –0.32 | 0.47 | –0.42 |
| Yunnan | 0.98 | 0.18 | –0.49 | 0.00 | –0.05 | 0.78 | 0.38 |
| Shaanxi | 0.97 | 0.94 | 0.63 | –0.91 | –0.04 | 0.09 | 0.05 |
| Gansu | 0.94 | 0.99 | 0.88 | –1.00 | 0.44 | 0.79 | –0.77 |
| Qinghai | –0.54 | –1.00 | –0.93 | –0.99 | –0.36 | –0.64 | 0.44 |
| Ningxia | 0.71 | –0.37 | –0.57 | –0.13 | –0.52 | –0.56 | –0.67 |
| Xinjiang | 0.11 | 0.19 | 0.51 | –0.95 | 0.02 | 0.00 | –0.58 |
| Tibet | –0.39 | 0.96 | 0.65 | –0.34 | 0.52 | –0.10 | –4.06 |

Source: Calculated on the basis of the *Input-Output Tables of Provinces in China in 2012* and *China Energy Statistical Yearbook* with related formulas.

Table 3. Embodied Carbon Competitiveness Index in International Trade of 28 Product Sectors in 31 Chinese Provincial-Level Administrative Regions in 2012 (Last 14 Product Sectors)

| Provincial-level Administrative Region | Metal Products | General and Special Equipment Manufacturing | Transport Equipment Manufacturing | Electrical Machinery and Equipment Manufacturing | Communication Devices, Computers and other Electronic Equipment Manufacturing | Instrumentation and Cultural and Clerical Machinery Manufacturing | Other Manufacturing |
|---|---|---|---|---|---|---|---|
| Beijing | 0.84 | 0.76 | 0.79 | 0.89 | 0.86 | 0.63 | 0.05 |
| Tianjin | 0.74 | 0.56 | 0.56 | 0.73 | 0.51 | 0.49 | –0.81 |
| Hebei | 0.48 | 0.09 | 0.25 | 0.37 | 0.26 | 0.03 | –0.79 |
| Shanxi | –1.00 | 0.04 | 0.31 | –0.37 | 0.78 | –1.00 | –1.00 |
| Inner Mongolia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liaoning | 0.50 | 0.29 | 0.43 | 0.60 | 0.48 | 0.27 | –0.60 |
| Jilin | 0.36 | 0.30 | 0.27 | 0.53 | 0.34 | 0.30 | 0.47 |
| Heilongjiang | 0.97 | 0.55 | 0.78 | 0.60 | 0.91 | 0.47 | 0.42 |
| Shanghai | 0.52 | 0.60 | 0.65 | 0.77 | 0.59 | 0.69 | 0.77 |
| Jiangsu | 0.63 | 0.48 | 0.57 | 0.71 | 0.47 | 0.40 | 0.69 |
| Zhejiang | 0.73 | 0.56 | 0.81 | 0.73 | 0.74 | 0.41 | –0.41 |
| Anhui | 0.62 | 0.37 | 0.77 | 0.74 | 0.47 | 0.30 | 0.11 |
| Fujian | –0.05 | 0.31 | 0.52 | 0.67 | 0.72 | 0.44 | 0.47 |
| Jiangxi | 0.86 | 0.51 | 0.69 | 0.84 | 0.49 | 0.51 | –0.35 |
| Shandong | –0.78 | 0.83 | 0.07 | 0.91 | 0.49 | –0.21 | –0.48 |
| Henan | 0.84 | 0.42 | 0.69 | 0.58 | 0.40 | –0.02 | 0.40 |
| Hubei | 0.92 | 0.57 | 0.36 | 0.59 | 0.28 | 0.24 | –0.47 |
| Hunan | 0.58 | 0.47 | 0.50 | 0.73 | 0.54 | 0.66 | –0.39 |
| Guangdong | 0.63 | 0.61 | 0.69 | 0.78 | 0.59 | 0.55 | –0.51 |
| Guangxi | 1.00 | 0.47 | 0.85 | 0.73 | 0.44 | 0.06 | –0.67 |
| Hainan | 0.67 | 0.41 | 0.58 | 0.88 | 0.99 | 0.54 | 0.98 |
| Chongqing | 0.54 | 0.68 | 0.50 | 0.61 | 0.49 | 0.75 | 0.35 |
| Sichuan | 0.55 | 0.44 | 0.38 | 0.72 | 0.46 | 0.38 | 0.26 |
| Guizhou | 0.70 | 0.17 | 0.63 | 0.67 | 0.72 | 0.14 | 1.00 |
| Yunnan | 0.87 | 0.57 | 0.43 | 0.92 | 0.48 | –1.00 | –1.00 |
| Shaanxi | 0.54 | 0.41 | 0.53 | 0.68 | 0.35 | 0.37 | 0.94 |
| Gansu | 0.88 | 0.49 | 0.36 | 0.93 | 0.27 | 0.26 | 1.00 |
| Qinghai | –0.63 | –0.26 | –0.60 | –0.57 | –1.00 | –1.00 | –0.98 |
| Ningxia | –0.14 | –0.16 | 0.37 | 0.19 | 0.66 | –0.23 | –0.51 |
| Xinjiang | 0.38 | 0.12 | 0.60 | 0.64 | 0.88 | 0.37 | 0.47 |
| Tibet | 0.29 | 0.25 | 0.78 | 0.81 | 0.63 | 0.63 | 0.98 |

| Provincial-level Administrative Region | Production and Supply of Power and Heat | Gas Production and Supply | Water Production and Supply | Construction | Transport, Warehousing and Postal Service | Wholesale and Retail and Catering | Other Services |
|---|---|---|---|---|---|---|---|
| Beijing | 1.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.89 | 0.61 |
| Tianjin | 0.00 | 0.00 | 0.00 | 0.88 | –0.02 | –0.14 | 0.22 |
| Hebei | 0.00 | 0.00 | 0.00 | 0.80 | –0.53 | –0.40 | –0.44 |
| Shanxi | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Inner Mongolia | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Liaoning | –1.00 | 0.00 | 0.00 | 0.90 | –0.27 | –0.38 | –0.04 |
| Jilin | 1.00 | 0.00 | 0.00 | 0.00 | –0.27 | –0.27 | 0.38 |
| Heilongjiang | –1.00 | 0.00 | 0.00 | 0.00 | –0.55 | –0.32 | 0.00 |
| Shanghai | 0.00 | 0.00 | 0.00 | 0.96 | 0.03 | 0.07 | 0.25 |
| Jiangsu | 0.00 | 0.00 | 0.00 | 0.89 | 0.00 | 0.00 | –0.45 |
| Zhejiang | 0.00 | 0.00 | 0.00 | 0.00 | –0.15 | 0.00 | –0.07 |
| Anhui | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | 0.97 |
| Fujian | 0.92 | –1.00 | –1.00 | 0.76 | –0.39 | 0.13 | –0.09 |
| Jiangxi | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.25 | 0.95 |
| Shandong | 0.00 | –1.00 | 0.00 | –1.00 | –0.97 | 0.06 | –0.32 |
| Henan | 0.00 | 0.00 | 0.00 | 0.82 | –0.56 | –0.20 | –0.69 |
| Hubei | –1.00 | –0.95 | –0.93 | 0.00 | 0.00 | 0.00 | –0.80 |
| Hunan | 0.00 | 0.00 | 0.00 | 0.92 | –0.78 | 0.00 | –0.50 |
| Guangdong | 0.46 | 0.00 | 0.00 | 0.96 | 0.19 | 0.39 | 0.22 |
| Guangxi | 0.00 | 0.00 | 0.00 | 0.68 | 0.28 | 0.88 | 0.27 |
| Hainan | 0.00 | 0.00 | 0.00 | 0.19 | 0.14 | 0.43 | 0.08 |
| Chongqing | 0.00 | 0.00 | 0.00 | 1.00 | 0.80 | 1.00 | 0.10 |
| Sichuan | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | –0.32 |
| Guizhou | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | –0.12 |
| Yunnan | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.82 |
| Shaanxi | 0.00 | 0.00 | 0.00 | 0.00 | 0.29 | –0.02 | –0.40 |
| Gansu | 0.00 | 0.00 | 0.00 | 0.00 | 0.78 | 0.90 | –0.13 |
| Qinghai | –0.71 | –0.86 | –1.00 | –0.57 | –0.88 | –0.73 | –0.94 |
| Ningxia | 0.00 | 0.00 | 0.00 | 0.00 | –0.78 | –0.53 | 0.19 |
| Xinjiang | 1.00 | 0.00 | 0.00 | 0.00 | –0.64 | –0.57 | –0.75 |
| Tibet | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 0.91 |

Source: Calculated on the basis of the *Input-Output Tables of Provinces China in 2012* and *China Energy Statistical Yearbook* with related formulas.

Table 4. Embodied Carbon Competitiveness Index in Inter-Provincial Trade of 28 Product Sectors in 31 Chinese Provincial-Level Administrative Regions in 2012 (Top 14 Product Sectors)

| Provincial-level Administrative Region | Agriculture | Coal Mining, Washing and Dressing | Oil and Gas Extraction | Metallic Ore Mining and Dressing | Nonmetallic Ore and other Ore Mining and Dressing | Food Manufacturing and Tobacco Processing | Textile |
|---|---|---|---|---|---|---|---|
| Beijing | 0.50 | –0.06 | 0.74 | 0.91 | 0.11 | 0.10 | 0.18 |
| Tianjin | –0.85 | 0.97 | 0.59 | 0.93 | 0.00 | –0.06 | –0.16 |
| Hebei | –0.59 | –0.99 | –1.00 | 0.28 | –0.99 | –0.35 | –0.10 |
| Shanxi | –0.79 | 0.39 | –0.70 | –0.86 | –1.00 | –0.70 | –0.82 |
| Inner Mongolia | –0.81 | 0.52 | 0.99 | 0.31 | –0.84 | –0.34 | –0.36 |
| Liaoning | –0.62 | –0.86 | –0.98 | 0.12 | –0.53 | 0.00 | –0.59 |
| Jilin | 1.00 | –1.00 | 1.00 | 1.00 | –1.00 | 1.00 | –1.00 |
| Heilongjiang | –0.18 | –0.24 | 1.00 | 0.15 | –0.03 | –0.09 | –0.03 |
| Shanghai | –0.30 | –1.00 | –0.16 | 0.99 | –1.00 | –0.05 | 0.32 |
| Jiangsu | 0.06 | –1.00 | –1.00 | –1.00 | –1.00 | –0.15 | 0.04 |
| Zhejiang | –0.55 | –0.14 | –1.00 | 0.96 | –0.19 | –0.04 | –0.11 |
| Anhui | –0.18 | –0.24 | –1.00 | 0.08 | –0.36 | –0.11 | –0.21 |
| Fujian | –0.82 | –1.00 | –0.03 | –0.84 | –0.89 | 0.04 | –0.22 |
| Jiangxi | –0.01 | –0.84 | –1.00 | 0.08 | –0.97 | –0.06 | –0.05 |
| Shandong | –0.99 | –0.97 | –0.99 | –0.90 | –0.94 | 0.97 | 0.76 |
| Henan | –0.23 | –0.43 | –1.00 | –0.56 | –0.89 | 0.26 | 0.15 |
| Hubei | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hunan | 0.19 | –0.99 | 0.00 | –0.87 | –0.29 | 0.05 | –0.03 |
| Guangdong | –0.84 | 0.13 | –0.33 | –0.18 | 0.27 | 0.31 | –0.04 |
| Guangxi | 0.57 | –1.00 | 0.00 | 0.51 | –0.76 | –0.01 | 0.10 |
| Hainan | –0.19 | 0.00 | 0.98 | 0.42 | –0.20 | –0.23 | 0.16 |
| Chongqing | –0.12 | 0.91 | –0.40 | –0.13 | –0.87 | –0.12 | –0.13 |
| Sichuan | –0.66 | 0.28 | –0.92 | 0.55 | –0.22 | 0.04 | 0.26 |
| Guizhou | –0.26 | 0.75 | –1.00 | –0.64 | –0.57 | –0.45 | –0.24 |
| Yunnan | –0.09 | 0.69 | 0.00 | –0.73 | –0.84 | –0.25 | –0.32 |
| Shaanxi | 0.05 | 0.25 | 0.04 | 0.65 | –0.24 | –0.18 | –0.07 |
| Gansu | –0.10 | –0.81 | –1.00 | –0.67 | –0.44 | –0.48 | –0.36 |
| Qinghai | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ningxia | –0.57 | –0.66 | –0.78 | –1.00 | –0.88 | –0.67 | –0.68 |
| Xinjiang | 0.69 | 0.66 | 1.00 | –0.13 | –0.44 | –0.27 | –0.43 |
| Tibet | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | –0.99 |

| Provincial-level Administrative Region | Manufacturing of Clothes, Leather, Down and Others | Wood Processing and Furniture Manufacturing | Papermaking, Printing and Manufacturing of Stationery and Sporting Goods | Petroleum Processing, Coking and Nuclear Fuel Processing | Chemical Industry | Nonmetallic Mineral Products | Metal Smelting, Calendering and Processing |
|---|---|---|---|---|---|---|---|
| Beijing | 0.11 | 0.12 | 0.17 | –0.49 | 0.12 | 0.07 | –0.06 |
| Tianjin | –0.07 | –0.51 | –0.34 | –0.55 | 0.35 | –0.28 | 0.12 |
| Hebei | –0.41 | –0.45 | –0.97 | –0.56 | –0.49 | 0.66 | 0.08 |
| Shanxi | –0.93 | –0.99 | –0.96 | –0.50 | –0.81 | –0.72 | –0.86 |
| Inner Mongolia | –0.97 | –0.41 | –0.95 | –0.67 | –0.32 | –0.26 | 0.19 |
| Liaoning | –0.35 | 0.24 | –0.73 | 0.14 | –0.17 | 0.24 | –0.23 |
| Jilin | –1.00 | 1.00 | –1.00 | –1.00 | 1.00 | 1.00 | –1.00 |
| Heilongjiang | 0.13 | 0.05 | –0.38 | –0.03 | –0.18 | –0.05 | –0.21 |
| Shanghai | 0.08 | 0.01 | 0.20 | –0.62 | 0.30 | –0.12 | –0.06 |
| Jiangsu | 0.67 | –0.12 | –1.00 | –0.61 | 0.03 | –0.37 | –0.85 |
| Zhejiang | 0.01 | 0.01 | 0.30 | –0.08 | 0.00 | –0.29 | –0.37 |
| Anhui | –0.16 | –0.17 | –0.47 | –0.25 | –0.26 | 0.07 | –0.26 |
| Fujian | –0.03 | 0.14 | 0.20 | –0.89 | –0.44 | 0.51 | –0.69 |
| Jiangxi | –0.13 | 0.10 | –0.18 | –0.53 | 0.04 | –0.08 | 0.15 |
| Shandong | 0.77 | 0.84 | 0.56 | 0.87 | 0.88 | 0.79 | –0.99 |
| Henan | –0.08 | 0.15 | –0.01 | –0.49 | –0.20 | 0.78 | –0.06 |
| Hubei | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hunan | –0.45 | 0.30 | –0.36 | –0.71 | –0.10 | 0.12 | –0.04 |
| Guangdong | 0.24 | 0.24 | 0.23 | 0.08 | 0.22 | 0.46 | 0.08 |
| Guangxi | 0.02 | 0.40 | 0.05 | –0.96 | –0.35 | 0.65 | 0.69 |
| Hainan | –0.07 | –0.16 | –0.17 | 0.16 | –0.18 | –0.46 | –0.38 |
| Chongqing | –0.21 | –0.17 | –0.34 | –0.35 | –0.12 | –0.21 | –0.25 |
| Sichuan | –0.39 | –0.18 | –0.79 | –0.83 | –0.10 | –0.09 | –0.25 |
| Guizhou | 1.43 | –0.46 | –0.64 | –0.53 | –0.43 | –0.37 | –0.29 |
| Yunnan | –0.44 | –0.55 | –0.93 | –0.41 | –0.31 | –0.80 | 0.49 |
| Shaanxi | –0.11 | 0.00 | –0.30 | 0.49 | –0.27 | –0.01 | –0.15 |
| Gansu | –0.46 | –0.74 | –0.83 | –0.11 | –0.51 | –0.59 | –0.20 |
| Qinghai | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ningxia | –0.66 | –0.69 | –0.69 | –0.29 | –0.61 | –0.71 | –0.59 |
| Xinjiang | –0.96 | –0.67 | –0.60 | 0.89 | –0.38 | –0.52 | –0.31 |
| Tibet | –0.69 | –0.79 | 0.99 | –1.00 | 0.72 | –0.59 | –1.00 |

Source: Calculated on the basis of the *Input-Output Tables of Provinces in China in 2012* and *China Energy Statistical Yearbook* with related formulas.

Table 5. Embodied Carbon Competitiveness Index in Inter-Provincial Trade of 28 Product Sectors in 31 Chinese Provincial-Level Administrative Regions in 2012 (Last 14 Product Sectors)

| Provincial-level Administrative Region | Metal Products | General and Special Equipment Manufacturing | Transport Equipment Manufacturing | Electrical Machinery and Equipment Manufacturing | Communication Devices, Computers and other Electronic Equipment Manufacturing | Instrumentation and Cultural and Clerical Machinery Manufacturing | Other Manufacturing |
|---|---|---|---|---|---|---|---|
| Beijing | 0.04 | 0.09 | –0.65 | 0.14 | 0.19 | 0.16 | 0.19 |
| Tianjin | –0.10 | –0.06 | 0.00 | –0.18 | 0.40 | 0.14 | 0.74 |
| Hebei | 0.99 | –0.46 | –0.47 | –0.33 | –0.98 | –0.99 | –0.74 |
| Shanxi | –0.99 | –0.87 | –0.91 | –0.96 | –0.90 | –0.96 | –0.98 |
| Inner Mongolia | 0.34 | –0.51 | –0.52 | –0.49 | –0.70 | –0.97 | –0.75 |
| Liaoning | –0.29 | –0.15 | –0.24 | –0.17 | –0.40 | –0.51 | –0.56 |
| Jilin | –1.00 | –1.00 | 1.00 | –1.00 | –1.00 | 1.00 | –1.00 |
| Heilongjiang | –0.19 | –0.20 | –0.15 | –0.06 | –0.19 | –0.25 | –0.42 |
| Shanghai | –0.04 | 0.19 | 0.02 | 0.05 | 0.32 | 0.60 | –0.03 |
| Jiangsu | 1.00 | –0.02 | 0.87 | 0.47 | 0.29 | 1.00 | –0.34 |
| Zhejiang | 0.41 | 0.29 | 0.05 | 0.21 | –0.13 | 0.44 | 0.19 |
| Anhui | –0.09 | –0.31 | –0.17 | 0.00 | –0.18 | –0.03 | –0.42 |
| Fujian | 0.29 | –0.16 | –0.09 | 0.11 | –0.11 | –0.01 | 0.42 |
| Jiangxi | –0.13 | –0.38 | –0.14 | 0.19 | –0.09 | –0.08 | –0.10 |
| Shandong | –0.66 | 0.86 | –0.44 | 0.64 | 0.52 | –0.53 | –0.87 |
| Henan | –0.40 | –0.30 | –0.24 | –0.17 | –0.10 | –0.11 | –0.58 |
| Hubei | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hunan | 0.51 | –0.01 | –0.28 | 0.06 | –0.03 | –0.23 | –0.42 |
| Guangdong | 0.33 | 0.24 | 0.10 | 0.35 | 0.42 | 0.33 | 0.81 |
| Guangxi | –0.57 | –0.27 | –0.19 | –0.11 | –0.38 | –0.19 | –0.74 |
| Hainan | –0.23 | –0.10 | –0.26 | –0.15 | –0.04 | –0.18 | –1.00 |
| Chongqing | –0.37 | –0.28 | –0.10 | 0.03 | –0.06 | 0.73 | –0.11 |
| Sichuan | –0.85 | –0.38 | –0.11 | –0.40 | –0.04 | –0.68 | –0.84 |
| Guizhou | –0.45 | –0.48 | –0.48 | –0.46 | –0.47 | –0.43 | –0.70 |
| Yunnan | –0.91 | –0.54 | –0.44 | –0.67 | –0.49 | –1.00 | –0.93 |
| Shaanxi | –0.23 | –0.19 | –0.21 | –0.10 | 0.12 | 0.39 | –0.46 |
| Gansu | –0.72 | –0.59 | –0.51 | –0.48 | –0.50 | –0.54 | –0.54 |
| Qinghai | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ningxia | –0.74 | –0.67 | –0.68 | –0.66 | –0.56 | –0.66 | –1.00 |
| Xinjiang | –0.99 | –0.51 | –0.51 | –0.53 | –0.50 | –0.73 | –0.32 |
| Tibet | –1.00 | –1.00 | –1.00 | –1.00 | –1.00 | –1.00 | –1.00 |

| Provincial-level Administrative Region | Production and Supply of Power and Heat | Gas Production and Supply | Water Production and Supply | Construction | Transport, Warehousing and Postal Service | Wholesale and Retail and Catering | Other Services |
|---|---|---|---|---|---|---|---|
| Beijing | 0.09 | –0.07 | 1.00 | –0.57 | 0.15 | 0.11 | 0.53 |
| Tianjin | –1.00 | 0.86 | –0.48 | –0.21 | 0.32 | 0.90 | –0.10 |
| Hebei | –0.99 | –0.60 | –0.94 | –0.82 | –0.36 | 0.01 | –0.76 |
| Shanxi | –0.04 | –0.95 | –1.00 | 0.00 | –0.37 | –0.81 | –0.91 |
| Inner Mongolia | 0.52 | –1.00 | –1.00 | –0.50 | 0.47 | 0.77 | –0.68 |
| Liaoning | –0.83 | –0.79 | –1.00 | –0.34 | –0.39 | –0.04 | –0.20 |
| Jilin | –1.00 | –1.00 | –1.00 | –1.00 | –1.00 | –0.91 | –0.29 |
| Heilongjiang | 0.98 | 1.00 | 1.00 | –0.24 | 0.56 | 0.97 | –0.43 |
| Shanghai | –1.00 | –1.00 | –1.00 | 0.02 | 0.05 | 0.80 | –0.03 |
| Jiangsu | 0.00 | –1.00 | 0.00 | –0.11 | –0.25 | 0.98 | –0.12 |
| Zhejiang | –0.69 | 1.00 | 0.00 | 0.00 | 0.03 | –0.04 | 0.07 |
| Anhui | 0.69 | –0.32 | –0.69 | –0.36 | –0.22 | –0.22 | –0.20 |
| Fujian | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | –0.55 |
| Jiangxi | –0.85 | –1.00 | –1.00 | –0.18 | –0.20 | –0.15 | –0.27 |
| Shandong | –0.97 | 0.48 | –0.88 | –1.00 | –0.84 | 0.33 | –0.42 |
| Henan | –0.51 | –0.82 | 0.00 | –0.24 | –0.10 | –0.45 | –0.40 |
| Hubei | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hunan | –1.00 | –1.00 | 0.00 | –0.17 | –0.44 | –0.84 | 0.28 |
| Guangdong | –0.30 | 0.15 | 0.00 | –1.00 | 0.38 | 0.27 | 0.00 |
| Guangxi | –0.45 | –1.00 | 0.00 | –0.29 | 0.37 | 0.03 | –0.52 |
| Hainan | –0.13 | –1.00 | –1.00 | –0.20 | –0.15 | 0.05 | –0.32 |
| Chongqing | –0.75 | –0.14 | –0.13 | –0.14 | –0.10 | –0.04 | –0.16 |
| Sichuan | 0.78 | 0.95 | 0.00 | –1.00 | –0.52 | 0.08 | 0.56 |
| Guizhou | 1.00 | –1.00 | 0.00 | –0.63 | –0.43 | –0.13 | –0.43 |
| Yunnan | 0.96 | –1.00 | 0.00 | –0.42 | –0.25 | –0.05 | –0.06 |
| Shaanxi | –0.46 | –0.92 | –0.93 | –0.44 | –0.15 | –0.21 | –0.44 |
| Gansu | 0.87 | –0.94 | –1.00 | –0.52 | –0.51 | 0.63 | –0.54 |
| Qinghai | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ningxia | –0.56 | –0.94 | –0.82 | 1.00 | –0.61 | –0.82 | –0.86 |
| Xinjiang | 1.00 | –0.60 | 0.00 | –1.00 | –0.40 | –0.96 | –0.60 |
| Tibet | –1.00 | –1.00 | 0.00 | –1.00 | 0.00 | 0.99 | 0.74 |

Source: Calculated on the basis of the *Input-Output Tables of Provinces in China in 2012* and *China Energy Statistical Yearbook* with related formulas.

Table 6. Embodied Carbon Competitiveness Index in General Trade of 28 Product Sectors in 31 Chinese Provincial-Level Administrative Regions in 2012 (Top 14 Product Sectors)

| Provincial-level Administrative Region | Agriculture | Coal Mining, Washing and Dressing | Oil and Gas Extraction | Metallic Ore Mining and Dressing | Nonmetallic Ore and other Ore Mining and Dressing | Food Manufacturing and Tobacco Processing | Textile |
|---|---|---|---|---|---|---|---|
| Beijing | 0.45 | 0.13 | 0.03 | 0.83 | 0.16 | 0.23 | 0.39 |
| Tianjin | –0.75 | 0.47 | 0.64 | 0.15 | 0.04 | 0.02 | –0.10 |
| Hebei | –0.60 | –0.97 | –1.00 | –0.66 | –0.96 | –0.35 | –0.15 |
| Shanxi | –0.78 | 0.39 | –0.70 | –0.94 | –1.00 | –0.69 | –0.72 |
| Inner Mongolia | –0.81 | 0.52 | 0.99 | 0.31 | –0.84 | –0.34 | –0.36 |
| Liaoning | –0.61 | –0.88 | –0.97 | –0.44 | –0.52 | –0.03 | –0.52 |
| Jilin | 0.10 | –1.00 | 1.00 | 0.50 | –0.98 | 0.81 | –0.50 |
| Heilongjiang | –0.20 | –0.28 | –0.04 | 0.04 | –0.02 | –0.05 | –0.02 |
| Shanghai | –0.27 | –0.22 | –0.13 | 0.49 | –0.20 | 0.03 | 0.13 |
| Jiangsu | –0.24 | –0.99 | –1.00 | –0.96 | –0.97 | –0.06 | 0.00 |
| Zhejiang | –0.63 | –0.15 | –0.04 | 0.82 | –0.25 | –0.02 | –0.01 |
| Anhui | –0.18 | –0.24 | –0.47 | –0.13 | –0.35 | –0.11 | –0.23 |
| Fujian | –0.19 | –0.87 | –0.19 | –0.59 | –0.52 | 0.06 | –0.55 |
| Jiangxi | –0.02 | –0.86 | –0.25 | –0.34 | –0.97 | –0.06 | –0.15 |
| Shandong | –0.92 | –0.97 | –0.99 | –0.95 | –0.81 | 0.95 | 0.71 |
| Henan | –0.25 | –0.44 | –1.00 | –0.60 | –0.88 | 0.27 | 0.15 |
| Hubei | 0.86 | –0.98 | –0.76 | –0.83 | 0.93 | –0.06 | 0.81 |
| Hunan | 0.19 | –0.99 | 0.00 | –0.92 | –0.29 | 0.06 | –0.05 |
| Guangdong | –0.66 | –0.11 | –0.48 | 0.13 | –0.02 | 0.24 | –0.14 |
| Guangxi | –0.09 | –1.00 | 0.00 | –0.38 | –0.29 | 0.06 | –0.01 |
| Hainan | –0.18 | 0.00 | 0.25 | 0.36 | –0.20 | –0.19 | 0.08 |
| Chongqing | –0.12 | 0.91 | –0.39 | –0.13 | –0.86 | –0.12 | –0.13 |
| Sichuan | –0.66 | 0.17 | –0.93 | 0.29 | –0.33 | 0.07 | 0.19 |
| Guizhou | –0.29 | 0.72 | –0.56 | –0.69 | –0.53 | –0.45 | –0.27 |
| Yunnan | –0.25 | 0.56 | 0.00 | –0.89 | –0.85 | –0.24 | –0.29 |
| Shaanxi | 0.02 | 0.27 | 0.07 | –0.09 | –0.22 | –0.13 | –0.06 |
| Gansu | –0.10 | –0.81 | –1.00 | –0.78 | –0.45 | –0.47 | –0.34 |
| Qinghai | –0.30 | –0.85 | 0.82 | 0.21 | –0.92 | –0.68 | –0.65 |
| Ningxia | –0.43 | –0.67 | –0.78 | –0.81 | –0.88 | –0.67 | –0.68 |
| Xinjiang | 0.40 | 0.53 | –0.26 | –0.48 | –0.46 | –0.27 | –0.46 |
| Tibet | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | –0.50 |

| Provincial-level Administrative Region | Manufacturing of Clothes, Leather, Down and Others | Wood Processing and Furniture Manufacturing | Papermaking, Printing and Manufacturing of Stationery and Sporting Goods | Petroleum Processing, Coking and Nuclear Fuel Processing | Chemical Industry | Nonmetallic Mineral Products | Metal Smelting, Calendering and Processing |
|---|---|---|---|---|---|---|---|
| Beijing | 0.23 | 0.37 | 0.26 | –0.28 | 0.33 | 0.12 | 0.20 |
| Tianjin | 0.07 | 0.06 | –0.16 | –0.53 | 0.10 | –0.20 | 0.13 |
| Hebei | –0.36 | –0.39 | –0.91 | –0.56 | –0.44 | 0.65 | 0.07 |
| Shanxi | –0.92 | –0.99 | –0.93 | –0.49 | –0.73 | –0.66 | –0.73 |
| Inner Mongolia | –0.97 | –0.41 | –0.95 | –0.67 | –0.32 | –0.26 | 0.19 |
| Liaoning | –0.19 | 0.27 | –0.48 | 0.05 | –0.20 | 0.24 | –0.24 |
| Jilin | –0.34 | 0.83 | –0.72 | –0.99 | 0.68 | 0.99 | –0.97 |
| Heilongjiang | –0.10 | 0.13 | –0.32 | –0.06 | –0.15 | –0.04 | –0.21 |
| Shanghai | 0.23 | 0.20 | 0.12 | –0.46 | 0.15 | –0.10 | –0.08 |
| Jiangsu | 0.56 | 0.07 | –0.28 | –0.59 | –0.07 | –0.33 | –0.73 |
| Zhejiang | 0.11 | 0.20 | 0.21 | –0.16 | –0.08 | –0.31 | –0.42 |
| Anhui | –0.13 | –0.15 | –0.33 | –0.25 | –0.24 | 0.06 | –0.25 |
| Fujian | 0.31 | 0.49 | 0.40 | –0.88 | –0.20 | 0.22 | –0.38 |
| Jiangxi | –0.06 | 0.14 | –0.06 | –0.56 | 0.05 | –0.05 | 0.06 |
| Shandong | 0.87 | 0.89 | 0.73 | 0.81 | 0.81 | 0.80 | –0.94 |
| Henan | –0.03 | 0.21 | 0.01 | –0.50 | –0.18 | 0.77 | –0.06 |
| Hubei | –0.05 | 0.96 | –0.47 | –0.74 | –0.15 | –0.71 | –0.70 |
| Hunan | –0.12 | 0.32 | –0.35 | –0.71 | –0.09 | 0.11 | –0.03 |
| Guangdong | 0.43 | 0.36 | 0.28 | 0.05 | 0.06 | 0.32 | –0.19 |
| Guangxi | –0.10 | 0.45 | 0.05 | –0.53 | –0.24 | 0.65 | 0.69 |
| Hainan | –0.17 | 0.01 | –0.10 | 0.17 | –0.14 | –0.43 | –0.34 |
| Chongqing | –0.21 | –0.17 | –0.33 | –0.35 | –0.11 | –0.21 | –0.25 |
| Sichuan | –0.13 | –0.06 | –0.35 | –0.88 | –0.12 | –0.08 | –0.30 |
| Guizhou | –0.45 | –0.46 | –0.54 | –0.53 | –0.41 | –0.34 | –0.30 |
| Yunnan | –0.39 | –0.46 | –0.93 | –0.41 | –0.29 | –0.71 | 0.49 |
| Shaanxi | –0.19 | –0.10 | –0.22 | 0.45 | –0.21 | –0.01 | –0.14 |
| Gansu | –0.47 | –0.45 | –0.57 | –0.10 | –0.49 | –0.52 | –0.29 |
| Qinghai | –0.54 | –1.00 | –0.93 | –0.99 | –0.36 | –0.64 | 0.44 |
| Ningxia | –0.64 | –0.63 | –0.68 | –0.30 | –0.61 | –0.71 | –0.60 |
| Xinjiang | –0.44 | –0.40 | –0.46 | 0.67 | –0.38 | –0.43 | –0.32 |
| Tibet | –0.71 | 0.39 | 0.61 | –0.28 | 0.20 | –0.06 | 0.93 |

Source: Calculated on the basis of the *Input-Output Tables of Provinces in China in 2012* and *China Energy Statistical Yearbook* with related formulas.

Table 7. Embodied Carbon Competitiveness Index in General Trade of 28 Product Sectors in 31 Chinese Provincial-Level Administrative Regions in 2012 (Last 14 Product Sectors)

| Provincial-level Administrative Region | Metal Products | General and Special Equipment Manufacturing | Transport Equipment Manufacturing | Electrical Machinery and Equipment Manufacturing | Communication Devices, Computers and other Electronic Equipment Manufacturing | Instrumentation and Cultural and Clerical Machinery Manufacturing | Other Manufacturing |
|---|---|---|---|---|---|---|---|
| Beijing | 0.35 | 0.61 | 0.61 | 0.64 | 0.56 | 0.55 | 0.28 |
| Tianjin | 0.18 | 0.29 | 0.44 | 0.39 | 0.49 | 0.37 | 0.04 |
| Hebei | 0.87 | –0.36 | –0.39 | –0.19 | –0.44 | –0.52 | –0.75 |
| Shanxi | –0.99 | –0.71 | –0.83 | –0.93 | –0.62 | –0.96 | –0.98 |
| Inner Mongolia | 0.34 | –0.51 | –0.52 | –0.49 | –0.70 | –0.97 | –0.75 |
| Liaoning | 0.08 | 0.04 | –0.01 | 0.15 | –0.11 | –0.16 | –0.57 |
| Jilin | –0.75 | –0.81 | 0.32 | –0.59 | –0.46 | 0.36 | –0.97 |
| Heilongjiang | –0.16 | –0.16 | –0.12 | 0.08 | –0.13 | –0.10 | –0.38 |
| Shanghai | 0.30 | 0.53 | 0.47 | 0.56 | 0.51 | 0.65 | 0.11 |
| Jiangsu | 0.61 | 0.30 | 0.59 | 0.69 | 0.46 | 0.50 | –0.33 |
| Zhejiang | 0.53 | 0.43 | 0.23 | 0.57 | 0.11 | 0.40 | –0.10 |
| Anhui | –0.03 | –0.19 | –0.14 | 0.15 | –0.04 | 0.08 | –0.41 |
| Fujian | 0.24 | 0.22 | 0.33 | 0.62 | 0.27 | 0.30 | 0.49 |
| Jiangxi | –0.09 | –0.27 | –0.10 | 0.50 | 0.22 | –0.01 | –0.12 |
| Shandong | –0.73 | 0.85 | –0.33 | 0.84 | 0.51 | –0.36 | –0.42 |
| Henan | –0.37 | –0.25 | –0.22 | 0.01 | 0.21 | 0.00 | –0.56 |
| Hubei | 0.92 | 0.57 | 0.36 | 0.59 | 0.28 | 0.24 | –0.47 |
| Hunan | 0.53 | 0.08 | –0.09 | 0.19 | 0.11 | –0.02 | –0.40 |
| Guangdong | 0.52 | 0.52 | 0.41 | 0.72 | 0.57 | 0.52 | –0.03 |
| Guangxi | –0.28 | –0.16 | –0.17 | 0.12 | 0.05 | –0.07 | –0.72 |
| Hainan | –0.13 | –0.02 | 0.27 | 0.09 | 0.12 | 0.01 | –0.95 |
| Chongqing | –0.34 | –0.25 | –0.05 | 0.11 | 0.10 | 0.73 | –0.10 |
| Sichuan | –0.11 | –0.06 | 0.16 | –0.02 | 0.28 | –0.04 | –0.66 |
| Guizhou | –0.45 | –0.45 | –0.46 | –0.45 | –0.46 | –0.38 | –0.68 |
| Yunnan | –0.69 | –0.42 | –0.41 | –0.59 | –0.38 | –1.00 | –0.93 |
| Shaanxi | –0.12 | 0.11 | –0.06 | 0.30 | 0.29 | 0.38 | –0.42 |
| Gansu | –0.55 | –0.49 | –0.47 | –0.42 | –0.45 | –0.45 | –0.51 |
| Qinghai | –0.63 | –0.26 | –0.60 | –0.57 | –1.00 | –1.00 | –0.98 |
| Ningxia | –0.70 | –0.63 | –0.67 | –0.59 | –0.59 | –0.57 | –0.90 |
| Xinjiang | –0.48 | –0.49 | –0.51 | –0.51 | –0.49 | –0.35 | –0.36 |
| Tibet | –0.13 | –0.32 | 0.39 | 0.04 | 0.11 | 0.18 | –0.15 |

| Provincial-level Administrative Region | Production and Supply of Power and Heat | Gas Production and Supply | Water Production and Supply | Construction | Transport, Warehousing and Postal Service | Wholesale and Retail and Catering | Other Services |
|---|---|---|---|---|---|---|---|
| Beijing | 0.22 | 0.13 | 1.00 | 0.50 | 0.22 | 0.23 | 0.57 |
| Tianjin | –1.00 | 0.88 | –0.49 | –0.17 | 0.23 | 0.44 | –0.02 |
| Hebei | –0.99 | –0.60 | –0.94 | –0.79 | –0.37 | –0.03 | –0.74 |
| Shanxi | –0.04 | –0.95 | –1.00 | 0.00 | –0.37 | –0.81 | –0.90 |
| Inner Mongolia | 0.52 | –1.00 | –1.00 | –0.50 | 0.47 | 0.77 | –0.68 |
| Liaoning | –0.85 | –0.81 | –1.00 | –0.31 | –0.37 | –0.11 | –0.16 |
| Jilin | –1.00 | –1.00 | –1.00 | –1.00 | –0.95 | –0.82 | –0.25 |
| Heilongjiang | 0.74 | 1.00 | 1.00 | –0.24 | 0.40 | 0.42 | –0.42 |
| Shanghai | –1.00 | –1.00 | –1.00 | 0.59 | 0.03 | 0.39 | 0.11 |
| Jiangsu | 0.00 | –1.00 | 0.00 | –0.04 | –0.29 | 0.98 | –0.06 |
| Zhejiang | –0.80 | 1.00 | 0.00 | 0.00 | –0.02 | –0.05 | 0.01 |
| Anhui | 0.68 | –0.32 | –0.70 | –0.36 | –0.20 | –0.21 | –0.19 |
| Fujian | 0.93 | –1.00 | –1.00 | 0.74 | –0.30 | 0.30 | –0.26 |
| Jiangxi | –0.86 | –1.00 | –1.00 | –0.09 | –0.20 | –0.13 | –0.29 |
| Shandong | –0.98 | 0.56 | –0.94 | –1.00 | –0.91 | 0.23 | –0.41 |
| Henan | –0.52 | –0.82 | 0.00 | –0.20 | –0.13 | –0.42 | –0.39 |
| Hubei | –1.00 | –0.95 | –0.93 | 0.00 | 0.00 | 0.00 | –0.80 |
| Hunan | –1.00 | –1.00 | 0.00 | –0.17 | –0.44 | –0.84 | 0.29 |
| Guangdong | –0.40 | –0.02 | 0.00 | –0.07 | 0.31 | 0.31 | 0.26 |
| Guangxi | –0.47 | –1.00 | 0.00 | –0.29 | 0.37 | 0.05 | –0.46 |
| Hainan | –0.13 | –1.00 | –1.00 | –0.18 | –0.13 | 0.07 | –0.27 |
| Chongqing | –0.75 | –0.14 | –0.13 | –0.14 | –0.10 | –0.03 | –0.16 |
| Sichuan | 0.71 | 0.95 | 0.00 | –1.00 | –0.60 | 0.01 | 0.55 |
| Guizhou | 1.00 | –1.00 | 0.00 | –0.63 | –0.44 | –0.16 | –0.43 |
| Yunnan | 0.96 | –1.00 | 0.00 | –0.42 | –0.24 | –0.04 | –0.04 |
| Shaanxi | –0.50 | –0.92 | –0.94 | –0.45 | –0.12 | –0.19 | –0.43 |
| Gansu | 0.87 | –0.94 | –1.00 | –0.51 | –0.47 | 0.65 | –0.52 |
| Qinghai | –0.71 | –0.86 | –1.00 | –0.57 | –0.88 | –0.73 | –0.94 |
| Ningxia | –0.57 | –0.94 | –0.83 | 1.00 | –0.61 | –0.81 | –0.85 |
| Xinjiang | 1.00 | –0.58 | 0.00 | –1.00 | –0.39 | –0.79 | –0.63 |
| Tibet | –1.00 | –1.00 | 0.00 | 0.91 | 0.00 | 0.99 | –0.26 |

Source: Calculated on the basis of the *Input-Output Tables of Provinces in China in 2012* and *China Energy Statistical Yearbook* with related formulas.

Also, it divides product sectors into the three industries for analysis, with those numbered 1 as the primary industry, those numbered 2~25 as the secondary industry and those numbered 26~28 as the tertiary industry (Figure 2).

## 5. Empirical Results and Analysis

### *5.1 Analysis on Low-Carbon Trade Competitiveness: A Holistic View*

Figure 1 shows the embodied carbon emission competitiveness index of 31 Chinese provincial-level administrative regions in international trade, inter-provincial trade and total trade in 2012. The index in international trade is generally lower than that for inter-provincial trade. As to the index in international trade, Beijing ranks first with an index of 0.5~0.8 and enjoys relatively high comparative advantage, while Qinghai ranks last with an index ranged between –1.0 and –0.8 and shows high comparative disadvantage. Apart from Inner Mongolia that is excluded for import and export statistics, five provincial regions range from 0 and 0.5 with low comparative advantage, 17 range from –0.5 and 0 with low comparative disadvantage, and six range from –0.8 and –0.5 with relatively high comparative disadvantage. It indicates that the majority of Chinese provincial regions suffer the comparative disadvantage in embodied carbon emission competitiveness for international trade and take a disadvantaged position in international trade, with carbon emission productivity in export being lower than the productivity in import. In international trade, carbon leakage is a serious problem. For reasons, foreign carbon emission intensity is lower due to more advanced technology overseas and China is always in trade surplus, with its export far exceeding import in volume. For the embodied carbon emission competitiveness index in inter-provincial trade, Tibet ranks first with an index of 0~0.5 and enjoys low comparative advantage, while Shanxi ranks last with an index ranged between –0.8 and –0.5 and suffers relatively high comparative disadvantage. Apart from Hubei and Qinghai that are excluded from statistics on inflow from other provincial regions and outflow, 10 range from 0 and 0.5 with low comparative advantage, 12 range from –0.5 and 0 with low comparative disadvantage, with five range from –0.8 and –0.5 with relatively high comparative disadvantage. The majority of Chinese provincial regions similarly suffer comparative disadvantage in embodied carbon emission competitiveness for inter-provincial trade. In inter-provincial trade, carbon emissions are transferred among the provincial regions and carbon leakage cannot be neglected. The embodied carbon emission competitiveness index in total trade covers both international trade and inter-provincial trade. Shanghai ranks first with an index of 0~0.5 and enjoys low comparative advantage, while Qinghai ranks last with an index ranged between –1.0 and –0.8 and suffers high comparative disadvantage. Nine provincial regions range from 0 and 0.5 with low comparative advantage, 14 from –0.5 and 0 with low comparative disadvantage, and six from –0.8 and –0.5 with relatively

high comparative disadvantage. Embodied carbon emission competitiveness in total trade is comparatively disadvantaged and carbon emission productivity in export and outflow from the provincial regions remains to be improved.

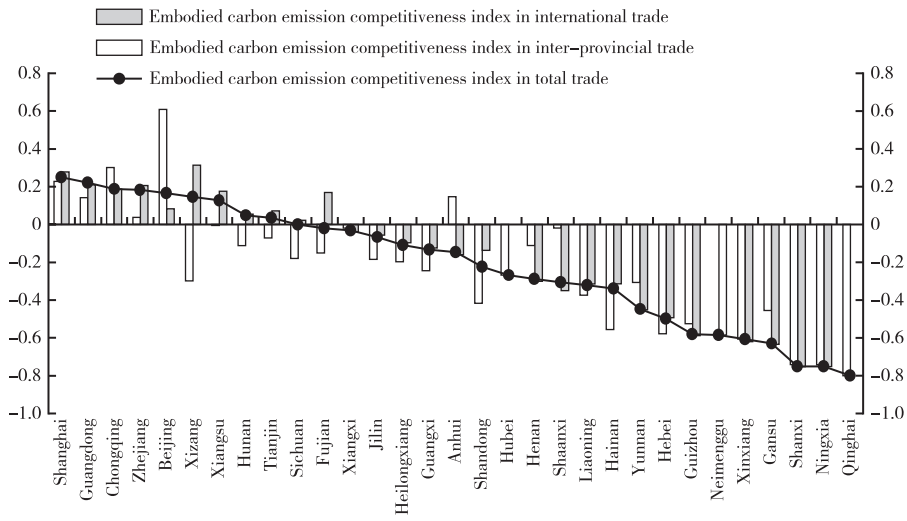


*Figure 1.* Embodied Carbon Emission Competitiveness Index in International Trade, Inter-Provincial Trade and Total Trade in 31 Chinese Provincial-Level Administrative Regions in 2012

Note: Provinces are ranked from high to low according to the embodied carbon emission competitiveness index in total trade and the right axis refers to the index in total trade.

### *5.2. Analysis on Low-Carbon Trade Competitiveness: From the Perspective of Product Sectors*

The paper categorizes product sectors into 28 types and embodied carbon emission competitiveness index for their trade is shown in Table 2~7. Moreover, in order to facilitate analysis, product sectors numbered 2~5 are named mining herein, those numbered 6~21 named manufacturing, those numbered 22~24 production and supply of power, gas and water, those numbered 26~28 services, and those numbered 1 and 25 indicate agriculture and construction, respectively. Regarding agriculture, 26 provincial regions have an embodied carbon competitiveness index of lower than 0 for international trade and 21 for inter-provincial trade, with Shandong ranking last with an index between –1.0 and –0.8. For total trade, 24 provincial regions have an index of lower than 0, with Shandong ranking last with an index between –1.0 and –0.8. It shows that the agriculture sector has relatively high competitiveness in embodied carbon emission for inter-provincial trade. With respect to mining, embodied carbon emission competitiveness index in international trade is lovoer than 0 for 27 provinces, index in inter-provincial trade is lower than 0 for 16 provinces, and 21 for total trade.

The mining sector has relatively high competitiveness in embodied carbon emission in inter-provincial trade. As for manufacturing, 31 provincial regions generally enjoy comparative advantage and are highly competitive in embodied carbon emission for international trade. Shanxi suffers high comparative disadvantage in the competitiveness for trade. About production and supply of power, gas and water, since related statistics on import and export is not available for the majority of provincial regions, the embodied carbon emission competitiveness index in international trade for most of them is not available, either. This is relevant to the characteristics of the product sector. Most players in the production and supply of power, gas and water are state-owned/controlled enterprises, which engaged in international trade only at a low level. For inter-provincial trade, 22 provincial regions have an embodied carbon emission competitiveness index of lower than 0; for total trade, 25 have an index of lower than 0. In this product sector, most provincial regions suffer comparative disadvantage for embodied carbon emission competitiveness in trade in general. With regard to construction, the sector is relatively highly competitive in embodied carbon emission in international trade and Ningxia enjoys high comparative advantage in embodied carbon emission competitiveness in trade. Services are relatively highly competitive in embodied carbon emission in trade, but the competitive advantage is not impressive; services in Qinghai generally suffer high comparative disadvantage in embodied carbon emission competitiveness in trade.

### *5.3. Analysis on Low-Carbon Trade Competitiveness: Three Industries*

As displayed in Figure2, Figure 3 and Figure 4, in the primary industry, for embodied carbon emission competitiveness index in international trade of the 31 provincial regions, it is lower than 0 in 26 of them, with Shandong, Hebei and Xinjiang ranking as the last three; for the index in inter-provincial trade of the 31provincial regions, it is lower than 0 in 21 of them; for the index in total trade, it is lower than 0 in 24 provincial regions, with Hubei ranking first with an index of 0.8~1.0. The 31 Chinese provincial-level administrative regions are generally weak for embodied carbon emission competitiveness in trade in the primary industry; embodied carbon emission competitiveness in inter-provincial trade is generally higher than that in international trade and inter-provincial trade can help promote the carbon emission productivity in the primary industry to improve. In the secondary industry, for embodied carbon emission competitiveness index in international trade of the 31 provincial regions, it is lower than 0 in 23 of them, with Beijing ranking first with an index of 0.5~0.8; for the index in inter-provincial trade, it is lower than 0 in 17 of them; for the index in total trade, it is lower than 0 in 21 of them. The 31 provincial regions generally suffer comparative disadvantage in embodied carbon emission competitiveness in trade in the secondary industry and similarly as in the primary industry, their embodied carbon emission competitiveness in inter-provincial trade is

generally greater than that for international trade. In the tertiary industry, for embodied carbon emission competitiveness index in international trade of the 31 provincial regions, it is lower than 0 in 18 of them, with Hubei and Qinghai ranking as the last two with an index between -1.0 and -0.8; for the index in inter-provincial trade, it is lower than 0 in 19 of them, with Inner Mongolia, Ningxia and Xinjiang ranking as the

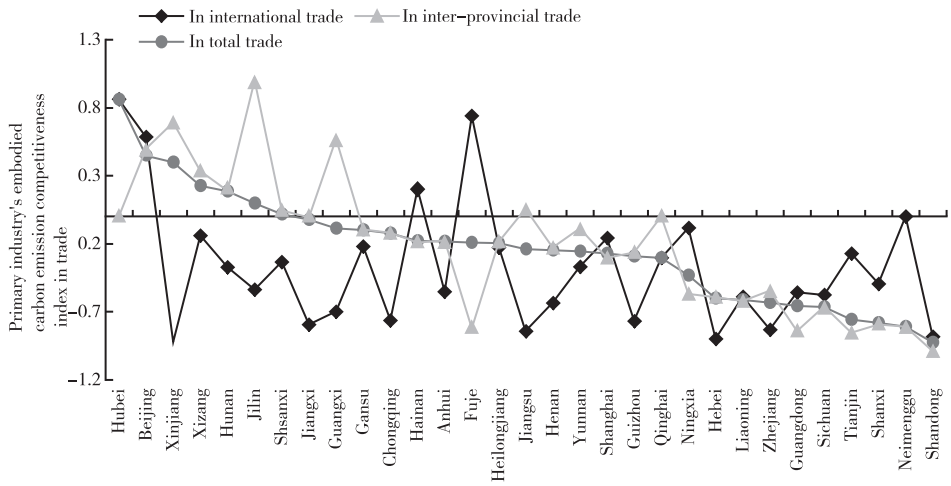


*Figure 2.* Embodied Carbon Emission Competitiveness Index in International Trade, Inter-Provincial Trade and Total Trade in the Primary Industry of 31 Chinese Provincial-Level Administrative Regions in 2012

Note: The sequence in the figure is by embodied carbon emission competitiveness index in total trade in the primary industry.

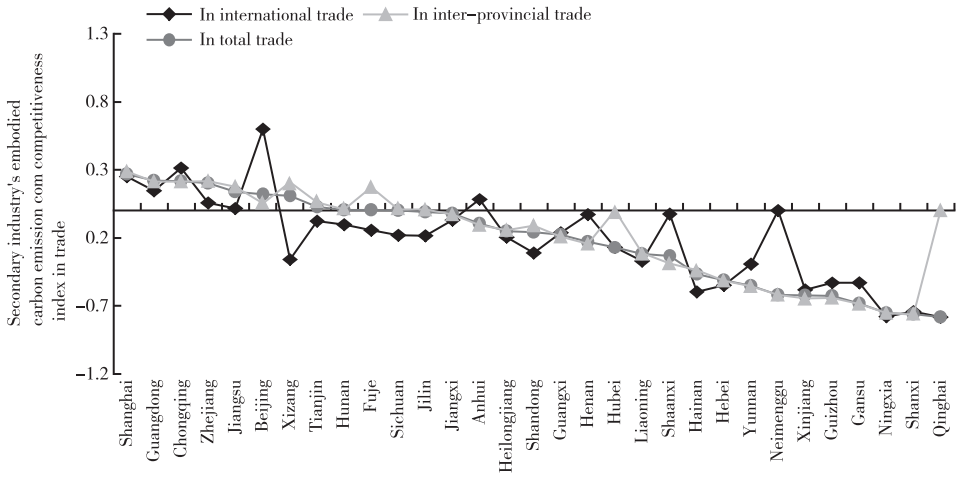


*Figure 3.* Embodied Carbon Emission Competitiveness Index in International Trade, Inter-Provincial Trade and Total Trade in the Secondary Industry of 31 Chinese Provincial-Level Administrative Regions in 2012

Note: The sequence in the figure is by embodied carbon emission competitiveness index in total trade in the secondary industry.

last three; for the index for general trade, it is lower than 0 in 21 of them, with Hubei and Qinghai ranking as the last two with an index between −1.0 and −0.8 and Tibet with an index of 0.8~1.0. Tibet enjoys high comparative advantage in embodied carbon emission competitiveness in trade in the tertiary industry mainly because its import and inflow from other provincial regions are relatively small and its industrial structure is incomplete. Besides, the 31 Chinese provincial-level administrative regions are relatively highly competitive in embodied carbon emission for international trade in the tertiary industry, but the competitive advantage is not distinct.

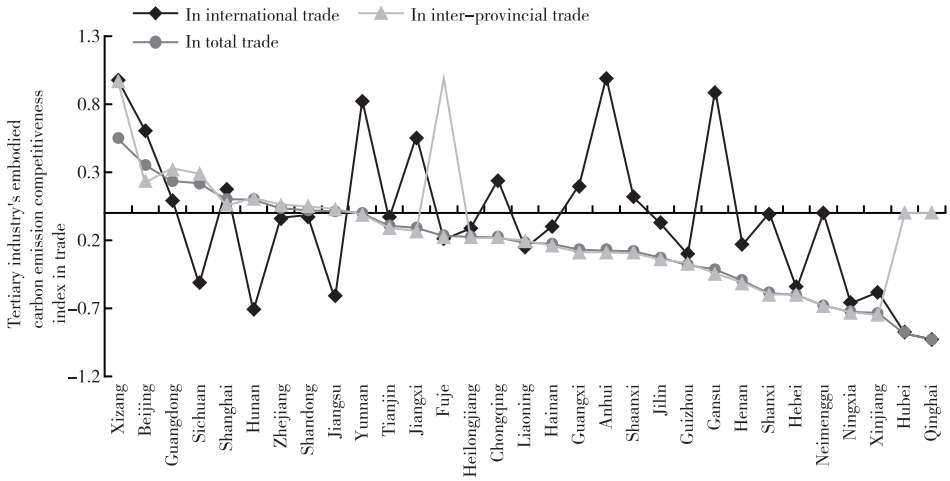


*Figure 4.* Embodied Carbon Emission Competitiveness Index in International Trade, Inter-Provincial Trade and Total Trade in the Tertiary Industry of 31 Chinese Provincial-Level Administrative Regions in 2012

Note: The sequence in the figure is by embodied carbon emission competitiveness index in total trade in the tertiary industry.

## 6. Conclusions

This paper measures the embodied carbon emission competitiveness index in international trade, inter-provincial trade and total trade of 31 Chinese provincial-level administrative regions from the perspectives of the whole, three industries and product sectors and draws the conclusions as follows. First, for embodied carbon emission competitiveness index in total trade, Shanghai ranks first, while Qinghai ranks last, and embodied carbon emission competitiveness in international trade of the 31 Chinese provinces is generally lower than that for inter-provincial trade. Besides, as international trade causes serious carbon leakage, embodied carbon emission

productivity in export is low. Second, various product sectors in the 31 provincial regions differ widely in embodied carbon emission competitiveness in international trade and inter-provincial trade. Some sectors enjoy certain comparative advantage, but the advantage is not obvious; for agriculture and mining, the competitiveness in international trade is lower than that for inter-provincial trade, but in manufacturing and services, the competitiveness for international trade is greater than that for inter-provincial trade. Third, the three industries in the 31 provincial regions have a wide gap in embodied carbon emission competitiveness in international trade and inter-provincial trade. The primary and secondary industries enjoy greater competitiveness in inter-provincial trade than that in international trade and inter-provincial trade helps promote carbon emission productivity in the primary industry to improve; the tertiary industry has greater competitiveness in international trade than that in inter-provincial trade, but the competitive advantage is not apparent.

## References

Greenaway, D., & Milner, C. (1993). *Trade and Industrial Policy in Developing Countries*. UK: Palgrave Macmillan.

Halicioglu, F. (2009). An Econometric Study of CO2 Emissions, Energy Consumption, Income and Foreign Trade in Turkey. *Energy Policy*, 37 (3), 1156-1164.

Jaffe, A., & Palmer, K. (1997). Environmental Regulations and Innovations: A Panel Study. *The Review of Economics and Statistics*, 79 (4), 610-619.

Kuik, O., & Hofkes, M. (2010). Border Adjustment for European Emissions Trading: Competitiveness and Carbon Leakage. *Energy Policy*, 38 (4), 1741-1748.

Porter, A., & Van der Linde, C. (1995). Towards a New Conception of the Environment Competitiveness Relationship. *Journal of Economics Perspectives*, 9, 97-118.

# Research on the Platform-Based Retail Business Model Innovation

Binbin Zheng*

With the rise of the platform economy, the retail industry is facing great pressure to shift from a traditional growth model to a platform-based growth model. The one-sided market theory applicable to the traditional business models cannot adequately explain business model innovation in the platform-based growth model. Based on a systematic analysis of the platform economy theory, business model innovation theory, value co-creation theory, and dynamic capability theory and in light of the characteristics of the retail industry, this paper proposes that to achieve platform-based growth, retail business model innovation should be focused on changing the ways to create customer value and capture enterprise value and leveraging modern information systems to achieve value co-creation during the transformation of key business processes ranging from procurement and sales to distribution. In addition, enterprises must get rid of the mindset of making profits from the difference between buying and selling prices and should instead explore new sources of revenue through linking dividend and information value. As platform operators, retail enterprises need to develop dynamic capabilities through the interaction of heterogeneous resources of various platform participants and especially the introduction of social resources, so as to propel innovation in retail business models and ultimately the transformation from traditional growth to platform-based growth.

**Keywords:** platform-based growth, business model, value co-creation, information value

## 1. Introduction

In the era of the network economy where all people and things are highly connected, traditional competition centered on product differentiation and individual enterprises has gradually evolved into platform competition (Tan *et al.*, 2015). In recent years, with the success of e-commerce platform enterprises such as Alibaba, JD.com, and Pinduoduo and the rise of new retail, smart retail, and unmanned retail

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featuring online-offline integration, the advantages of retail enterprises empowered by platforms have been gaining growing attention (Sridhar, 2011; Chao, 2015). Platform-based growth has become an effective way for traditional retail enterprises in China to upgrade their business models (Zhu, 2018). A "platform" is an economic organization designed to achieve benefits by promoting bilateral and multilateral users to conclude transactions (Eisenmann *et al*., 2006). The key issues, however, lie in how to move from traditional growth to platform-based growth and how to conduct business model innovation for the latter. Many retail enterprises face three challenges in this regard: first, in the internet age, how to shift from the traditional thinking of selling goods to the internet thinking of connecting users from all groups to achieve value synergy? second, how to move from the traditional functions of procurement and sales to platform governance, i.e., functions of managing the relationship among various participants and empowering all types of users? third, procurement, sales, and distribution are the key business processes of retail enterprises (Yahagi, 2011), so how can these key business processes be reformed to make new business models practicable for platform-based growth?

From an academic perspective, a business model articulates the logic, among other things, that demonstrates how a business creates and delivers value to customers while achieving its own value (Teece, 2007; Zott and Amit, 2010). Currently, a growing number of studies discuss business models from the angle of platform competition. Most of them point to two noticeable changes in business models against the backdrop of the platform economy: customer value creation has evolved from linear delivery to networked co-creation (Luo and Li, 2015), while enterprise value attainment has been gradually separated from the delivery of customer value, and instead a new source of revenue is required (Wang, 2011). Although the existing studies have transcended the traditional concept that enterprises are the sole creator of value while customers are purely the user of value (Normann and Ramirez, 1993), they mostly fixate on value co-creation under the enterprise customer relational duality paradigm in the context of service-dominant (S-D) logic (Vargo and Lusch, 2016). And there is little research on the co-existence of multiple players such as suppliers and customers in the retail industry and the value co-creation network encompassing bilateral interactions. Moreover, the existing research focuses on how enterprises and customers achieve value co-creation through resource interaction while giving little attention to how enterprises capture value. Some studies point out that with the rise of the "free" internet economy, enterprises must broaden their sources of revenue by restructuring product portfolios and user portfolios (Wang, 2011), but they disregard value creation by making full use of information, which is now an essential factor of production (Yang and Tao, 2015; Qi *et al*., 2017). Information is a valued and exclusive resource brought by platforms that connect all things, and the creation of information value is at the core of the shift of retail enterprises from the traditional thinking of operating physical

commodities to the internet thinking of operating commodity data (Yi, 2018).

While research on retail business model innovation has yielded fruitful results, platform-based growth has disrupted the value logic of business models. Therefore, the existing researches are insufficient to thoroughly answer the aforesaid questions, and there are still quite limited studies on retail business model innovation based on the transformation of growth models amidst the rise of the platform economy. Given that China's economy is in the critical period of shifting from old drivers of growth to new ones and enterprises are in urgent need of transformation and upgrading for new growth and aiming to fill in the theoretical gaps of the existing research, this paper examines platform innovation of retail business models and their path and mechanism during the transformation from traditional growth to platform-based growth, provides theoretical support for exploring circulation innovation in the context of the platform economy, and puts forward practical suggestions for retail enterprises on how to foster new drivers of growth.

## 2. Theoretical Basis

### *2.1. Platform Economy and Platform-Based Growth*

#### 2.1.1. Platform Economy

Platforms serve as intermediaries that connect two or more distinct groups of users and enable their direct interaction and are economic organizations with a structure of two-sided markets (Zhu and Furr, 2016). They can exist in both the real world and the virtual space (Tiwana, 2015; Xu, 2006). Modern information technologies represented by the internet, cloud computing, and big data have spurred the development of platforms, which have evolved from product platforms and industrial platforms to platform enterprises and then to platform ecosystems (Gao and Zhang, 2018).

As platform enterprises such as Apple, Microsoft, Google, Amazon, Facebook, Alibaba, JD.com, and Pinduoduo have sprung up in recent years, the platform economy, a brand-new economic growth model, has drawn extensive attention from the academic community, industry, government and other social sectors. Different from the one-sided market that is divided into buyers and sellers in the traditional economy, the platform economy is characterized by two-sided markets and network externalities. By connecting people to people and people to things, platforms efficiently bring together market demand and supply across time and space, making it easier for the supply side to identify, explore, and create market opportunities on the demand side, thus forming value synergy, lowering operating risks, and getting excess economic rent (Liu, 2015). Additionally, the scale of users on one side of a platform can impact the effectiveness of users on the other side. More connections and value interactions enable better match

between supply and demand on the platform and therefore generate more value. Such network effects will attract more participants (Zhu, 2018).

Modern information technologies such as the internet, Internet of Things (IoT), and big data are fully employed by platform enterprises. By connecting two-sided markets, platform operators systematically gather resources, facilitate transactions, and improve efficiency on a win-win basis to achieve network-based value creation and increase value for all parties involved, making them a dominant organizational form and a powerful engine of new economic growth in the mobile internet era.

### 2.1.2. Platform-Based Growth

In the platform economy, the competitiveness of enterprises no longer depend on a single product or technology, size, or brand but on the resource integration capabilities of their platforms and responsiveness to user needs (Li *et al*., 2013). The platform economy is shaking up the traditional organization of economic activities, reshaping the value chain, and transforming the logic of value creation and value distribution. Based on the platform economy theory, a platform-based growth model is defined as a new-type enterprise growth model where enterprises leverage modern information technologies and network externalities and platform operators empower all groups of users and promote them to close deals to achieve growth through network-based value-adding operations.

By integrating heterogeneous resources between supply and demand and promoting massive amounts of connections and value interactions between platform participants (e.g., buyers, sellers, complementors and so on), platform-based growth bolsters enterprise growth through network-based value creation. Therefore, to achieve platform-based growth, retail enterprises need to first change their logic of customer value creation. Platform-based growth emphasizes value co-creation among all parties within the value network. Unlike the existing linear value delivery method from the perspective of the value chain or value co-creation in the relational duality paradigm in the context of S-D logic (Vargo and Lusch, 2016), platform-based growth of retail enterprises is more focused on how retailers and suppliers together deliver "supply-side" value to customers, retailers and customers deliver "demand-side" value to suppliers, and suppliers and customers deliver "connection-side" value to retailers (Liu, 2015). The construction of a value co-creation network where any two of the three parties, namely retailers, customers, and suppliers, represent a duality has become the core of retail business model innovation from traditional growth to platform-based growth. Second, with the change of the value creation approaches, enterprise value attainment has been gradually separated from customer value creation and delivery. In the traditional growth model, enterprises provide products for customers while customers pay the corresponding fees for them, i.e., the two sides attain value through

product exchange. In the platform-based growth model, even if enterprises provide customers with high-quality products or services catering to their needs, they may not directly capture revenue from that. The free internet model is a case in point. In addition, previous research emphasizes customer value creation over enterprise value attainment. In practice, some seemingly perfect business models, instead of bringing in profits, can force enterprises to shut down after "burning a lot of money". Therefore, during retail business model innovation, it is necessary to analyze the mechanism of enterprise value attainment, reconstruct the value network, and open up new sources of revenue to achieve profitability and ensure the stability of business models (Wang, 2011).

The concept, characteristics, and strategic elements of platforms have been defined in the existing studies, which shed light on what a platform is and how to build one. However, there is still little systematic research on how traditional enterprises, especially retail enterprises, can transform themselves into platform enterprises, and even less research on the customer value creation mechanism and enterprise value attainment mechanism in platform-based business models.

### *2.2. Retail Business Model Innovation*

#### 2.2.1. Connotations

Driven by the advancements in science and technology, changes in the business environment, market opportunities, consumer behavior, and other factors, constant innovation is required for business models to accommodate to social development and maintain competitive advantage. Research on business model innovation, which is generally based on the transaction cost theory, resource-based theory, resource dependency theory, dynamic capability theory, social capital theory, and value chain theory, has yielded fruitful results, and representative studies include those by Morris *et al*. (2005), Osterwalder and Pigneur (2013), and Zott and Amit (2011). Karl Marx's theory of circulation points out from the holistic perspective of social reproduction and business capital division that the retail industry serves as a circulation intermediary that connects production and consumption, where retailers make profits by selling products or services directly to end consumers. This attribute determines the particularities of retail business models compared with others.

Purchasing goods from suppliers and selling them to consumers is the most traditional business model in the retail industry, as adopted by the earlier "traveling merchants" (peddlers), "sedentary merchants" (mom-and-pop grocery stores), and open-air markets (Li and Ren, 2018). Retailers purchase from various suppliers to develop diversified product portfolios to attract consumers. The combination of procurement and sale by retailers reduces the search costs on the supply side and the consumer side,

improves transaction efficiency, and helps lower social circulation costs.

As commerce further evolved, the shift in the retail business model from single-store operations to chain store operations has broken the limits of business districts and connected a wide range of consumers through multiple stores and the store network to achieve business growth. Modern business models such as supermarkets, convenience stores, and specialty stores fall within this category. The aggregation of market demand in chain store operations can help enterprises achieve economies of scale, improve bargaining power, reduce procurement costs, and gain competitive advantage through reform of centralized procurement business processes. This represents an important business model innovation in chain store operations. However, centralized procurement and scattered store sales have given rise to time and space gaps between procurement and sale. In order to ensure the availability of the right products in sufficient stock when the customers demand them, an important topic in retail business model innovation for chain stores is how to build an efficient commodity distribution system. With the advances in information technology, chain enterprises have invested heavily in the construction of information systems, POS deployment in stores, and real-time sharing of information between stores and the headquarters. Based on information systems, retail enterprises have established high-frequency and small-batch logistics and distribution systems to achieve rapid iteration of in-store products and reduce inventory risk (Zheng, 2018). The application of information systems by chain enterprises introduce information technology system to strengthen business management business management, propelling the rapid development of chain business models and supply chain management.

Procurement, sales, and distribution are key business links in the modern retail business model. Procurement includes the purchasing activities from manufacturer brands, as well as the development of private brand products and imports from overseas. Correspondingly, distribution covers the primary logistics of products carrying manufacturer brands from the production stage to the distribution centers of retail enterprises, secondary logistics from distribution centers to stores, logistics from raw materials procurement for private brand products to production, as well as sorting, reprocessing, and other functions performed by distribution centers. Stores sell products through well-thought decorations and layout, suitable prices, and a variety of promotional activities.

The connotations of procurement, sales, and distribution vary by the value created by enterprises for customers. For instance, Walmart provides customer value with the "everyday low prices" marketing strategy and has achieved business model innovation featuring low-cost procurement and distribution by improving the efficiency of logistics and distribution and underpinning the construction of information systems (Li and Wang, 2006). Aeon, another well-known supermarket brand, puts customer experience at the core of its marketing strategy, provides customers with products of unique value

and excellent quality and has achieved business model innovation by enhancing the capability of its commodity department to develop private brand products (Zheng, 2018). In order to provide customers with the convenience of instant consumption, the convenience store giant 7-Eleven has established dedicated plants, set up a product development team and shared distribution system, built a high-frequency and small-batch logistics and distribution system, and accelerated the iteration of in-store goods to achieve business model innovation (Zheng, 2018). Based on the changes in the market landscape and their unique values and leveraging information technology, retail enterprises continuously adjust key business processes such as procurement, sale, and distribution to bring about new business models and provide consumers with valuable products or services to increase sales and revenue. The general framework of a retail business model is illustrated in Figure 1 below.

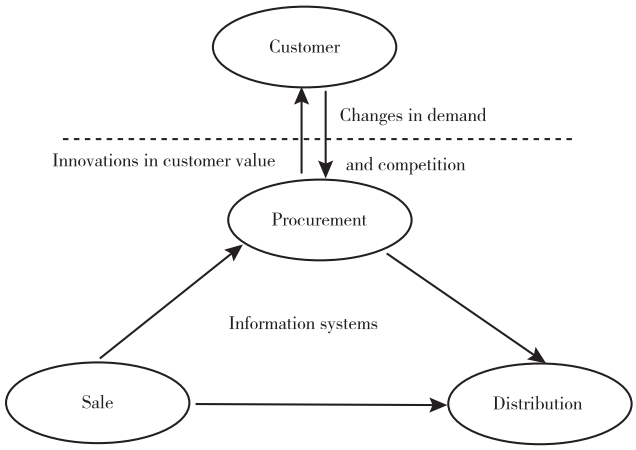


*Figure 1*. General Framework of a Retail Business Model

Source: drawn by the author.

### 2.2.2. Value Co-Creation of Retail Enterprises in the Platform Economy

With the rise of the internet in recent years, traditional retail business models have been severely challenged by online models (Sheng and Wu, 2010). Online retail has been favored by consumers since it transcends the restrictions of time and space and offers countless product varieties. Since 2016, new concepts such as new retail, smart retail, and unmanned retail have emerged, blazing a new trail of innovation powered by online and offline integration. The advances in information technology, digital transformation of the technological foundation of the retail industry, changes in consumer behavior, and data resources are the main driving forces of retail business model innovation in the internet era (Qi *et al*., 2017).

In the internet era, the retail industry has become borderless, gapless, and

encompassing (Qi *et al*., 2017). Integrating the resources of various retail entities represented by suppliers and building a value network for value co-creation has become an important way of innovation for retail enterprises. Although the existing literature has analyzed business model innovation from different perspectives and scenarios, the emphasis on customer value, transformation from unidirectional value creation to value co-creation, and shift from value chain creation logic to value network co-creation logic are the consensus among current business model innovation studies (Gummesson and Mele, 2010).

Business model innovation in the context of the value chain creation logic is mainly based on unidirectional value provision, emphasizing effective control and acquisition of resources (Hallen *et al*., 2014; Jensen *et al*., 2016). This is the main value creation method in the traditional growth model, where the monotony, scarcity, and homogeneity of commodity resources in parallel with the intensified competition constitute the main bottlenecks to the development of enterprises. Therefore, to underpin the ability to acquire commodity resources has become the main direction of retail business model innovation. As can be seen in Figure 2, retailers collaborate with and integrate the resources of suppliers or manufacturers, carry out product and service innovation based on market demand, guide suppliers or manufacturers to produce and provide products that meet market demand, and sell products and services to customers through their vast network of channels to achieve customer value creation and delivery (Yan, 2015). The purpose of business model innovation is to improve the value chain management capability of retailers. Products or services provided by suppliers act as the carriers of value creation, and retailers serve as the key nodes to achieve value exchange of products or services. In this case, production and consumption are two independent processes and only interact in market exchange. However, because of the communication and interaction with customers and the restrictions of market information asymmetry on the product development, production, and design capabilities of suppliers, such product-oriented business model innovation can hardly increase customer stickiness and results in new forms of homogeneous competition.

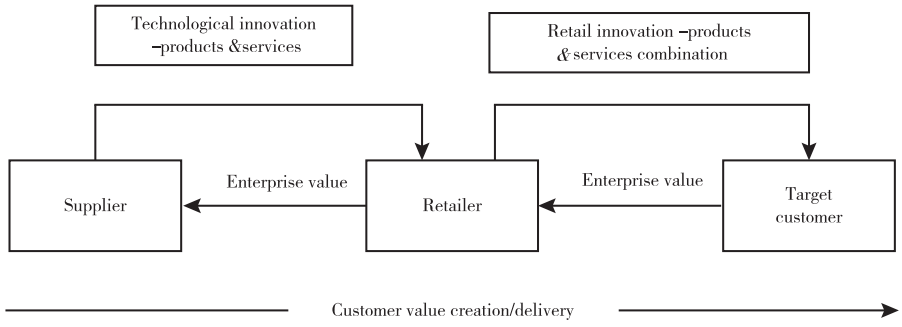

*Figure 2*. Unidirectional Value Creation Process

Source: drawn by the author.

With the advent of the internet era, the logic of value creation has seen dramatic changes. The internet has transcended the limitations of time and space for transactions, sped up transactions, reduced intermediate processes, and connected people to people and people to things. The value creation theory has shifted from the traditional linear value chain thinking to the complex and dynamic value network thinking; business model innovation under the network-based value co-creation logic highlights value co-creation, with a focus on two-way interactions and cross-sectoral integration (Liu, 2015). The platform business model is a typical example of value co-creation.

Value co-creation is a dynamic process in which all actors co-create value through information interaction and resource integration (Payne *et al*., 2008). From the service-dominant viewpoint, value is jointly created by the enterprise and the customer, and value co-creation is premised on the enterprise-customer relationship (Vargo and Lusch, 2008). By contrast, in the platform business model, a retail platform brings together suppliers, consumers, and complementors, among others; individual enterprises are no longer the sole value creator; all parties are connected through the platform, and the interactions between retailers and customers, suppliers and customers, retailers and suppliers, and retailers and complementors have enabled various actors in the value network to co-create social value through many-to-many relationships (Jian *et al*., 2016). All parties go beyond the duality of competition and cooperation and co-create value in information interaction, where the production and consumption processes are integrated rather than independent of each other. As a platform operator, a retailer no longer simply performs a role in value transfer and exchange; instead, it integrates resources from various sectors, empowers all parties, and extends the value-added effect to the entire network. Such a shift in functions poses new challenges for retail business model innovation during the transformation from traditional growth to platform-based growth.

### *2.3. Dynamic Capabilities*

Dynamic capabilities are an enterprise ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece, 2007). In the turbulent and unpredictable market environment, dynamic capabilities enable enterprises to promote organizational change and achieve strategic transformation through the reconfiguration of resources. Whether a retail enterprise can successfully move from traditional growth to platform-based growth ultimately depends on its dynamic capabilities and path dependence (Liu, 2015).

Teece (2007) asserts that dynamic capabilities can be grouped into three categories

of activities: perception, acquisition and transformation. Hao *et al*. (2013) believe that dynamic capabilities includes the ability to identify the environment, the ability to integrate and reconfigure resources, and flexible organization and technology, etc. Wang and Ahmed (2007) classify dynamic capabilities into adaptive capability, absorptive capability, and innovative capability. Luo and Li (2015) categorize dynamic capabilities into market-oriented perception capability, social networking capability, organization and learning absorption capability, and communication, coordination, and integration capability. In fact, dynamic capabilities are composed of various elements, and their connotations often vary by the development needs of different enterprises.

The existing research finds that dynamic capabilities can promote transformation of enterprises and enable them to gain competitive advantage, but the processes and mechanisms vary widely in varying environments. For example, in the e-commerce market, enterprises need to develop dynamic capabilities in response to the continued involvement of external stakeholders to promote enterprise value creation (Koch, 2010). As for restructuring and gradual supply chain transformation, resource integration and reconfiguration methods determine different dynamic capabilities, leading to path differences (Xiao *et al*., 2015).

A platform business model empowers growth by connecting different groups of users and through value interactions. It is a co-creational organization that engages consumers and multi-stakeholders, and its value comes from resource interactions between multiple participants (Ramaswamy and Ozcan, 2015). Therefore, in the process of transformation towards platform-based growth, the formation of dynamic capabilities not only highlights resource interactions between enterprises and consumers but also involves interactions with other stakeholders. Nonetheless, there is still little in-depth discussion in the existing research on how various actors interact with resources and how dynamic capabilities promote the formation of platforms.

With the advent of the internet era, innovative retail business models have cropped up, such as new retail, smart retail, digital retail, and unmanned retail. Current studies are gradually shifting their focus from the traditional growth model based on the value chain creation logic to the platform-based growth model based on the network-based value co-creation logic, and have addressed the important role of dynamic capabilities in business model innovation. In general, scholars around the world have systematically discussed the issues regarding business models, promoting the development of this research area. However, the existing literature provides no systematic answers to such questions as how the key processes of procurement, sale, and distribution in platform business models can be reformed to achieve customer value co-creation, and how enterprises can acquire value to achieve sustainable development given the separation of customer value creation and delivery and enterprise value attainment. Therefore, starting from the transformation

of key processes, this paper discusses the general theoretical framework including the path and mechanism of retail business model innovation from traditional growth to platform-based growth and is of practical significance to enable enterprises to embrace the platform economy and help foster new drivers of economic growth.

## 3. Characteristics of Platform-Based Retail Business Model Innovation

### *3.1. Changes in Customer Value Creation*

#### 3.1.1. Procurement

In the platform-based growth model, it is an inevitable trend for retail business models to shift from unidirectional value creation to network-based value co-creation. If traditional buyers continue to purchase goods based on personal experience, preferences, or sales data, they will find it difficult adapting to the rapidly changing consumer needs and the platform model. When a retail enterprises transitions toward platform-based growth, it needs to attract various user groups such as suppliers and customers while engaging complementors and the cross-sectoral supply chain to promote information interaction and value sharing among the participants.

A traditional e-commerce platform is a third-party access system designed to achieve benefits by facilitating transactions between different users (Eisenmann and Parker, 2006). Unlike traditional e-commerce platforms, the platform business model emphasizes value co-creation among all parties in the value network as the retail industry is shifting to platform-based growth. Retailers and customers create value together. After obtaining revenue from direct transactions with the customers, the platform operator needs to promote value creation and direct transactions between the supplier and the customer and value co-creation between the retailer and the suppliers aimed at meeting customer needs. As the value creation method changes, the relationships between retailers, suppliers, and customers become more complicated. They together form a value co-creation network where any two of them interact with each other. Through value co-creation, they connect product information and complete business processes such as procurement and product development. Therefore, in terms of value co-creation and retail business model innovation, the interests and resources of different platform participants should be integrated and properly coordinated in order to achieve the value-added effect for the platform.

#### 3.1.2. Sales

In the traditional growth model, retail enterprises attract consumers to their stores with convenient locations, inviting decorations and in-store layout, diversified product

portfolios, and various promotional activities in order to deliver value and obtain sales revenue, and retail spaces act as an isolating mechanism that prevents the loss of consumers. With the development of digital technologies, however, online and offline shopping channels become increasingly diversified, and stores are no longer the only node for value transfer. Even if consumers are attracted to a store, there will not necessarily be transactions as consumers can compare prices and place orders online, which actually results in a loss of consumers for the physical store. Therefore, customer guidance and closed-loop management has become an important issue in sale innovation in the platform business model.

Physical stores, as the unique resources of brick-and-mortar retailers, should be fully utilized. The aesthetic design of store space can provide consumers a good shopping experience and increase the value of goods, while the creation of commercial space can play a complementary role in connecting customers. For example, Daikanyama T-Site has gone far beyond a bookstore that sells nothing but books. By making use of the physical space and adopting innovative business models, it has become a place where people can buy or read books, drink coffee and socialize. Alibaba's Hema supermarket and YH Super Species, which focus on "high-quality shopping experience + on-site services + convenient delivery", represent business model innovation that combines physical stores and mobile apps. How to fully tap into the value of store space, develop a multi-screen connection model, and prevent customer loss is a vital part of closed-loop customer management in the platform business model.

### 3.1.3. Distribution

In the traditional growth model, logistics mainly refers to the distribution from logistics centers to stores. The function of logistics is to replenish store inventory in a timely manner, accelerate the iteration of in-store goods, and achieve a balance between reducing inventory risks and losing sale opportunities due to shortages. In the platform-based growth model, consumers can place orders online or offline, pick up their goods themselves, or have them delivered to the doorstep. A new type of distribution system that encompasses distribution from logistics centers to stores, logistics centers to customers, logistics centers to suppliers, and stores to customers should be established. To meet the diverse needs of different distribution entities, the logistics systems are becoming more complicated. For example, the distribution from logistics centers to stores requires sales prediction and inventory management based on the zero inventory thinking in a bid to reduce logistics costs and improve logistics accuracy. For consumers, logistics is needed for online and offline integration in order to meet personalized and fragmented needs through targeted and fast experiential services. For logistics enterprises, they need to efficiently integrate logistics resources based on whole-chain big data to shift towards intelligent logistics. Retail

enterprises can expand their own logistics networks or build logistics stations based on information systems and empower logistics to make it more intelligent and automated by using real-time data and data technologies (Han and Wang, 2018). Although self-built logistics systems can reduce marginal costs and increase the marginal benefits, they require continuous inputs. For example, JD Logistics has been stuck in an awkward situation of chronic losses. Therefore, the construction of logistics systems needs to fully utilize social logistics systems and integrate with social logistics resources through the connection to platform operators.

### *3.2. Changes in Enterprise Profit Model*

#### 3.2.1. Linkage Dividend

In the traditional growth model, retailers purchase goods in bulk to reduce costs goods and improve operating efficiency, and make profits through the difference in prices. However, in the platform-based growth model, consumers pursue unique products to express their individuality. In this case, traditional mass production can no longer meet consumer demands. Moreover, the countless varieties of products on the internet and transparent prices make it increasingly difficult for retailers to make profits from commodity sales. Wang (2011) proposes that in the face of the free economy trend enabled by the internet, enterprises need to restructure their value network and explore new sources of revenue to achieve profitability and ensure the stability of business models.

Retail enterprises, as platform operators, connect suppliers, complementors, and customers and thus dig into in-depth consumer needs to provide consumers a better experience during interaction and increase the value of products for consumers. By connecting multiple heterogeneous resources, they can satisfy long-tail needs and improve the efficiency of matching and sharing of resources, so that the platform can achieve network-based added value and all participants can get more value. Therefore, business models in the internet era pursue linkage dividend (Luo and Li, 2015).

Linkage dividend refers to a situation where retail enterprises, instead of directly selling products to make money or focusing on pursuing sale dividends, take their products as an entrance to attract customers and create continuous value for consumers through value synergy and interaction to get revenue (Luo and Li, 2015). For example, by linking Taobao customers with its financial platform and attracting scattered deposits, Alibaba has leapfrogged in financial innovation and obtained financial benefits from massive amounts of deposits. The innovation of platform-based retail business models needs to depend on various participants linked through the platform and the platform's advantage in heterogeneous resources to achieve value, rather than simply pursue the spread between buying and selling products.

### 3.2.2. Information Value

Yang and Tao (2015) point out that the value co-creation logic in the internet era just regards information as an element supporting the value creation process rather than truly gives weight to and uses information as an important production factor or tries to use information itself to create new value. Sviokla and Rayport (1995) propose to create value through the collection, organization, selection, aggregation, and distribution of information.

Retail is one of the industries where big data is most widely used, but it is also among the industries that face greatest difficulty in big data application. The retail industry collects an enormous amount of membership data, sales data, customer shopping history, logistics data, and service data through modern information technologies, and the amount of data has continued to grow rapidly (Li and Ren, 2018). On the basis of data collection and analysis, the retail industry has gradually achieved digital transformation in terms of customer behavior, goods, services, marketing, supply chain, and decision making. Retail big data has become an important operating resource, which comes from a wide range of data sources including both online and offline channels and in different types such as structured and unstructured data. How to transform these big data into valuable information is the key to the attainment of enterprises value. On the basis of introducing POS information systems, 7-Eleven strengthens the management of individual products based on real-time data such as customer groups, time periods, and climate change to detect hot and slow-selling products as early as possible and then, through its effective logistics and distribution system, continuously brings in popular products while getting rid of slow-selling products in an effort to adjust the product structure and improve the turnover rate of products. In addition, through real-time analysis of sales data via POS, it cooperates with first-class factories, famous chefs, and well-known brands to develop high-quality private brand products with high added value, which greatly enhances its competitiveness (Zheng, 2018). It can be seen that 7-Eleven has successfully transformed big data into valuable information that helps it improve its competitiveness through the collection, organization, selection, aggregation, and distribution of big data.

At present, only a small amount of data has been utilized by physical retailers, while the majority of data stays untapped in China. There is no specific method for how to translate large amounts of data into information support for business decision-making; instead, business decisions are often made based on experience and feelings, which may lead to decision bias, weakening the competitive edges (Li and Ren, 2018). When establishing an integrated data processing system, the retail industry should work out a complete set of data collection, analysis, and application solutions, standardize the processing of commodity data and business data, construct a data analysis model, and

improve the effects of data collection, analysis and application through continuous trial and error to turn it into valuable information.

In the platform-based growth model, retail enterprises should attach importance to the value of information itself. The data collected via each node needs to be analyzed to make it valuable information to empower various users on the platform and achieve the value-added effect. How to organize, select, aggregate, and distribute information to create value is an urgent issue to solve in retail business model innovation.

### *3.3. Establishment of Information Systems*

The information system is the infrastructure of retail business models, where data technology is the core, and big data, cloud computing, and other next-generation technologies are the important underpinnings for business model innovation. The collection, analysis, and processing of massive amounts of data to turn it into valuable information depends on the establishment of information systems. Information technology capabilities are the foundation for the construction and development of multilateral platforms (Tan *et al.*, 2015), since the subject of platform-based growth is no longer an individual enterprise but an ecosystem of various stakeholders. To put it in another way, information technology capabilities are the basis for promoting value co-creation among platform participants.

Information systems provide important information support for decision-making during the business processes of procurement, sales, and distribution and are the guarantee for the effective implementation of these processes. For example, Daimaru, a Japanese department store chain, invested 500 million yen in 2002 to upgrade 2000 POS devices and introduce single-item management software that can collect highly segmented data by stores and style, greatly improving its data analysis capabilities (Yahagi, 2011).

As the initial investments in information systems are often enormous, enterprises need to consider which systems they should invest in themselves or can be constructed through collaboration, so as to empower all platform participants to create value and reduce the access costs for key members while raising their platform switch costs, thereby attracting and retaining key members (Wang, 2015). For example, after Alibaba became a shareholder, department store chain Intime connected to the internet giant's information system and quickly completed digital transformation of product management, membership management, and supply chain management, reducing the time and costs for information system construction and improving operating efficiency.

### *3.4. Development of Dynamic Capabilities*

Dynamic capabilities play a pivotal role in business model transformation from

traditional growth to platform-based growth organization. The dynamic capabilities of the retail industry mainly include procurement capabilities, sales capabilities, and logistics and distribution capabilities and can also be divided into logistics and store inventory coordination capabilities, store operation capabilities, collaboration capabilities with suppliers, individual product management capabilities, and capabilities for cross-sectoral cooperation in private brand commodities (Yahagi, 2011).

The retail business processes, in which retail enterprises translate organizational and individual knowledge and experience into business operations, are a summary of the past business knowledge and a concrete manifestation of an enterprise's dynamic capabilities (Yahagi, 2011). First, dynamic capabilities are developed during the process of continuous trial and error. Second, compared with traditional business environments, consumers serve as important value co-creators in the platform business model (Erdem *et al*., 2016). Consumer involvement has become an important factor in the development of dynamic capabilities for enterprises, and the synergy between enterprise and consumer resources has propelled the transformation of internet organizations. Capturing, adapting to, and guiding consumer changes can boost collaborative dynamic capabilities between enterprises and consumers (Xiao *et al*., 2015). Finally, a platform is a co-creational organization that engages consumers and multi-stakeholders, and its value comes from resource interactions between multiple participants (Ramaswamy and Ozcan, 2015). The development of dynamic capabilities not only emphasizes resource interaction between enterprises and consumers but also involves interaction with other stakeholders such as suppliers. Therefore, platforms should fully promote resource interaction among all participants to cultivate dynamic capabilities, so as to accomplish their business model innovation.

## 4. A General Theoretical Framework for Retail Business Model Innovation

With the rise of the platform economy, the innovation of retail business models and related theories in one-sided markets no longer work in two-sided markets because of platform-based growth. On the basis of the platform economy theory, value co-creation theory, and dynamic capabilities theory, this paper comprehensively analyzes the changes in the way customers create value, shift in enterprise profit models, and model innovation driven by dynamic capabilities during the transformation of retail enterprises from traditional growth to platform-based growth. In view of this, a general theoretical framework for retail business model innovation is constructed, as shown in Figure 3.

Specifically, customer value is co-created by platform members, which has changed the procurement and product development methods. A retailer's platform consists of a physical store and an online platform. It attracts customers to the store and improves their shopping experience through store layout and achieves closed-loop customer

management online. In terms of the enterprise profit model, the retailer attains its enterprise value from linkage dividend and information value and needs to get rid of the traditional mindset of making profits from the spread between buying and selling prices. Dynamic capabilities, as the guarantee of business model innovation, are developed through business operations, inter-organizational learning, knowledge sharing, and resource interactions, which form mutually reinforcing relationships. In short, to achieve platform-based growth, the key no longer lies in how much resources an enterprise acquires or controls but how to integrate social resources, supplier resources, and complementary resources.

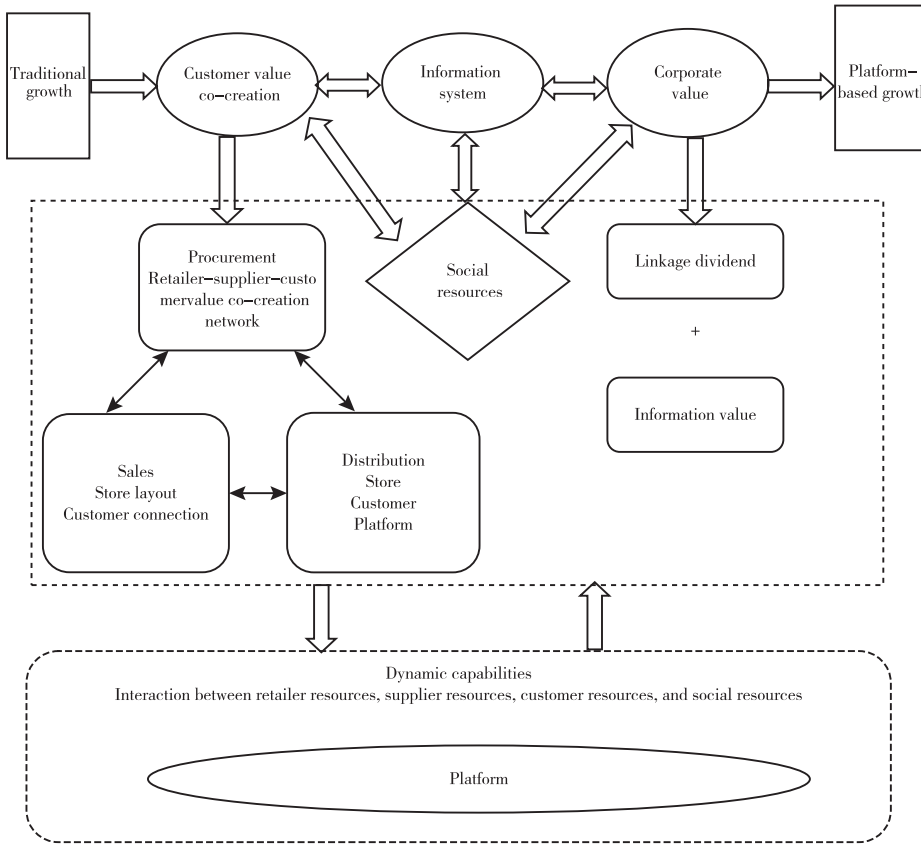


*Figure 3*. Theoretical Framework of Platform-Based Retail Business Model Innovation
Source: drawn by the author.

## 5. Conclusion

In the platform economy, the retail industry is facing great pressure to shift from

a traditional growth model to a platform-based growth model. The one-sided market theory applicable to the traditional business models cannot adequately explain business model innovation in the platform-based growth model. Based on a systematic analysis of the platform economy theory, business model innovation theory, value co-creation theory, and dynamic capabilities theory and in light of the characteristics of the retail industry, this paper proposes that to achieve platform-based growth, innovation in retail business models should be focused on changing the ways to create customer value methods and capture enterprise value and leveraging modern information systems to achieve value co-creation during the transformation of key business processes ranging from procurement and sales to distribution. In addition, enterprises must get rid of the mindset of making profits from the spread between buying and selling prices and explore new sources of revenue by linkage dividends and information value. As platform operators, retail enterprises need to develop dynamic capabilities through the interaction of heterogeneous resources of various platform participants and especially the introduction of social resources, so as to propel innovation in retail business models and ultimately the transformation from traditional growth to platform-based growth. Finally, a general theoretical framework for retail business model innovation is constructed, laying a theoretical foundation for future business model innovation. Plus, this theoretical framework can be used to analyze more cases so as to discover the general law and internal mechanism of retail business model innovation towards platform-based growth.

## References

Eisenmann, T., Parker, G., & Van, A. (2006). Strategies for Two-Sided Markets. *Harvard Business Review*, 43 (2), 92-101.

Erdem, T., Keller, K. L., Kuksov, D., & Pieters, R. (2016). Understanding Branding in a Digitally Empowered World. *International Journal of Research in Marketing*, 33 (1), 3-10.

Gao, L., & Zhang, Y. (2018). Evolution and Implications of Platform Theory. *Forum on Science and Technology in China* (*Zhongguo Keji Luntan*), 1, 123-131.

Gummesson, E., & Mele, C. (2010). Marketing as Value Co-Creation Through Network Interaction and Resource Integration. *Journal of Business Marketing Management*, 4 (1), 181-198.

Hallen, B., Katila, R., & Rosenberger, J. (2014). How Do Social Defenses Work? A Resource Dependence Lens on Technology Ventures, Venture Capital Investors, and Corporate Relationships. *Academy of Management Journal*, 57 (4), 1078-1101.

Han, C., & Wang, B. (2018). Research Status and Trend of New Retail. *China Business*

*and Market* (*Zhongguo Liutong Jingji*), 32 (12), 20-30.

Hao, J., Alon, I., Chun, K., & Yu, C. (2013). When Should Organizational Change Be Implemented? The Moderating Effect of Environmental Dynamism Between Dynamic Capabilities and New Venture Performance. *Journal of Engineering & Technology Management*, 30 (2), 188-205.

Jensen, J., Cobbs, J., & Turner, B. (2016). Evaluating Sponsorship Through the Lens of the Resource—Based View: The Potential for Sustained Competitive Advantage. *Business Horizons*, 59 (2), 163-173.

Jian, Z., Linghu, K., & Li, (2016). Evolution and Prospects of Value Co-Creation Research: A Perspective from Customer Experience to Service Ecosystems. *Foreign Economy & Management* (*Waiguo Jingji YuGuanli*), 38 (09), 3-20.

Koch, H. (2010). Developing Dynamic Capabilities in Electronic Marketplaces: A Cross-Case Study. *Journal of Strategic Information Systems*, 19 (1), 28-38.

Li, F., & Wang, X. (2006). Study on the Formation Mechanism of Retailers' Competitive Advantage. *China Soft Science* (*Zhongguo Ruankexue*), 6, 129-137.

Li, F., Ren, Y., & Heng, L. (2018). Motivation of Formation in Retail Revolution: From the Perspective of Technology Revolution. *Technology Economics* (*Jishu Jingji*), 37 (9), 25-35.

Li, Y., Liu, H., & Huang, S. (2013). Trends of Platform Economy Research. *Economic Perspectives* (*Jingjixue Dongtai*), 7, 123-129.

Liu, J. (2015). Dual Model of Corporate Growth: Platform for Growth and Its Internal Mechanism. *China Industrial Economics* (*Zhongguo Gongye Jingji*), 6, 148-160.

Luo, Y., & Li, L. (2015). Business Model Innovation in Internet Era: From the Perspective of Value Creation. *China Industrial Economics* (*Zhongguo Gongye Jingji*), 1, 95-107.

Morris, M., Schindehutte, M., & Allenc, J. (2005). The Entrepreneur's Business Model: Toward a Unified Perspective. *Journal of Business Research*, 58 (6), 726-735.

Normann, R., & Ramirez, R. (1993). From Value Chain to Value Constellation: Designing Interactive Strategy. *Harvard Business Review*, 71 (4), 65-77.

Osterwalder, A., & Pigneur, Y. (2013). Designing Business Models and Similar Strategic Objects: The Contribution of IS. *Journal of the Association for Information Systems*, 14, 237-244.

Payne, A., Storbacka, K., & Frow P. (2008). Managing the Co-Creation of Value. *Journal of the Academy of Marketing Science*, 36 (1), 83-96.

Qi, Y., Si, Y., & Wu, L. (2017). Research on Business Model Innovation in Retail Industry Against the Backdrop of Digital Technology Revolution. *Management World* (*Guanli Shijie*), 12, 182-183.

Ramaswamy, V., & Ozcan, K. (2015). Brand Value Co-Creation in a Digitalized World: An Integrative Framework and Research Implications. *International Journal of*

*Research in Marketing*, 33 (1), 93-106.

Sheng,Y., & Wu, B. (2010). Business Model Literature Review and Retail Business Model. *Commercial Research* (*Shangye Yanjiu*), 6, 40-43.

Sridhar, S. (2011). Dynamic Marketing Budgeting for Platform Firms: Theory, Evidence, and Application. *Journal of Marketing Research*, 48 (6), 929-943.

Sviokla, J., & Rayport, J. (1995). Exploiting the Value Chain. *Harvard Business Review*, 73 (11-12), 75-85.

Tan, B., Pan, S. L., Lu, X., & Huang, L. (2015). The Role of Is Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba. com. *Journal of the Association for Information Systems*, 16 (4), 248-280.

Teece, D. (2007). Explicating Dynamic Capabilities: The Nature and Microfoundations of Sustainable Enterprise Performance. *Strategic Management Journal*, 28 (13), 1319-1350.

Tiwana, A. (2015). Evolutionary Competition in Platform Ecosystems. *Information Systems Research*, 26 (2), 266-281.

Vargo, S., & Lusch R. (2016). Institutions and Axioms: An Extension and Update of Service-Dominant Logic. *Journal of the Academy of Marketing Science*, 44 (1), 5-23.

Vargo, S., & Lusch, R. (2008). Service-Dominant Logic: Continuing the Evolution. *Journal of the Academy of Marketing Science*, 36 (1), 1-10.

Wang, C., & Ahmed P. (2007). Dynamic Capabilities: A Review and Research Agenda. *International Journal of Management Reviews*, 9 (1), 31-51.

Wang, Q. (2011). Business Model Innovation Based on Value Network Reconstruction. *China Industrial Economics* (*Zhongguo Gongye Jingji*), 1, 79-88.

Wang, Q. (2015). Analysis of Agricultural Product Circulation Model from the Platform Perspective. *Journal of Jilin Business and Technology College* (*Jinlin Gongshang Xueyuan Xuebao*), 31 (3), 47-50 + 101.

Xiao, J., Xie, K., Wu, Y., & Liao, X. (2015). Transformation from Partner-Oriented to Consumer-Oriented Supply Chain: Case Study on Supply Chain of E-Commerce Enterprises. *Management World* (*Guanli Shijie*), 4, 137-154 + 188.

Xu, J., & Zhang, X. (2006). Study on Platform Economics. *China Industrial Economics* (*Zhongguo Gongye Jingji*), 5, 40-47.

Yahagi, T. (2011). *The Core Competencies of Japanese Excellent Retail Companies*. Tokyo: Nikkei Publishing Inc., 12-30.

Yan, G. (2015). Integrated Merchants and Platform Merchants: Two Main Directions of Innovation and Transformation of Circulation Enterprises. *China Business and Market* (*Zhongguo Liutong Jingji*), 29 (5), 68-73.

Yang, X., & Tao, X. (2015). Research on Value Co-Creation Against the Backdrop of Social Commerce: From the Perspective of Flexible Value Network. *Management World* (*Guanli Shijie*), 8, 170-171.

Yi, S. (2018). New Retail: Challenges and Proposals. *China Development Observation* (*Zhongguo Fazhan Guancha*), 16, 32-34.

Zheng, B. (2018). Mechanism of Building Long-Term Competitive Advantage: A Case Study of 7-Eleven. *Journal of Commercial Economics* (*Shangye Jingji Yanjiu*), 3, 133-136.

Zhu, F., & Furr, N. (2016). Products to Platforms: Making the Leap. *Harvard Business Review*, 94 (4), 74-78.

Zhu, L., He, J., & Huang, H. (2018). Formation and Evolution Mechanism of internet Platform: A Case Study of HSTYLE. *Journal of Management Case Studies* (*Guanli Anli Yanjiu & Pinglun*),11 (02): 163-180.

Zott, C., & Amit, R. (2010). Designing Your Future Business Model: An Activity System Perspective. *Long Range Planning*, 43 (2/3), 216-226.

Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, 1 (38), 375-414.