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The Coupling Coordination Relationship between Urban Economic Upgrading and Labor Employment Based on GTAP Model

Hongyi Sun

University of Southern California, Marshall School of Business – 3551 University Ave, Los Angeles, CA 90089, United States

Email: hongyisun2023@163.com

Abstract

In order to investigate the coupling coordination relationship between urban economic upgrading and labor employment, a computational model based on GTAP is proposed in the research. The main content is that based on the basic principle of GTAP model, the sum calculation of regions and departments is selected, the time cost is introduced into the GTAP model, the relevant research on the employment of labor population is conducted, and the results such as the impact of labor quality improvement on China's industry is finally obtained. The experimental results show that, based on the calculation of GTAP model, the decrease of unskilled labor force and the increase of skilled labor force will lead to the decrease of the output of unskilled intensive industry by 0.80%, the increase of the output of skilled labor intensive industry by 0.24%, and the increase of the output of capital intensive industry and service industry by 0.29% and 0.20% respectively. But the output of agriculture, food processing and mineral resources decrease by 0.71%, 0.53% and 0.29 %, respectively. It is concluded that the GTAP model proposed in the research has high prediction accuracy and

high feasibility for the coupling coordination relationship between urban economic upgrading and employment of labor population.

Keywords: GTAP model; urban economic upgrading; employment of labor population; skilled labor force

1. Introduction

Under the current complex macroeconomic situation and the increasingly fierce competition in regional development, the challenges faced in the development of urban agglomerations continue to increase. For a long time, urban agglomerations have not gotten rid of the development model driven by the pursuit of high-speed economic growth, and gradually exposed problems such as overlapping industrial structures, slowing population development, and inefficient utilization of urban space resources, resulting in the development of industries, population, and space between cities. There is a certain imbalance, which hinders the improvement of the regional market mechanism and the improvement of the efficiency of resource allocation. An in-depth analysis of the problems faced by the coordinated development of industries, population and spatial elements in various cities will improve the overall coordination of urban agglomeration development and the quality of regional economic development. The overall goal of urban agglomeration development is to gradually form a highly integrated urban agglomeration with high degree of economic integration, close spatial organization, less obstacles to employment resource flow, coordinated industrial development and urbanization, and developed infrastructure network. Between cities within a city cluster. The high integration of urban agglomerations is the result of the organic integration of cities within the urban agglomerations, the common result of the division of labor and cooperation of various elements, and the important foundation for ensuring the high-quality development of urban economy. Urban agglomeration. Therefore, building a mutually beneficial mechanism of industrial elements, population elements and spatial elements of urban agglomerations is conducive to the healthy and coordinated development of urban agglomerations, and is an important prerequisite for enhancing the economic vitality of the whole city. Clusters. It can be seen that clarifying the actual level of industrial, population and spatial development of each city and the level of coordinated development of each system is the main premise of coordinated development of urban agglomeration [1].

Population and economic growth are the two most important aspects of the urban growth. The 2009 World Development Report released by the World Bank clearly depicts the population agglomeration and the urbanization process around the world since the 21st century, and points out that the driving force for the continuous development and expansion of cities comes from the increase in population size and the increasing economic efficiency. The traditional urban economic theory holds that industrialization and local economic growth are the driving force of urbanization, and the agglomeration of production activities and jobs in cities is the fundamental reason driving population migration to cities. However, in recent years, some new viewpoints believe that in the post-industrial era and the background of globalization, with the increasingly rich labor force, people's employment opportunities are less and less constrained by geography, and the concern for the quality of life plays an increasingly important role in the decision-making of residence. Therefore, the development prospects of the city will mainly depend on its ability to provide a good living and working environment, and the ability of the city to provide this environment is defined as "Amenity", that is, urban or local quality. Urban quality is a non-productive public good, including public services such as education, medical care, and public safety. High-quality cities, as consumption centers, attract people to move in, which in turn promotes urban economic growth. In fact, whether urban growth is attributable to population immigration caused by economic growth or economic growth driven by population immigration is still debated. Numerous researches have confirmed that urban population and economic growth are mutually causal, showing a positive feedback phenomenon of urban growth [2].

However, most of the existing researches have ignored the different forms of urban growth reflected by the relative differences in population and economic growth of cities at different stages of development. In the early stage of urban development, the improvement of urban economic efficiency mainly comes from the local specialization of production, and the localized external economy brought about by the agglomeration of industrial specialization is the key to urban economic growth [3]. The improvement of production efficiency at this stage is the driving force for urban growth, and it is also the main reason for driving population immigration, which makes urban economic growth relatively faster than population growth. With the continuous development of the city, the positive feedback mechanism of population and economic growth has been formed, and the urban population and economic growth have gradually achieved a benign dynamic balance and relatively synchronous and stable development. However, as cities continue to expand, their industries are becoming more

diverse. Due to the scale effect of the local market and the diversification of the external economy, more employment options and higher urban quality have attracted a large number of people to move in, so that the urban population growth is relatively faster than the economic growth (Figure 1).

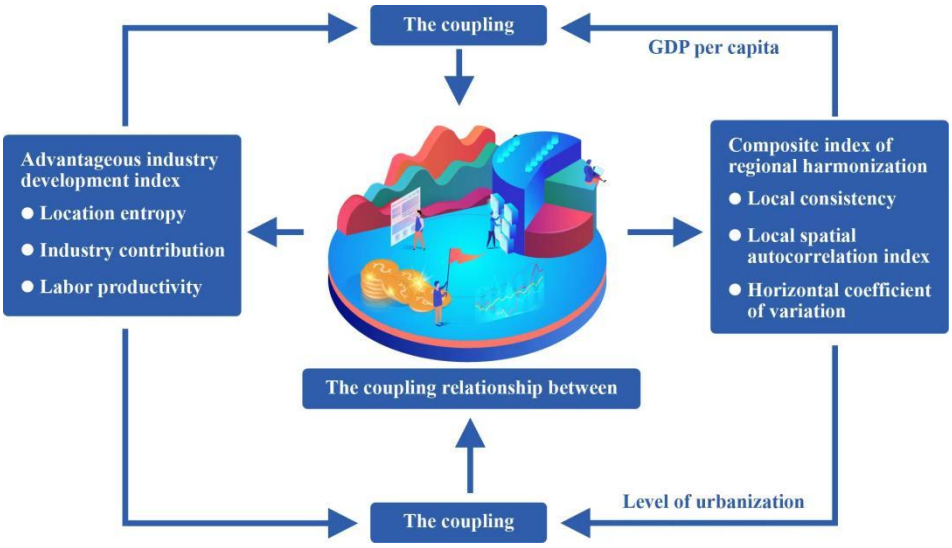

Figure 1 Analysis of the interactive coupling mechanism and regularity of urbanization and labor productivity

2. Literature Review

In different development stages of a city, the growth of population and economy is not always synchronized, and the relative difference of its growth will change continuously with the development of the city, showing the dynamic evolution characteristics of urban growth [4]. However, in most of the researches on urban growth in China, the economic growth or population growth of the city is considered unilaterally, and there are few researches in which the two are considered comprehensively. A few studies focus on the interaction between urban population and economic growth, while ignoring the dynamic differences between urban population and economic growth at different stages of development, only emphasizing the reciprocal relationship between them. Whether there is a difference between population and economic growth. Therefore, cities at different stages of development have different characteristics of urban growth. Ignoring the link between population and economic growth in urban growth may fail to capture the diversity and complexity of urban growth in China. Therefore, based on the relative relationship between urban population and economic growth in China, this study analyzes the types and influencing factors of urban growth, which is of

great significance for a deeper understanding of China's urbanization and urban growth path. It has important practical significance to put forward the urban development strategy more pertinently.

Population employment is the most critical element of the industrial development, and the industrial development is the fundamental way and carrier to solve the problem of population employment. The coordination of the two determines the development quality of a region's national economy. The upgrading of the industrial structure and the employment of the floating population is a relationship of contradiction and unity [5]. In the short term, the upgrading of the industrial structure is in conflict with the goal of increasing employment, which will lead to the loss of employment opportunities and the increase of unemployment. However, in the long run, the extensive and low-level industrial structure cannot drive sustained and rapid economic growth. Without economic growth, there will be no increase in labor positions, and ultimately limit the growth of labor employment. Conversely, in the long run, only the advanced industrial structure and thus the improvement of labor productivity can create more jobs and promote employment better. At different development stages of a city, the growth of population and economy is not always synchronized, and the relative difference in growth will be reflected in different forms of urban growth. The multi-dimensional analysis of economy, population, and space is of great significance for the research of urban development. However, the scientific quantitative and accurate analysis of the transmission mechanism of each system development to local economic development is the important and difficult point of the research[6].

Takes the economic activity of each country or region as a sub-model. Through the international trade, various countries or regions are linked into a whole. A series of mathematical equations are used to describe the economic behavior of various economies in economic life and their relationship with each other, reflecting the entire economic reality. It relies on actual economic data to describe, simulate and predict economic activities, and analyze the impact of changes in a variable on the macroeconomics, industries, and production factors of various economic entities in various countries.The dynamic GTAP method is used to investigate the economic impact of the East Asian economic crisis, it is found that the economic crisis makes the overall investment of the whole region decline with the continuous advancement of the global regional economic integration process. Scholars at home and abroad gradually begin to use computable general equilibrium model to quantify the economic impact of regional economic integration. Although the GTAP model is mainly

used in the field of trade analysis at the beginning of its creation, due to the perfect structure and data of GTAP, it has been extended by scholars to resources, environment, population and other aspects.

3. Research Methods

3.1 Research on GTAP model and urban economy

3.1.1 The basic principle of GTAP model

This model has been widely used in international trade policy, environmental policy, international research on issues such as immigration and poverty. In the GTAP database, the input-output tables of most countries are updated to 2007. It includes 129 countries (regions) and 57 industries. The input elements are divided into land, unskilled labor, skilled labor, capital and natural resources. Among them, countries (regions) and industries can be combined according to the needs of research. It also includes the standard GTAP model, which needs to be solved by RunGTAP [7]. The standard GTAP model is a relatively static model developed in 2003, which is a relatively simple and widely used model.

The structure of the GTAP model is similar to the single-country multi-sector computable general equilibrium. First, sub-models are established for each country (region), and these models involve production modules, consumption modules, government modules, and trade modules. Models are linked together. In the standard static GTAP model, the main assumptions include perfect competition in the market, constant returns to scale, free movement of labor within the country, and no movement of land between sectors. Under these assumptions, the minimization of producer costs, the maximization of consumer utility, and the clearing of commodity markets and factor markets are realized. At the same time, according to the Armington hypothesis, there is incomplete substitution between domestically produced commodities and imported commodities [8].

3.1.2 Aggregation of regions and sectors

In the research, the used method is the computable Global Trade Analysis Project (GTAP). This model is a global trade analysis model used to simulate and analyze the global trade situation. It can flexibly analyze the impact of changes in international trade prices and quantities brought about by tariff reductions, regional trade agreements, and adjustments to trade and subsidy policies, as well as changes in national welfare [9]. When considering the

equivalent tariff of trade time cost, the constructed time cost equivalent tariff database will be used, which contains the total equivalent tariff of each product in the GTAP database for the whole time of trade. The research includes 140 countries and regions and 57 production sectors. Since the core of the research is the economic effects of trade facilitation among SCO member states, the 140 countries (regions) are divided into 9 regions (as shown in Table 1), including China, Russia, India, Pakistan, Kazakhstan, Kyrgyzstan, USA, EU and other countries or regions. Because Tajikistan and Uzbekistan are not listed separately in the database, and the total trade volume of the two countries accounts for a very small proportion in the SCO region, the grouping of countries and regions in the research does not affect the reliability and directivity of the simulation results.

Table 1 Region division of GTAP database

No.	Region division	The original region of the GTAP database
1	China	China Mainland, China Hong Kong, China Taiwan
2	Russia	Russia
3	Pakistan	Pakistan
4	India	India
5	Kazakhstan	Kazakhstan
6	Kyrgyzstan	Kyrgyzstan
7	The United States	The United States
8	The European Union's 27 countries	Romania, Bulgaria, Latvia, Croatia...
9	Other countries/regions	Other countries/regions

3.1.3 Introducing time cost into GTAP model

The introduction of time cost equivalent tariffs into the GTAP model is an extremely complicated process, because the GTAP model only includes traditional trade barriers such as tariffs and subsidy quotas, and there are no related variables about trade costs. In the existing literature, reducing the time cost of trade is equal with advances in trade technology. Therefore, in the time cost equivalent tariff database, the reduction of trade delay costs is transformed into technological progress and the impact of technological progress, that is, the

reduction of implicit trade costs on economic welfare, which is specifically described in the import demand function [10].

As shown in Figure 2, S1 is the global supply curve, D1 is the initial import demand curve, and P and Q are the initial equilibrium price and quantity, respectively. Due to the reduction in the time cost of trade (subject to any changes in tariffs and other non-tariff barriers), the import demand curve changes from D1 to D2, and consumers are now willing to pay a higher price P1 for goods that reach the market faster and fresher quality Q*. Then P*-P1 is the corresponding trade time equivalent tariff. The market then further reaches the new equilibrium price P2 and the equilibrium quantities Q2.

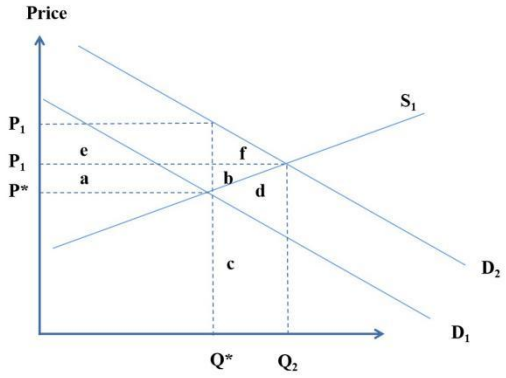

Figure 2 The impact of lowering trade delay costs on economic welfare

In the import demand function, the impact of the equivalent tariff of the reduction of the time cost of trade can be reflected, and the equivalent tariff of the reduction of the time cost of trade can be equivalent to the technological progress, that is, ams can be used as a shock variable. In the GTAP model, the import demand function is Formula (1).

$$\mathrm{qxs}_{i,r,s} = -\mathrm{ams}_{i,r,s} + q\mathrm{im}_{i,s} - \sigma_{m}^{i}\left(\mathrm{pms}_{i,r,s} - \mathrm{ams}_{i,r,s} - p\mathrm{pim}_{i,s}\right) \quad (1)$$

The import price function is Formula (2).

$$-\mathrm{pim}_{i,s} = \sum_{K}\theta_{i,k,s}\left(pm\ \mathrm{s}_{i,r,s} - \mathrm{ams}_{i,r,s}\right) \quad (2)$$

Table 2 reflects the changes in the import and export trade volume and trade balance of each member country on the basis of a 30% reduction in the trade time cost. Among the member countries of the organization, except for Kyrgyzstan, the import and export volume of other member countries has increased. Among them, China's import value increases the most and is higher than the export increment, resulting in a decline in the trade surplus [11]. In addition to China, the import and export volume of India and Kazakhstan increase more, and also show a trend that the growth rate of import volume is greater than the growth rate of export volume.

Russia's import value increases by a large margin, while the export value increases by a relatively small amount, resulting in the most obvious decrease in the trade surplus. The import trade volume of Kyrgyzstan increases, while the export volume shows a downward trend. The reason may be that with the improvement of customs clearance efficiency and the reduction of trade costs, Kyrgyzstan's advantages as a transit trade platform for trade transit have weakened. As can be seen from Table 2, China's overall import and export rates have increased by 1.66% and 0.87% respectively. In terms of exports, Kazakhstan shows the most significant growth of 9.71 percent. Kyrgyzstan's exports decreases to 19.09%. In terms of imports, Kazakhstan and Kyrgyzstan show the largest growth, with 34.85% and 54.05% respectively.

Table 2 Changes in the import and export volume of various countries (unit: million US dollars; %)

Country/Region	Change in export value	Change in import value	Change in balance of trade	Change in export rate	Change in import rate
China	22 157. 68	29 491. 05	-7 333. 37	0. 87	1. 66
Russia	5 859. 58	16 613. 06	-10 753. 48	0. 26	4. 54
Pakistan	813. 11	1 613. 84	-800. 73	2. 23	2. 81
India	11 330. 44	13 542. 08	-2 211. 63	2. 23	2. 47
Kazakhstan	11 619. 55	16 348. 79	-4 729. 24	9. 71	34. 85
Kyrgyzstan	-239. 35	4 908. 55	-5 147. 90	-19. 09	54. 05
The United States	4 508. 86	-14 599. 38	19 108. 23	0. 40	-0. 58
The European Union's 27 countries	-9 114. 36	-16 552. 40	7 438. 04	-0. 05	-0. 27
Other countries/regions	-18 963. 86	-23 694. 23	4 730. 37	-0. 20	-0. 29

3.1.4 Changes in economic effects

After imputation and reclassification of the original data, specific exogenous variable shocks are set according to the assumed trade policy changes, and RunGTAP software is used to solve the general equilibrium simulation. Considering that on+e of the goals of RCEP is to eliminate tariffs among member countries, a simulation scenario is set up in the research. The specific simulation scenario settings are shown in Table 3.

Table 3 Simulation scenario settings

Scenario 1	Tariffs among RCEP members have been reduced to zero
Scenario 2	Tariffs among RCEP members will be reduced to zero, and technical barriers to trade will be reduced by one percent
Scenario 3	Tariffs among RCEP members will be reduced to zero, and technical barriers to trade will be lowered by 2%
Scenario 4	Tariffs among RCEP members will be reduced to zero and technical barriers to trade will be reduced by 5%
Scenario 5	Tariffs among RCEP members will be reduced to zero, and technical barriers to trade will be reduced by 10 percent

Figure 3 shows China's GDP and welfare trends under five scenarios, both of which increase gradually with the gradual reduction of technical trade barriers. Therefore, from the perspective of China's economic development and welfare, China should actively promote the reduction of intra-regional technical trade barriers in the RCEP negotiation process, so as to promote China's economic development and improvement of welfare [12].

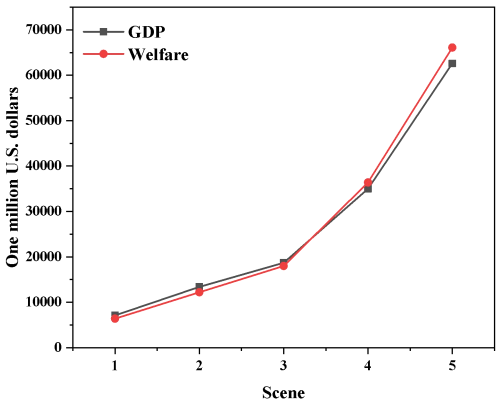

Figure 3 China's GDP and welfare changes under five scenarios

Figure 4 shows the changes in the growth rate of China's import and export trade scale under the five scenarios. It can also be seen that with the gradual reduction of technical trade barriers in the RCEP region, the growth rate of China's import and export trade scale is also gradually increasing [13].

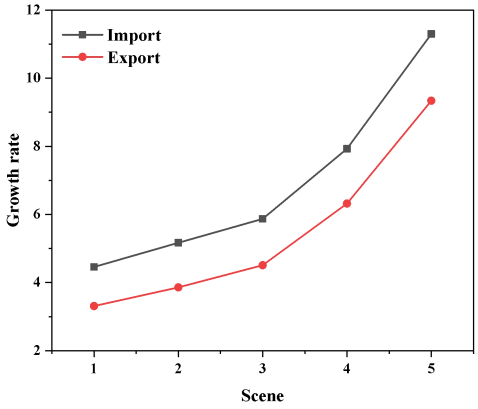

Figure 4 Changes in the growth rate of import and export trade scale

3.2 Research on the relationship between the GTAP model and the employment of the labor force

3.2.1 The impact of declining labor force on China's economy

In the research,the computable general equilibrium model GTAP is used to simulate and predict the impact of labor reduction on China's economy under the background of constant population size, and how much skilled labor needs to be increased to maintain China's original welfare when the number of unskilled labor decreases by a certain percentage level, and the impact of this change in labor structure on China's economy is analyzed [14]. In the comparison scenario, other economic variables such as population size, industry skill level, and industrial policy are kept constant to analyze the economic impact of a reduced labor force.

As for the impact of declining labor force on China's macroeconomy, Table 4 shows the impact on China's macro-economy when the number of labor force drops by 5%. It can be seen that the reduction of labor force will damage China's welfare by 79.8923 billion US dollars, GDP will drop by 1. 79%, and residents' income will decrease by 2. 07%.

However, the reduction of labor will bring a slight improvement in terms of trade, accompanied by a decrease in imports and exports, of which total exports will drop by 2. 81% and total imports will drop by 1. 69%.

Table 4 The impact of declining labor force on China's macroeconomics

Variable	Welfare($100 million)	Change in GDP (%)	Personal income (%)	Terms of trade (%)	Terms of trade (%)	Total imports (%)

Decline by 5%	-798. 923	-1. 79	-2. 07	0. 56	-2. 81	-1. 69

As for the impact of the decline in the number of labor force on the factors of production in China [15], Table 5 shows the impact of a 5% decline in the labor force on China's factor prices and rates of return. From the simulation results, it can be seen that when the number of labor force decreases by 5%, except for the increase in the price and return rate of labor force, the price and return rate of other factors of production decrease to varying degrees. Among them, the price of unskilled labor increases the most, reaching 3.21%. The rate of return increases by 2.79%, the price of skilled labor increases by 2.83%, and the rate of return increases by 2.53%. Among other factors of production, the price and the rate of return of natural resources decline the most, by 8.70% and 9.01%, respectively. The price and the rate of return of land also decline to a large extent, by 7.11% and 7.53%. The price of capital and the rate of return decline by a smaller margin, falling by 1.17% and 1.54% respectively.

Table 5 The impact of the decline in the number of laborers on China's factors of production %

Elements	Land	Unskilled labor	Skilled labor	Capital	Natural resources
The price	-7. 11	3. 21	2. 83	-1. 17	-8. 71
The rate of return	-7. 53	2. 79	2. 53	-1. 54	-9. 01

3.2.2 The impact of declining labor force on China's industry

As for the impact of the decline in the number of labor force on the production, price, import and export of China's industries [16], Table 6 shows the impact of the decline in the number of laborers on the output, prices, and imports and exports of various industries in China. When the number of laborers drops by 5%, the output of each industry will decline to varying degrees, and the output of unskilled labor-intensive industries, skilled labor-intensive industries, and capital-intensive industries will decline by about 3%. The output in the services sector declines by 2.5%, and the output in agriculture, food processing, and mineral resources industries decline by about 2%.

Table 6 The impact of labor force decline on Chinese industry %

Industrial category	Agriculture	Food processing	Mineral resources	Unskilled labor intensive	Skilled labor intensive industry	Capital intensive industry	Service industry

				industry			
Output	-1. 98	-1. 97	-1. 93	-3. 07	-2. 91	-3. 13	-2. 50
Price	-0. 13	0. 29	-0. 49	0. 63	0. 39	0. 47	0. 65
Export	0. 21	-1. 33	2. 52	-3. 37	-2. 47	-3. 29	-2. 17
Import	-2. 49	-1. 35	-3. 23	-0. 70	-1. 66	-1. 17	-1. 32

4. Analysis of Results

Table 7 shows the impact of labor quality improvement on China's macro economy [17-18]. When the unskilled labor force decreases by 5% and the skilled labor force increases by 15. 4%, various macroeconomic indicators in China change slightly. The welfare level is almost unchanged, the GDP decreases by 0. 41%, the residents' income decreases by 0. 43%, and the terms of trade deteriorates slightly. But the total exports increase by 0. 20% and the total imports decrease by 0. 04%, almost unchanged at the original level.

Table 7 The impact of labor quality improvement on China's macroeconomics

Variable	Welfare($100 million)	Change in GDP (%)	Personal income (%)	Terms of trade (%)	Terms of trade (%)	Total imports (%)
Impact level	-0. 307	-0. 41	-0. 43	-0. 06	0. 20	-0. 04

As for the impact of labor quality improvement on factors of production in China, when the unskilled labor decreases and the skilled labor increases, the price of unskilled labor in China will increase by 4.01%, and the rate of return will increase by 4.09%. down 12.88%. At the same time, the prices and rates of return of other factors of production decline to varying degrees[19-20]. The prices of capital, land, and natural resources decrease by 0.83%, 0.49%, and 0.32%, respectively, and their rates of return decrease by 0.67%, 0.35%, and 0.19%, respectively. See Table 8.

Table 8 The impact of labor quality improvement on China's factors of production %

Elements	Land	Unskilled labor	Skilled labor	Capital	Natural resources
The price	-4.90	4.01	-13.08	-0. 83	-0. 32
The rate of return	-0.35	4.09	-12. 88	-0. 67	-0. 19

As for the impact of labor quality improvement on China's industry production, prices, and imports and exports, Table 9 shows the impact of China's labor force improvement on various industries in China. The decrease in unskilled labor and the increase in skilled labor first lead to a decrease of 0.80% in the output of unskilled labor intensive industries, an increase of 0.24% in the output of skilled labor-intensive industries, and an increase of 0.29% and 0.20% in the output of capital-intensive industries and service industries, respectively. However, the output of agriculture, food processing industry and mineral resources industry decrease by 0.71%, 0.53% and 0.29% respectively[21-25].

Table 9 The impact of labor quality improvement on Chinese industry %

Industrial category	Agriculture	Food processing	Mineral resources	Unskilled labor intensive industry	Skilled labor intensive industry	Capital intensive industry	Service industry
Output	-0.71	-0. 53	-0. 29	-0. 80	0. 24	0. 29	0. 20
Price	1.44	0. 63	0. 32	0. 33	-0. 06	-0. 06	-0. 89
Export	-6. 10	-2. 61	-1. 93	-1. 38	0. 54	0. 59	2. 89
Import	2. 81	1. 10	0. 56	0. 40	-0. 12	-0. 10	-1. 64

5. Conclusion

The city's development is a continuous process with continuous changes in people and economies. Also, population and economic growth do not always go hand-in-hand at different stages of a city's development. Cities at different stages of development may face different levels of inconsistency and divergence in population and economic growth. Employed population is the most critical element of industrial development, and industrial development is the fundamental way and carrier to solve the problem of population employment. The coordination of the two determines the development quality of a region's national economy. In order to solve the above problems, the GTAP model proposed in the research has high prediction accuracy and high feasibility for the coupling and coordination relationship between urban economic upgrading and labor employment.

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