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Import technology sophistication and high-quality economic development: evidence from city-level data of China

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ABSTRACT

This paper adopts five dimensions and 15 indexes of green development, people's life, innovation ability, economic vitality and coordinated development to establish an evaluation system of high-quality economic development. It uses principal component analysis to measure the economic high-quality development of 233 prefecture-level cities from 2003 to 2016, and empirically studies the impact of import sophistication on China's high-quality economic development. The results show that the increase in the sophistication of imported technology can significantly promote the high-quality development of the regional economy, and this effect is applicable to both imported intermediate and final products. In regions with higher and lower levels of economic development, eastern areas, and regions with high-quality development above 90% quantiles, the increase in imported technology content can significantly drive the high-quality development of the local economy. However, it has a great negative impact on the areas with a high-quality development index below 10% quantile. The robustness and endogeneity check support the above viewpoint. Further mechanism analysis shows that the final product import competition and intermediate product import spillover play a mediating role in the process of import sophistication affecting the high-quality economic development. The conclusion of this paper has important theoretical value and practical significance for the use of import trade to achieve high-quality economic development.

1. Introduction

Since the reform and opening up, the rapid economic growth of more than 40 years has enabled China to make remarkable achievements, the social productive forces have been highly liberated and the people's living standards have been greatly improved. However, the rapid development under the guidance of aggregate thinking

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has also led to a series of negative problems, such as environmental degradation, a widening income gap, uncoordinated industrial and regional development, low production efficiency and so on. At present, China's economic development is in an important period of strategic opportunities, social contradictions are mainly manifested in the contradiction between the people's growing need for a better life and unbalanced and inadequate development. Starting from the overall situation, the Chinese government is putting forward a new strategic call for high-quality development. This is the inevitable requirement of adapting to the new normal of economic development and solving social contradictions. At the same time, it also injects a powerful driving force for a more comprehensive and harmonious development.

The liberalization of import trade is an important link in building a new open economic system in China. According to the data of the National Bureau of Statistics, by the end of 2019, China's imports of goods reached 2078.409 billion US dollars, which has doubled compared with 2009. Import expansion has met the domestic market demand of upgrading, it brings low-cost resource selection from the global scope to domestic enterprises, which promotes the progress of enterprise efficiency. However, while the scale of imports is expanding, what impact the technological content of imported products will have on the high-quality development of China's economy is a key issue worthy of consideration by the government and academia. It can be seen that research on the impact of import sophistication on China's high-quality development is not only an important part of tapping the comprehensive impact of import trade, but also a useful exploration in order to realize China's high-quality economic development.

2. Literature review

According to the subject of this article and by consulting relevant research, we find that much literature has explained the complex economic impact of import trade from the perspective of reducing import tariffs in the past, which involves the impact of import trade liberalization on profit margin, innovation, output fluctuation, human capital optimization, export domestic value-added, export sophistication and other aspects of enterprise. However, it does not pay enough attention to the economic effect of import sophistication. The existing literature on the sophistication of import technology mainly focuses on macro-economic growth, meso-industrial structure, development mode, total factor productivity growth, micro-enterprise innovation, export sophistication and so on. For example, Worz (2005) found that the import trade of medium and high-tech commodities has a significant positive impact on long-term economic growth through the study of African, Latin American and other countries. Shao (2017) used the data of manufactured goods and services trade to prove that the improvement of the import technology sophistication of manufactured goods and services trade contributes to China's economic growth, and the driving role of service trade is stronger. Ding and Liu (2018) believe that the positive effect of improving the technical content of imported products on the upgrading of industrial structure shows obvious industry heterogeneity, which is significant in high and low technology industries, but not significant in energy industries. This conclusion

still holds in countries along the Belt and Road initiative (Liu & Ding, 2019). Wei and Geng (2016) found that the higher the content of imported technology, the more conducive to promoting the transformation of China's industrial economic development mode, especially for capital-intensive industries. Liu et al. (2019) verified that the increase in China's import sophistication can significantly promote the growth of total factor productivity and technological progress of industry in the world by building an endogenous growth model. With the help of a mathematical economic model and empirical model analysis, Xing et al. (2018) showed that the import products with different technologies had different effects on enterprise innovation, and the import of high-tech products and low-tech products had significant negative and positive effects, respectively. Wang and Yang (2019) found that the optimization of import technology structure significantly increased the sophistication of China's export mainly through transfer, learning and competition effects. Hsieh and Woo (2005) believed that the import of a large number of high-tech intermediate goods from developed countries would have a significant skill-upgrading effect on the high-skilled labour market in developing countries. Liu and Zhang (2017) found that the improvement in import technology can significantly promote the optimization of the employment skill structure of China's manufacturing industry.

Another kind of research closely related to this paper focuses on high-quality development. The literature reports on research conducted on the high-quality development of the regional economy from different perspectives, such as the tax burden (Cao & Chen, 2021), industrial agglomeration (Lv & Yuan, 2020), infrastructure investment (Pan & Luo, 2020), financial resource allocation (Wei, 2019), consumption structure upgrading (Chen & Wu, 2019), scientific and technological innovation (Wei et al., 2020), environmental regulation (Li & Wang, 2019), FDI characteristics (Hu & Xu, 2020), etc., and has specifically explored the influence of these factors on the high-quality development of the regional economy. From the perspective of deepening the research, this may be constrained due to limited data acquisition channels, as a considerable part of the literature is based on the provincial level, and the literature on the high-quality development of prefecture-level cities still accounts for a small part. For example, based on the supply side perspective, Tao and Wu (2020) used provincial panel data from 2008 to 2017 to discuss the relationship between imports and high-quality development. However, the main focus of this research is on the import structure, that is, the different impacts of total imports, imports of goods, and imports of services on high-quality development. Hu and Xu (2020) also took 30 provinces, municipalities and autonomous regions of China from 2001 to 2016 as samples when they studied the impact of FDI quality characteristics on China's high-quality economic development. In terms of research methods, there are two main types of high-quality development measurement. The first is to build an index system. For instance, Wei and Li (2018) proposed a high-quality economic development level measurement system covering 10 aspects of economic structure optimization, innovation-driven development, efficient resource allocation, perfect market mechanisms, stable economic growth, regional coordination and sharing, high-quality products and services, perfect infrastructure, ecological civilization construction and economic achievements that benefit the people, dividing China's 30 provinces into three types:

advanced type, mediocre type and backward type. The economic quality evaluation system established by Chen and Wu (2019) includes five dimensions: economic dynamic transformation, economic structure optimization, economic system stability, economic green development and economic welfare sharing. The second high-quality development measurement is to use a single index for quantitative expression, the most typical is to use total factor productivity or green total factor productivity as a substitute index. Han et al. (2020) and Xu and Gu (2020) used total factor productivity to measure high-quality development when discussing the internal relationship between national audit and official promotion incentives and the quality of regional economic development. Shangguan and Ge (2020) assert that green total factor productivity takes into account both the increase of expected output and the decrease of unexpected output, so it can better measure the quality of urban economic development. Yu et al. (2019) used green total factor productivity as a proxy index to evaluate the temporal and spatial transition characteristics of China's economy from rapid growth to high-quality development in different stages since the reform and opening up. Individual literature also uses economic growth to represent high-quality regional development (Ming et al., 2019).

The above research provides valuable experience and inspiration for us to understand the comprehensive impact of import sophistication on the overall economy, industries and enterprises, and indirectly indicates that the technical structure of imports will affect one aspect of high-quality economic development to a certain extent. However, we have not found any direct literature on import sophistication and high-quality development. Therefore, using the panel data of 233 cities from 2003 to 2016, this paper focuses on the impact of import sophistication on high-quality economic development, and clusters the sample areas according to different standards to test the heterogeneity of import technology content. By changing the attribute and calculation method of some indexes in a high-quality development system, the robustness check is carried out. The system generalized method of moments (GMM) is used to introduce the lag time of endogenous variables into the model to deal with the possible endogenous problems. Compared with the existing studies, the possible innovations of this paper are as follows: (1) At present, China's evaluation of the high-quality development of regional economy is still in the exploratory stage and there is no consistent standard. In empirical analysis, single indicators, such as economic growth and total factor productivity, are used as substitutes. However, it is obvious that the single dimension index cannot fully reflect the multidimensional requirements under the profound connotation of this concept, and that the conclusions may be biased by using it in empirical research. Based on the essence of the new development concept, this paper constructs an evaluation index system to comprehensively investigate the high-quality economic development from five perspectives and 15 indicators, which lays the foundation for the accuracy of the conclusion; (2) Most of the existing high-quality development empirical articles are mainly carried out among provinces. However, as we all know, there are obvious differences in the economic development of different cities within and among provinces, therefore this paper further extends the research to prefecture-level cities, and makes a more detailed analysis; (3) The research on import sophistication often involves only one

aspect of high-quality economic development, such as industrial upgrading, transformation of industrial economic development mode, etc, but the local effect is not equivalent to the global effect. We conduct an in-depth analysis of the impact of import sophistication on high-quality economic development and its mechanism, which expands the current academic research perspective, in order to provide more theoretical evidence for the high-quality development effect of import trade.

3. The mechanism by which the import sophistication affects the high-quality development of economy

By combining the international trade theory, endogenous growth theory and other economic theories with the domestic and foreign literature, we believe that there are two main channels through which the import sophistication affects the high-quality development: import competition effect and import spillover.

3.1. Import competition channel

The impact of import competition on high-quality economic development is mainly realized by promoting the adjustment of resource allocation. If the degree of market competition before import is low, import competition can improve overall productivity by stimulating the market and eliminating backward and inefficient enterprises (Huang, 2020; Huang & Li, 2020). Enterprises can adjust their product structure and scope according to their own production advantages, stop production of products without core competitive advantages, and make resources flow among various departments within the enterprise to form an optimal allocation (Qiu et al., 2020). At the same time, the delisting behaviour of some enterprises with low productivity caused by the survival of the fittest mechanism of competitive effect will promote factors to move between different industries; when the factors are transferred to some high value-added industries, the advanced transformation of industrial structure is realized, and multiple channels jointly promote the high-quality economic development.

However, the effect of import competition is still faced with some doubts, mainly because when the import scale is large, some enterprises are forced to face the risk of bankruptcy and delisting due to intensified competition (Horst & Joachim, 2010), which reduces the employment rate of residents, thus affecting personal income. Even the surviving enterprises may reduce the growth rate of employees' wages because of the profit decrease (Li et al., 2020). Import competition may reduce innovation efficiency by weakening R&D motivation (Zhao, 2020), leading to lower output (Liu & Qiu, 2016). The impact on market share and profit will also reduce the productivity of enterprises and industries (Acharya & Keller, 2008; Chen et al., 2017). In addition, when the production process is overdependent on advanced machinery, equipment and intermediate products from medium and high-tech industries, domestic enterprises will lose the discourse power of technical standards and the initiative of marketing (Liu & Zhang, 2009). In high-tech industries and some areas where technology is not yet mature, excessive import of high sophistication products will also exclude from the market the domestic enterprises that originally provided such products due

to the substitution effect, or occupy the share of domestic high-end products, result-ing in 'low-end locking' (Ding & Liu, 2018; Jia, 2016). It is undeniable that these are negative effects on the high-quality economic development.

3.2. Import spillover channel

Import spillover mainly affects five aspects of high-quality economic development by acting on enterprise behaviour. It has been generally agreed that import trade will produce a technology spillover effect, but will the spillover effect have a positive impact on local enterprises and economic development? Scholars still have different opinions on this question. On the one hand, some studies suggest that the import of products with different technical contents enables enterprises to acquire more advanced knowledge and technology (Aristei et al., 2013; Caselli & Coleman, 2001), promotes technological progress of enterprises (Coe & Helpman, 1995), and increases the sophistication of product export (Zhu & Zeng, 2015). The introduction of foreign products with professional knowledge and R&D achievements provides the possibility of technology spillover. Through the study and imitation of R&D knowledge hidden in the imported products, the acquisition of advanced technology can be realized, and even secondary innovation can be carried out on this basis, which has become an important way for importers to realize technology localization. In other words, importing high-tech products or purchasing technology and corresponding equipment will bring about direct technology diffusion (Worz, 2005).

Other scholars have clarified the negative impact of import spillover on technology or total factor productivity of enterprises from the perspective of import dependence (Gereffi et al., 2005) and absorptive capacity constraint (Funk, 2001; Keller, 2004). Li and Ding (2019) believe that if the importer only makes the decision to use imported products for short-term production investment based on comparative advantage, the existence of a crowding-out effect will reduce the space for independent research and development of the enterprise. In the long run, this may lead to technological dependence on developed countries and further solidify domestic industrial structure through the industry lock-in effect. The main reason for considering absorptive cap-acity is that there are differences in human resources, R&D intensity and the tech-nical level of enterprises, which make the ability of enterprises to learn and absorb foreign advanced technology uneven. When evaluating the spillover effect of import trade, the matching degree with the actual technologies of the enterprise and industry needs to be considered. The higher the matching degree is, the more likely the spill-over effect will be. That means there is a threshold effect of absorptive capacity. When the level of human capital and R&D investment are within a certain threshold value, the promotion effect of import spillover on total factor productivity can be brought into full play, and when it exceeds a certain threshold value, it will turn into a restraining effect (Feng et al., 2019). Wang and Chen (2018) found that the import of medium-technology products significantly promoted China's technological pro-gress, while the import of high-tech products has a certain inhibitory effect. It can be seen that the acquisition of tacit technical information and know-how behind imported products is closely related to the absorptive capacity and utilization degree

of economic entities (Narula & Dunning, 2010; Xiao & Xie, 2016), the relationship between import spillover and high-quality development may be non-linear.

In addition, due to the different technical information and uses, the import spillover effect may vary with the product type. In theory, with the large amount of technical knowledge contained in the imported intermediate products, which are mainly invested in the production field for the production of other products, it may be easier to achieve in-depth diffusion and transfer with the processing process. Acharya and Keller (2008) showed that the spillover effect of high-quality intermediate imports is more prominent. Li and Ding (2019) found that the import spillover of intermediate goods has a significant promoting effect, while the import spillover of capital goods has no obvious effect when studying the impact of import spillover on the energy efficiency of manufacturing industry. Therefore, it is necessary to test the import spillover effect by product.

From the channels of import sophistication influencing high-quality economic development, we can obtain three basic hypotheses:

> Hypothesis 1: on the whole, the increase of import technology content has an impact on the high-quality economic development, but the direction is not clear. Moreover, due to the differences in ideas and economic foundation among cities, and the technological differences among enterprises, the impact may have regional heterogeneity.

> Hypothesis 2: the effect of import competition may realize the optimal allocation of resources through the active stimulation and passive mechanism of survival of the fittest, while it may also have adverse effects on high-quality economic development by increasing the risk of enterprise bankruptcy, creating low-end locking and enlarging income inequality. Therefore, the impact of the import competition mechanism on high-quality economic development needs to be verified.

> Hypothesis 3: importers can transform the advanced knowledge and skills of imported products into the technologies they need through imitation and learning, while excessive dependence on imported technology may lead to a crowding-out effect and industrial solidification, and the spillover effect is greatly restricted by the absorption capacity of the importing party, therefore, the mediating role of import spillover effect is still uncertain.

4. Research design

4.1. Measurement of import sophistication

Import sophistication is an important index to measure the regional import structure and technical content of imported products. In this paper, the calculation of import sophistication mainly refers to the methods of Hausmann and Rodrik (2003), Jarreau and Poncet (2010), and further extends it to the city level. Specifically, the calculation of urban import sophistication index is divided into two steps:

In the first step, the export sophistication of each HS 6-digit product is calculated as follows:

$$prody_q = \sum_j \frac{E_{jq}/E_j}{\sum_j (E_{jq}/E_j)} Y_j \qquad (1)$$

In this function, E_{jq} is the export volume of product q in country j, E_j is the total export volume of country j, Y_j is the per capita GDP of country j, and $prody_q$ is the

export sophistication of product q. The basic idea of Hausmann and Rodrik (2003) is that the export sophistication of a commodity is closely related to the income of the country where the commodity is located, therefore it is not difficult to find that the export sophistication of HS 6-digit products is actually to give a certain weight to the per capita GDP of exporting countries in order to carry out a weighted average, the weight is the ratio of the proportion of exported commodities in the total export value of a country to the sum of the proportions of the countries. The export volume data of national 6-digit products is from the BACI bilateral trade statistics Database, the comparable per capita GDP of each country is derived from the World Bank's per capita GDP measured in 2010 constant US dollars after adjusting for global purchasing power parity. The BACI database of CEPII provides us with bilateral trade product data of about 220 countries in the world. By matching the above two databases, trade data and per capita GDP data of 175 countries in the world are obtained. The total exports of these countries account for more than 96% of the world's total exports over the years, so they are highly representative.

The second step is to obtain the urban import sophistication by calculating the weighted average of the export sophistication of the above products; the weight is the proportion of a product's import volume in the city's total import volume. The specific formula is as follows:

$$\text{imprody}_u = \sum_m \frac{M_{um}}{M_u} prody_m \tag{2}$$

where, $imprody_u$ is the import sophistication of city u, M_{um} is the import volume of product m in city u, and M_u is the total import volume of city u. Similarly, the import sophistication of urban intermediate goods and final products can be obtained by changing the weight to the proportion of intermediate products or final products in formula (2). The import volume of urban products comes from the Customs Enterprise Database. Since the database only provides data up to 2016, the sample period span of this paper is 2003–2016. In order to ensure that the 6-digit customs product code is consistent within the sample year and facilitate the later calculation of the import sophistication of intermediate and final products, we need to unify the import commodity classification of each city to the HS2002 version according to the conversion relationship between HS2007 and HS2002, HS2012 and HS2002, HS2002 and BEC. Products with BEC codes of 42, 53, 121, 22, 32, 111, 21 and 31 are classified as intermediate products, and products with codes of 112, 122, 51, 522, 61, 62, 63, 41 and 521 are classified as final products. Using the above formula, the import sophistication of urban intermediate and final products can be obtained.

4.2. Construction of high-quality development index system of regional economy

The objective evaluation of the high-quality development of regional economy is the basic premise of this paper. In October 2015, the Fifth Plenum of the 18th Central Committee of the Communist Party of China clearly put forward the concept of innovative, coordinated, green, open and shared development, which is the reference

standard and targeted direction of high-quality development. Guided by the new concept of development, General Secretary Xi Jinping summarized the basic meaning of high-quality development. He pointed out that 'high-quality development is development that can well meet the people's growing needs for a better life. It is development that embodies the new development concept. It is development in which innovation becomes the primary driving force, coordination becomes the endogenous characteristic, green becomes the universal form, openness becomes the inevitable choice, and sharing becomes the fundamental purpose'. So far, the definition and requirements of high-quality development are basically clear. Therefore, on the basis of understanding in depth the meaning of high-quality development and referring to the relevant evaluation index systems at home and abroad (Held et al., 2018; Li et al., 2019), we have constructed a regional economic high-quality development evaluation system with green development, people's life, innovation ability, economic vitality and coordinated development as the first-level indexes, and 15 secondary indexes in total (Table 1). The five primary indexes contain the ideas of new development concepts such as

Table 1. Evaluation index system of high-quality development of regional economy.

Primary indexes	Secondary indexes	Index interpretation	Property Positive index	Inverse index
Green development	Air pollution degree	Sulphur dioxide emissions / GDP (10000 tons / 100 million)		√
	Industrial wastewater discharge	Industrial wastewater discharge / GDP (10000 tons / 100 million)		√
	Industrial smoke /dust discharge	Industrial smoke emission / GDP (10000 tons / 100 million)		√
People's life	Medical and health work	Number of hospitals and health centres / total population at the end of the year (number / 10000 people)	√	
	Urban transportation	Urban road area per capita (square metre)	√	
	Income of urban residents	Per capita disposable income of urban residents (yuan)	√	
	Income of rural residents	Per capita disposable income of rural residents (yuan)	√	
Innovation ability	Per mu GDP	GDP / land area (10000 yuan / mu)	√	
	Total factor productivity	Measured by DEA Malmquist productivity index method (%)	√	
Economic vitality	GDP growth rate	After deflated by the base period index: (GDP of the next year − GDP of the previous year) / GDP of the previous year (%)	√	
	Asset liability ratio of enterprises above designated size	Liabilities / assets (%)		√
	Foreign trade dependence	Total import and export / GDP (%)	√	
Coordinated development	Industrial coordination	Added value of secondary industry / GDP (%)	√	
		Added value of tertiary industry / GDP (%)	√	
	Regional coordination	Per capita GDP of each city / national GDP (%)	√	

Source: Authors' collation.

green, shared, innovation, openness and coordination.[1] In the determination of secondary indexes, combined with the availability of data, this paper selects 15 indexes that can reflect the primary indexes at different levels. Specifically, in terms of green development, we select three negative indexes such as 'air pollution degree', 'industrial wastewater discharge', 'industrial smoke/dust discharge' to measure the regional environmental protection situation from the perspective of air pollution, water pollution and solid waste pollution. Environmental pollution is not only related to local economic development, but also related to people's health, safety and quality of life, directly affecting the quality development of the local economy. In terms of people's lives, this article sets up four evaluation indexes, using 'medical and health work' to measure the medical quality and medical services that people can enjoy. 'Urban transportation' is used to illustrate the development degree of urban road infrastructure, because good traffic facilities configuration will make people's life more convenient. 'Income of urban residents' and 'Income of rural residents' are the basic conditions for people to enjoy a better life, reflecting the difficulty of achieving a good quality of life. In terms of innovation ability, we use 'per mu GDP'[2] and 'total factor productivity' to measure the innovation efficiency and actual results of the region. 'Per mu GDP' reflects the output level of gross domestic product per unit area. 'Total factor productivity' can measure the comprehensive productivity and use efficiency of various factor resources, reflecting the state of resource allocation in the entire economic system. Obviously, the increase of these two positive indexes is based on the improvement of innovation ability. In terms of economic vitality, we have proposed three indexes. 'GDP growth rate' is used to express the economic development momentum, because high-quality development needs to be supported by a certain GDP growth rate. 'Asset liability ratio of enterprises above designated size' reflects the debt level and risk degree of enterprises as market entities, because if the development of an enterprise is based on a high debt ratio, it is often difficult to ensure the sustainability of development, let alone high-quality development. 'Foreign trade dependence' measures the degree of a country's participation in the international economy and opening up. Active and close economic and trade exchanges with the world are an important boost for China's economic development, which is conducive to realizing the transformation of domestic advantages and enhancing the vitality of development. In terms of coordinated development, 'industrial coordination' and 'regional coordination' are mainly used to evaluate the rationality of industrial structure and the balance of regional development. The coordination of the two is the goal and yardstick of high-quality development. Low-level industrial structure and the large gap between regions' development are problems that must be resolved to achieve high-quality development. Each secondary index does not duplicate each other and highly represents many aspects of high-quality development at the same time. The combination of the direct and indirect measurement index, and the positive and reverse index further increases the accuracy of evaluation. On the whole, the index system is a scientific evaluation system, which highlights the essential requirements of high-quality development to the greatest extent under the premise of highly representative and operable statistical principles. We eliminate the regional samples with serious data missing, use the interpolation method to supplement a small

amount of missing data, and finally calculate the high-quality development index and sub-index of 233 prefecture-level cities in China from 2003 to 2016.[3] The data are from the EPS statistical database, the Wind Financial Terminal and the China Economic and Social Development statistical database.

In this paper, the Malmquist index of Data Envelopment Analysis (DEA) is used to measure the urban total factor productivity. In practice, taking each city as a unit, GDP and fiscal revenue are set as output indicators, labour input and capital stock are set as input indicators. The labour force is measured by the sum of private, individual employees and unit employees, the capital stock of each region is measured by the total fixed assets, using the consumer price index and fixed asset price index with 2010 as the base period to deflate the output index and capital stock, then we can get the total factor productivity of each region.

In order to eliminate the influence of multiple index dimensions in the high-quality development evaluation system, it is necessary to standardize each index by attribute. We use formula $B_{it}^* = \frac{B_{it}}{B_{max}}$ to treat the positive index dimensionless; B_{it} and B_{it}^* respectively represent the values of index i before and after standardization in year t, and B_{max} is the maximum value of the index in each region. For the reverse index, we transform it by taking the reciprocal, and then standardize it according to the positive index. We use formula $B_{it}^* = \frac{1}{|B_{it}-T|}$ to standardize the appropriate index, where T is the moderate value of index i.

The few existing measures of high-quality development evaluation system mainly involve the linear weighting method (Ma et al., 2019) and the principal component analysis method (Zhan & Cui, 2016). In terms of research ideas, the former mainly believes that each subordinate index reflects the connotation of superior indicators from different aspects and has the same importance, therefore, equal weight assignment is adopted in the linear weighting process. The latter thinks that each subdivision index has a different ability and degree to provide superior index information, and its importance should be distinguished by giving different weights in the calculation process. In view of this, we mainly use the principal component analysis (PCA) in the empirical analysis of the text, and use the linear weighted method to recalculate the regional economic high-quality development index in the robustness check, so as to ensure the accuracy of the conclusion.

Specifically, we use PCA to calculate the weight of the secondary indexes in the first level indexes, and then calculate each first-level index; the same method can be used to get the total index of high-quality development of regional economy. On the calculation of the total index of economic development quality of prefecture-level cities by linear weighting method, taking economic vitality as an example, the formula is $F = \sum_1^3 F_i q_i$, where F_i is the three major secondary evaluation indexes from the perspective of economic vitality, and q_i represents the corresponding weight of each index, according to the guiding ideology of the linear weighting method, we assign equal weight to it. Similarly, we can get the general index of high-quality economic development.

4.3. Control variables

There are many factors that affect the high-quality development of regional economy. This paper draws on relevant researches and adds other factors that may affect the

regional economic development: (1) The degree of government intervention (He & Liu, 2020; Li & Shen, 2020). Generally speaking, the greater proportion of fiscal expenditure in GDP indicates that the government regulation is stronger. In the contemporary market economic system, the government intervenes in the economy by means of macro-control to achieve the goal of overcoming market malfunctions. However, the influence of government intervention on economic development is relative, and there is a large gap in the effects of different regions in different periods (Wang et al., 2020). In the early stage of high-quality economic development, the development system is not yet complete. At this time, the government needs to guide and intervene in environmental protection, coordinated development, and protection of disadvantaged industries, etc. In the mature stage of development, excessive government intervention will lead to a distorted mechanism, which is not conducive to high-quality economic development (Zhang & Liao, 2019). (2) The state of human resources. This is judged by the proportion of students in colleges and universities in the total population at the end of the year (Cheng & Wang, 2020; Zhu & Liu, 2020). The development of the economy is inseparable from the support of human capital. Talent is the first resource and the most active element in economic activities. Much competition in today's world is essentially competition of talents. The large-scale and excellent-quality talent group is a solid force for the sustained and rapid development of regional economy. Only by giving full play to the advantages of human resources and mobilizing the creativity and subjective initiative of talent can the 'talent dividend' be effectively released in high-quality economic development. (3) Urbanization. Based on the practice of Sun and Zhou (2015), this is measured by the proportion of non-agricultural employment (i.e. employment in the secondary and tertiary industries) in total employment. Urbanization provides a lot of human resources for regional industrial upgrading and industrial production mode transformation, and stimulates the huge investment demand in infrastructure, public service facilities, housing and other fields. The transfer of employment to non-agricultural industries also increases farmers' wage income, which can lead to the expansion of consumer demand and consumption upgrading. It can be seen that urbanization is an important engine supporting the high-quality development of the regional economy. However, the problems of big city disease and food security caused by excessive urbanization will undoubtedly affect the healthy development of regional economy. (4) Investment status of fixed assets. Referring to the algorithm of Wei and Li (2020), Nie and Jian (2020), this is measured by the proportion of fixed asset investment in GDP. As one of the 'troika', investment is the key variable connecting supply and demand. The fixed assets investment with reasonable structure and appropriate scale can make up for the shortage in the regional economic development. In recent years, the investment trend in the fields of information networking, consumption upgrading, high-tech industry, new infrastructure and so on has become more and more obvious, which means that investment that is closer to the market requirements and in high-end transformation is accelerating to lead high-quality development. However, the government investment with poor accuracy and effectiveness may cause waste and uneven allocation of production resources, and is ultimately not conducive to local high-quality development. (5) Self-sufficiency rate of local finance (Chu et al.,

Table 2. Descriptive statistics.

Symbol	Variable name	Mean	Standard deviation	Minimum	Maximum
allsophistication	Import sophistication	0.018	0.012	0.000	0.337
midsophistication	Import sophistication of intermediate products	0.012	0.006	0.000	0.083
finalsophistication	Import sophistication of final products	0.006	0.011	0.000	0.333
quality	High-quality economic development index measured by PCA method – foreign trade dependence is a positive index	0.176	0.053	0.066	0.433
qualitymo	High-quality economic development index measured by PCA method – foreign trade dependence is a moderate index	0.249	0.242	−0.264	7.174
averquality	High-quality economic development index measured by linear weighting method	0.298	0.058	0.167	0.561
govin	Degree of government intervention	0.142	0.066	0.040	0.716
hure	Human resources	0.017	0.023	0.000	0.131
urban	Urbanization	0.969	0.069	0.438	1.472
invfixed	Investment status of fixed assets	0.621	0.254	0.087	2.103
fiscal	Self-sufficiency rate of regional finance	0.519	0.223	0.055	1.541
green	Green development	0.037	0.061	0.002	0.949
life	People's life	0.280	0.086	0.080	0.647
innovation	Innovation ability	0.136	0.070	0.022	0.611
vitality	Economic vitality	0.137	0.155	−0.371	0.662
harmony	Social harmony	0.265	0.103	0.026	0.783

Source: Authors' calculations.

2020). Generally, the larger the ratio of local public budget revenue to public budget expenditure, the higher the financial self-sufficiency rate is, the stronger the government's financial balance ability and self-development ability are, and the more secure it is for the economy to achieve high-quality development. However, it also reflects that the government expenditure is not positive and investment in public utilities is insufficient to a certain extent, which may have a negative impact on high-quality economic development. The above data are from the Wind Financial Terminal, the EPS statistical database and the statistical yearbooks of various provinces and cities. The descriptive statistics of the main variables in this paper are shown in Table 2.

4.4. Model construction

In this paper, the panel data fixed effect model[4] is used to investigate the impact of import sophistication on the high-quality development of regional economy. The model is set as follows:

$$\text{Quality}_{ut} = \beta_0 + \beta_1 \text{all} complexity_{ut} + \beta_m Z_{ut} + \gamma_u + \delta_t + \varepsilon_{ut} \tag{3}$$

In formula (3), $Quality_{ut}$ represents the high-quality development index of regional economy in year t, $allsophistication_{ut}$ is the regional import sophistication, Z_{ut} is a set

of control variables, γ_u is regional fixed effect, δ_t is time fixed effect, and ε_{ut} is random error term. Similarly, replacing allsophistication with midsophistication and finalsophistication we can test the economic high-quality development effect of intermediate import sophistication and final product import sophistication. Taking green, life, innovation, vitality and harmony as dependent variables, we can also explore the impact of import sophistication on various sub-items of regional economic development.

5. Analysis of empirical results

5.1. Full sample benchmark regression and itemized regression

Considering the stability of regression results, this paper adds various control variables in turn when analyzing the impact of import sophistication on regional high-quality development. The results in Table 3 indicate that when the government intervention degree, human resources, urbanization, fixed assets investment, financial self-sufficiency rate are introduced gradually, and the regional and time fixed effects are controlled, the regression coefficient of import sophistication is significantly positive at the level of 1%, which indicates that the higher the technology content of regional imported goods is, the more helpful it is to achieve high-quality development of local economy.

The regression results of control variables show that government intervention and urbanization bring about an obvious economic high-quality improvement effect. It has been the mainstream view in the academia that government intervention can promote high-quality economic development, and has passed some empirical tests (Wang et al., 2020; Zhang & Liao, 2019). As an important part of the national

Table 3. Regression results of benchmark model.

Variable	Quality					
	(1)	(2)	(3)	(4)	(5)	(6)
allsophistication	0.159***	0.156***	0.146***	0.141***	0.141***	0.140***
	(0.057)	(0.057)	(0.048)	(0.044)	(0.044)	(0.044)
govin		0.031*	0.038*	0.037*	0.040**	0.042**
		(0.017)	(0.020)	(0.019)	(0.017)	(0.018)
hure			0.272	0.273	0.270	0.268
			(0.255)	(0.246)	(0.250)	(0.250)
urban				0.058*	0.058*	0.058*
				(0.034)	(0.034)	(0.034)
invfixed					−0.003	−0.003
					(0.004)	(0.004)
fiscal						0.005
						(0.006)
Constant	0.166***	0.163***	0.160***	0.105***	0.105***	0.103***
	(0.002)	(0.003)	(0.005)	(0.036)	(0.037)	(0.037)
Region FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Obs.	3262	3262	3262	3262	3262	3262
N	233	233	233	233	233	233
R^2	0.793	0.793	0.796	0.798	0.798	0.798

Note: the robust standard error is shown in brackets below the regression coefficient, *, **, and *** are significant at 10%, 5% and 1% level respectively. The following tables are the same as this table.
Source: Authors' calculations.

Table 4. Total sample itemized regression.

Variable	Green	Life	Innovation	Vitality	Harmony
allsophistication	0.361**	0.029	0.031	−0.009	−0.124
	(0.168)	(0.042)	(0.040)	(0.094)	(0.308)
govin	0.012	−0.013	−0.009	−0.001	0.065
	(0.037)	(0.030)	(0.034)	(0.059)	(0.055)
hure	0.967	0.463**	0.191	0.105	1.471***
	(0.797)	(0.193)	(0.146)	(0.211)	(0.328)
urban	0.097	0.011	0.127**	0.019	0.093*
	(0.098)	(0.032)	(0.058)	(0.042)	(0.055)
invfixed	0.014	0.015***	−0.045***	0.051***	−0.005
	(0.010)	(0.006)	(0.006)	(0.017)	(0.012)
fiscal	0.003	0.036***	0.076***	0.093***	0.012
	(0.011)	(0.010)	(0.009)	(0.02)	(0.017)
Constant	−0.077	0.173***	0.049	−0.07	0.213***
	(0.109)	(0.031)	(0.056)	(0.044)	(0.056)
Region FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Obs.	3262	3262	3262	3262	3262
N	233	233	233	233	233
R^2	0.145	0.789	0.731	0.888	0.418

Source: Authors' calculations.

governance system, local governments play an irreplaceable macro-control role in implementing the development concept and leading the development direction. Government intervention does not mean 'more is better' in management and control. If the visible hand of government is inserted into every gap of economic development, it may lead to the disadvantages of insufficient market vitality and distorted resources. Fully respecting the decisive position of the market in the allocation of resources, making strong policy planning, providing appropriate and efficient government services, and implementing strict and standardized macro supervision are the key points for the government to make up for the market deficiency and achieve the best combination of the two. Urbanization is an inevitable trend of rural population gathering in cities and towns along with the process of industrialization. It is a key link in realizing the transformation of people's employment, make up the income gap and maintain social harmony, and the resulting factor flow also objectively promotes the regional industrial upgrading and technological progress, improving the urban total factor productivity. The positive effect will become more and more significant as time goes on (Jiang & Yang, 2020).

Table 4 shows the regression results of import sophistication to each item in the economic high-quality evaluation system. The increase in import sophistication has a positive effect on optimizing the natural environment, improving people's life and improving innovation ability, but only has a significant impact on green development. The reason may be that the internal technology content of imported products has a positive effect on the production mode and means of domestic enterprises through the spillover effect, which promotes the continuous improvement of management, the adoption of advanced equipment and technology, the improvement of resource utilization efficiency, and the reduction of pollutant production and emission in the manufacturing process of commodities from the source. The increase of import sophistication has a negative impact on economic vitality and social harmony, which may be due to the excessive dependence of some domestic enterprises on capital

goods and high technology imported from foreign developed countries, resulting in different degrees of laziness in R&D and innovation, efficiency improvement and other aspects, facing the risk of being eliminated due to failure to meet market demand, and reducing the production vitality of the whole industry. As different industries and regions have different digestion and absorption capacity for imported goods, the utility degree caused by increasing the sophistication of imports will be different between industries and regions, which will bring hidden dangers to the coordinated development of industries and balanced development of regions.

5.2. Further analysis

5.2.1. Heterogeneity analysis based on product category

The difference between the use of intermediate products and final products determines that we need to carry out differentiated analysis according to product types. The results of sub-product regression are shown in Table 5. The increase in import sophistication of intermediate products and final products has a significant positive effect on the transformation of economic development to high-quality, and from the coefficient size and significance, we find that the promotion effect of intermediate products is stronger than that of final products.

The itemized regression results show that the improvement of intermediate technology content has no significant impact on green development, people's life, enterprise innovation, economic vitality and social harmony. As mentioned above, the extent to which external top technology, machinery and equipment, and experience and skills can be 'used for us' depends on the development strength of domestic enterprises, the mastery and proficiency of advanced concepts and technologies, and the ability to imitate and learn from high-end imported products. At the same time, it is also related to the existence of home country control barriers and absorption threshold. Therefore, the impact of intermediate import sophistication on various aspects of economic development may not be absolutely positive or negative. The reason why importing high sophistication final products has a significant positive effect on green development may be that the introduction of foreign capital goods such as high-quality machinery and equipment has increased the flexibility of integration with intermediate products of different performance and quality. Appropriate matching of production materials and production resources can help improve the factor utilization efficiency of enterprises. In addition, the cost-saving effect of reasonable allocation of resources provides the necessary financial support for enterprises to improve the technological process and guide enterprises to green production.

5.2.2. Heterogeneity analysis based on the level of economic development

Considering the influence of the regional development stage on the utilization degree of technology contained in imported products, we divide all samples into three types of urban agglomerations with high-, medium- and low-income level according to the average of per capita GDP of cities over the years, and verify the influence of import sophistication on cities with different income status. As shown in Table 6, the promotion of import sophistication has a significant driving effect on high-quality

Table 5. Heterogeneity analysis based on product categories.

Variable	Quality		Green		Life		Innovation	
	mid	final	mid	final	mid	final	mid	final
midsophistication/finalsophistication	0.259*** (0.078)	0.109* (0.062)	0.057 (0.152)	0.417** (0.188)	0.214 (0.134)	−0.031 (0.034)	0.090 (0.109)	0.006 (0.058)
govin	0.044** (0.018)	0.043** (0.018)	0.018 (0.041)	0.012 (0.037)	−0.013 (0.029)	−0.012 (0.029)	−0.008 (0.033)	−0.008 (0.034)
hure	0.282 (0.260)	0.272 (0.250)	1.004 (0.829)	0.963 (0.793)	0.466** (0.191)	0.470** (0.193)	0.194 (0.145)	0.194 (0.147)
urban	0.061* (0.036)	0.058* (0.034)	0.102 (0.104)	0.095 (0.096)	0.013 (0.033)	0.012 (0.032)	0.128** (0.058)	0.127** (0.058)
invfixed	−0.003 (0.004)	−0.003 (0.004)	0.014 (0.010)	0.014 (0.010)	0.015*** (0.006)	0.015*** (0.006)	−0.045*** (0.006)	−0.045*** (0.006)
fiscal	0.005 (0.006)	0.005 (0.006)	0.004 (0.011)	0.004 (0.011)	0.036*** (0.010)	0.037*** (0.010)	0.076*** (0.009)	0.076*** (0.009)
Constant	0.099** (0.039)	0.104*** (0.037)	−0.078 (0.114)	−0.072 (0.106)	0.170*** (0.031)	0.173*** (0.031)	0.048 (0.056)	0.049 (0.056)
Region FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	3262	3262	3262	3262	3262	3262	3262	3262
N	233	233	233	233	233	233	233	233
R^2	0.797	0.797	0.136	0.146	0.789	0.789	0.731	0.731

Variable	Vitality		Harmony	
	mid	final	mid	final
midsophistication/finalsophistication	−0.364 (0.323)	0.081 (0.067)	−0.361 (0.329)	−0.062 (0.375)
govin	−0.001 (0.060)	−0.003 (0.060)	0.064 (0.054)	0.064 (0.055)
hure	0.106 (0.210)	0.096 (0.212)	1.459*** (0.309)	1.464*** (0.330)
urban	0.017 (0.041)	0.017 (0.042)	0.090 (0.055)	0.093* (0.055)
invfixed	0.051*** (0.017)	0.051*** (0.017)	−0.005 (0.012)	−0.005 (0.012)
fiscal	0.094*** (0.020)	0.093*** (0.020)	0.012 (0.017)	0.011 (0.017)
Constant	−0.065 (0.043)	−0.069 (0.044)	0.217*** (0.056)	0.212*** (0.056)
Region FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Obs.	3262	3262	3262	3262
N	233	233	233	233
R^2	0.888	0.888	0.418	0.417

Source: Authors' calculations.

Table 6. Heterogeneity analysis based on economic development level.

Variable	Quality			Green			Life		
	high	medium	low	high	medium	low	high	medium	low
allsophistication	0.183*** (0.038)	0.117 (0.083)	0.056** (0.024)	0.611*** (0.076)	0.017 (0.192)	0.064 (0.052)	−0.008 (0.042)	0.162 (0.102)	0.033 (0.078)
govin	0.129 (0.118)	0.086*** (0.029)	0.014 (0.015)	0.462 (0.372)	0.015 (0.037)	−0.032 (0.022)	−0.003 (0.112)	0.044 (0.055)	0.015 (0.031)
hure	0.224 (0.283)	0.095 (0.205)	0.561** (0.262)	1.288 (0.839)	−0.430 (0.761)	0.252 (0.756)	0.287 (0.285)	0.249* (0.146)	1.408* (0.806)
urban	0.214* (0.122)	0.029** (0.013)	−0.024* (0.014)	0.340 (0.357)	−0.012 (0.035)	−0.008 (0.025)	−0.027 (0.033)	0.036 (0.028)	0.003 (0.073)
invfixed	0.007 (0.007)	−0.005 (0.005)	−0.008 (0.005)	0.009 (0.019)	0.013 (0.008)	0.014** (0.006)	0.009 (0.011)	0.023** (0.009)	0.019* (0.010)
fiscal	0.023** (0.010)	0.010 (0.008)	−0.018* (0.009)	0.011 (0.017)	0.010 (0.019)	−0.032 (0.022)	0.038** (0.016)	0.001 (0.015)	0.062*** (0.019)
Constant	−0.036 (0.125)	0.118*** (0.015)	0.165*** (0.015)	−0.370 (0.374)	0.042 (0.027)	0.054 (0.033)	0.265*** (0.032)	0.145*** (0.031)	0.127* (0.069)
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	1092	1092	1078	1092	1092	1078	1092	1092	1078
N	78	78	77	78	78	77	78	78	77
R^2	0.769	0.846	0.837	0.279	0.089	0.205	0.824	0.816	0.746

Table 6. (Continued)

	Innovation			Vitality			Harmony		
	high	medium	low	high	medium	low	high	medium	low
	−0.008 (0.033)	−0.037 (0.090)	0.110* (0.058)	0.051 (0.115)	0.335 (0.325)	−0.135 (0.167)	−0.437 (0.277)	−0.098 (0.236)	0.261 (0.215)
	−0.160 (0.106)	0.040 (0.059)	0.052 (0.034)	0.019 (0.272)	−0.079 (0.133)	0.061 (0.072)	0.228 (0.339)	0.059 (0.102)	−0.008 (0.044)
	−0.042 (0.171)	−0.112 (0.279)	0.781* (0.414)	−0.071 (0.345)	0.408 (0.278)	−1.347* (0.755)	1.829*** (0.481)	2.297*** (0.496)	−0.443 (0.572)
	0.296*** (0.075)	0.040** (0.020)	0.089*** (0.028)	−0.017 (0.094)	0.052 (0.077)	0.090 (0.079)	0.132* (0.068)	0.050 (0.068)	0.147 (0.104)
	−0.037*** (0.011)	−0.035*** (0.011)	−0.050*** (0.010)	0.078** (0.036)	0.031 (0.020)	0.068** (0.031)	−0.014 (0.035)	−0.022 (0.017)	−0.005 (0.011)
	0.078*** (0.012)	0.067*** (0.016)	0.072*** (0.020)	0.094** (0.039)	0.081** (0.031)	0.153*** (0.039)	0.002 (0.037)	0.034 (0.023)	0.036 (0.023)
	−0.087 (0.072)	0.123*** (0.023)	0.072*** (0.029)	−0.024 (0.088)	−0.092 (0.08)	−0.187*** (0.083)	0.262*** (0.061)	0.222*** (0.07)	0.090 (0.101)
	YES	YES	YES	YES	YES	YES	YES	YES	YES
	YES	YES	YES	YES	YES	YES	YES	YES	YES
	1092	1092	1078	1092	1092	1078	1092	1092	1078
	78	78	77	78	78	77	78	78	77
	0.680	0.755	0.807	0.875	0.914	0.890	0.371	0.535	0.533

Source: Authors' calculations.

development in high-income areas and low-income areas, and it can be seen from the core independent variable coefficient that the driving effect is stronger in high-income areas than in low-income areas. For cities with medium economic development level, the promotion effect is not significant.

The increase of import technology content has a significant role in promoting the green development of economically developed areas and the innovation ability of low-income areas. Behind the rapid economic development that has brought abundant material enjoyment to the people, there may be many problems related to sustainable development, such as waste of resources and environmental pollution. Generally speaking, the enterprises in developed areas, which are in the forefront of development, will realize the importance of improving the production process and reducing pollutant emissions earlier due to the increasingly fierce conflict between economy and environmental protection. The influx of high-quality goods and services, as well as the accompanying advanced knowledge and technology resources, increase the frequency of enterprises to update old and inefficient equipment, which is conducive to enterprises in high-level economic development areas to break through their own technological barriers and change to green business mode. Imported intermediate products of various forms and high sophistication can constitute a complete intermediate product supply system with the existing domestic intermediate products, providing enterprises in areas with weaker economic development with more production options that fit their own technologies. Reverse absorption and imitation effect can also help enterprises with relatively backward technology to improve R&D strength, and ultimately affect the quality of regional economic development. The reason why the regions with medium development are not significantly affected by the technology of imported products may be related to the lack of awareness of learning from import trade and the weak ability to cope with import competition and squeeze.

5.2.3. Heterogeneity analysis based on regional distribution

China's regional economic development is higher in the east and lower in the west, will the effect of import sophistication on high-quality economic development also present such regional differences? In order to answer this question, this paper divides cities into eastern, central and western regions according to China's regional distribution. The results of heterogeneity regression in Table 7 show that the increase of import technology content has a positive effect on the eastern, central and western cities, but it only affects the eastern region significantly, followed by the central region and the western region. We believe that the differential impact of the above-mentioned situation is closely related to the gradual decline of the import technology spillover effect from east to west (Jiao et al., 2017). High R&D investment, abundant human capital and good infrastructure are the important factors for the eastern region to absorb import technology spillovers; the reason why the results are not significant in central and western regions is not only the gap between the overall resource endowment and the eastern region, but also the large technological gap between local and external developed technologies.

Table 7. Heterogeneity analysis based on geographical distribution.

Variable	Quality			Green			Life		
	east	mid	west	east	mid	west	east	mid	west
allsophistication	0.161*** (0.056)	0.095 (0.068)	0.015 (0.026)	0.519*** (0.177)	0.117 (0.103)	0.017 (0.055)	−0.003 (0.047)	−0.019 (0.079)	0.012 (0.105)
govin	0.102* (0.055)	0.021 (0.028)	0.026* (0.014)	0.060 (0.135)	−0.092** (0.041)	0.001 (0.014)	−0.060 (0.064)	−0.080* (0.047)	0.008 (0.036)
hure	0.144 (0.410)	0.387** (0.163)	0.167* (0.092)	1.695 (1.242)	0.220 (0.244)	0.035 (0.249)	0.162 (0.297)	0.653*** (0.179)	0.559* (0.312)
urban	0.308 (0.221)	0.032 (0.020)	−0.032*** (0.011)	0.802 (0.596)	−0.006 (0.020)	−0.012 (0.029)	0.037 (0.075)	−0.039 (0.031)	0.111 (0.091)
invfixed	0.004 (0.006)	−0.015** (0.006)	−0.008 (0.006)	0.014 (0.016)	−0.001 (0.007)	0.010 (0.012)	0.004 (0.009)	−0.001 (0.008)	0.003 (0.009)
fiscal	0.028** (0.012)	−0.008 (0.008)	0.018 (0.012)	−0.005 (0.027)	0.008 (0.013)	0.011 (0.019)	0.041*** (0.015)	0.052*** (0.017)	0.039* (0.023)
Constant	−0.134 (0.215)	0.116*** (0.020)	0.177*** (0.014)	−0.757 (0.585)	0.037* (0.022)	0.024 (0.029)	0.206*** (0.073)	0.192*** (0.031)	0.040 (0.091)
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	1344	1260	658	1344	1260	658	1344	1260	658
N	96	90	47	96	90	47	96	90	47
R^2	0.760	0.866	0.858	0.185	0.305	0.305	0.759	0.837	0.844

Table 7. (Continued)

	Innovation			Vitality			Harmony		
	east	mid	west	east	mid	west	east	mid	west
	0.052 (0.036)	−0.014 (0.085)	0.018 (0.072)	0.118 (0.101)	0.037 (0.326)	−0.070 (0.128)	−0.492** (0.203)	−0.044 (0.203)	0.588*** (0.160)
	−0.008 (0.046)	−0.120*** (0.037)	0.093** (0.036)	−0.302** (0.152)	−0.085 (0.098)	0.149*** (0.036)	0.081 (0.109)	0.279** (0.107)	−0.090* (0.048)
	−0.182 (0.139)	0.737*** (0.270)	0.119 (0.328)	0.179 (0.384)	−0.567 (0.460)	0.034 (0.343)	1.333** (0.641)	1.291*** (0.423)	2.319*** (0.478)
	0.044 (0.041)	0.137* (0.076)	0.160*** (0.039)	−0.109 (0.169)	0.070 (0.064)	−0.127 (0.116)	−0.045 (0.184)	0.171** (0.070)	0.037 (0.142)
	−0.041*** (0.007)	−0.040*** (0.010)	−0.051*** (0.016)	0.144*** (0.029)	−0.009 (0.018)	0.007 (0.016)	0.014 (0.018)	−0.026 (0.025)	0.014 (0.030)
	0.075*** (0.012)	0.073*** (0.016)	0.090*** (0.030)	0.113*** (0.037)	0.108*** (0.022)	0.006 (0.031)	0.015 (0.023)	0.075*** (0.025)	−0.019 (0.051)
	0.141*** (0.039)	0.037 (0.075)	0.002 (0.041)	0.052 (0.156)	−0.111* (0.064)	0.106 (0.114)	0.388** (0.181)	0.067 (0.076)	0.235 (0.146)
	YES	YES	YES	YES	YES	YES	YES	YES	YES
	YES	YES	YES	YES	YES	YES	YES	YES	YES
	1344	1260	658	1344	1260	658	1344	1260	658
	96	90	47	96	90	47	96	90	47
	0.775	0.757	0.674	0.869	0.904	0.936	0.455	0.520	0.385

Source: Authors' calculations.

Table 8. Heterogeneity analysis based on high-quality economic development: quantile regression.

Variable	q10	q25	q50	q75	q90
allsophistication	−0.112*	−0.048	−0.077	−0.038	0.365**
	(0.065)	(0.064)	(0.075)	(0.099)	(0.144)
govin	0.005	0.065***	0.099***	0.117***	0.180***
	(0.016)	(0.016)	(0.019)	(0.025)	(0.036)
hure	0.403***	0.506***	0.597***	0.606***	0.703***
	(0.041)	(0.040)	(0.047)	(0.062)	(0.091)
urban	−0.044***	−0.057***	−0.054***	−0.059***	−0.051*
	(0.012)	(0.012)	(0.014)	(0.018)	(0.027)
invfixed	−0.007**	−0.015***	−0.030***	−0.049***	−0.055***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.008)
fiscal	0.083***	0.097***	0.104***	0.121***	0.131***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.011)
Constant	0.126***	0.143***	0.164***	0.199***	0.203***
	(0.012)	(0.012)	(0.014)	(0.018)	(0.026)
Obs.	3262	3262	3262	3262	3262

Source: Authors' calculations.

The itemized regression results show that the increase of import sophistication significantly promotes the green development of the eastern region and the coordinated development of the western region, which is not conducive to the coordinated economic development of the eastern region. The impact of import sophistication on the coordinated development shows a completely different effect in the east and the west, which is mainly related to the types of regional imports. Due to the different stages of economic development, the maturity and stability of industrial structure are different, therefore the eastern region has greater demand for capital goods and intermediate goods with higher technology content, while the import structure of the western region is the opposite. Importing high sophistication capital goods and intermediate goods may squeeze out domestic manufacturers' production share of similar products in the region's industry, hinder the effective convergence of the domestic industrial production chain, and have a negative impact on the transformation of this type of high-tech industry (Ding & Liu, 2018; Liu & Zhang, 2009), which is bad for the coordinated development of local economy. From the research conclusions of evolutionary economic geographers on product sophistication and knowledge mobility, we can see that it is relatively easier and faster for western regions to absorb and learn knowledge with medium sophistication (Olav et al., 2010), and the role of technology spillover and knowledge diffusion on industrial structure upgrading is more prominent.

5.2.4. Quantile regression based on high-quality development degree

The effect of import sophistication on high-quality development may vary with the degree of high-quality development in different regions. In this paper, five quantiles (10%, 25%, 50%, 75%, 90%) are selected and analysed by panel quantile regression. The regression results in Table 8 show that, at the three quantiles of 25%, 50% and 75%, the increase in import sophistication is unfavourable to the high-quality development of economy, but the impact is not obvious. Below the 10% quantile and above the 90% quantile, the impact of import sophistication on the dependent variable is significant at the level of 10% and 5% respectively, but the effect direction is opposite. This may be due to the fact that many basic conditions in the use of human resources, infrastructure construction and other aspects of cities with poor economic development quality have not yet reached the

level of mutual integration and reasonable connection with foreign high-tech goods and services, and the import spillover effect cannot be fully exerted because of the restrictions of market subjects and objective environment. On the contrary, thanks to the relatively mature supporting facilities and resource reserves, the import spillover channels for areas with high-quality economic development above 90% quantile are relatively smooth, import competition also improves the production efficiency and resource allocation efficiency of enterprises (Melitz & Ottaviano, 2008), and multiple channels work together to promote the high-quality development of local economy.

5.3. Robustness check

This paper remeasures the economic high-quality development index by changing the index attribute and calculation method, so as to observe the consistency of the regression results.

5.3.1. Change the attribute of index
In the calculation of high-quality economic development using multiple secondary indexes above, the degree of dependence on foreign trade is treated as a positive index. However, the dependence on foreign trade is like a 'double-edged sword' for the development of a country. Excessive dependence on foreign trade will aggravate the economic and political conflicts between China and other countries, make the domestic development more vulnerable to external volatile environment and factors, and increase the risk of national security. Therefore, this paper draws on the practices of some domestic scholars (Zhan & Cui, 2016), taking the dependence on foreign trade as a moderate index and use PCA to calculate it again. It can be seen from Model (1) to Model (6) in Table 9, that when all kinds of control variables are added in turn, the increase in import technology content has a significant effect on promoting high-quality economic development at the level of 10%, the regression results are basically consistent with the benchmark regression.

5.3.2. Change the calculation method
Linear weighting method and principal component analysis are two methods commonly used in this kind of research literature. In order to verify the reliability of regression results under the PCA method in the text, this paper uses the linear weighted method to remeasure the high-quality economic development. Model (7) to Model (12) in Table 9 show that the addition of control variables does not change the significant positive impact of the increase in import sophistication on the explained variables, and once again shows that increasing the technology content of imports can significantly accelerate the process of high-quality development of regional economy.

5.4. Endogeneity check

There may be a two-way causality between high-quality economic development and import sophistication, and there may also be some other factors affecting them both.

Table 9. Robustness check.

Variable	Qualitymo						Averquality					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
allsophistication	0.276*	0.258*	0.253*	0.257*	0.265*	0.246*	0.122*	0.130*	0.118*	0.113**	0.115**	0.109*
	(0.157)	(0.148)	(0.143)	(0.145)	(0.145)	(0.130)	(0.071)	(0.068)	(0.060)	(0.056)	(0.055)	(0.056)
govin		0.182	0.186	0.187	0.118	0.172		−0.071**	−0.062**	−0.064**	−0.083***	−0.064**
		(0.144)	(0.148)	(0.148)	(0.141)	(0.194)		(0.028)	(0.027)	(0.027)	(0.029)	(0.029)
hure			0.127	0.127	0.188	0.134			0.317	0.318	0.335*	0.317
			(0.569)	(0.572)	(0.564)	(0.568)			(0.216)	(0.206)	(0.196)	(0.197)
urban				−0.045	−0.051	−0.057				0.065	0.063	0.061
				(0.104)	(0.094)	(0.096)				(0.050)	(0.047)	(0.046)
invfixed					0.063***	0.064***					0.018***	0.018***
					(0.023)	(0.023)					(0.006)	(0.006)
fiscal						0.120						0.042***
						(0.142)						(0.007)
Constant	0.175***	0.158***	0.156***	0.200**	0.187**	0.124	0.302***	0.309***	0.305***	0.243***	0.240***	0.218***
	(0.014)	(0.021)	(0.022)	(0.099)	(0.090)	(0.103)	(0.002)	(0.004)	(0.005)	(0.050)	(0.047)	(0.046)
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	3262	3262	3262	3262	3262	3262	3262	3262	3262	3262	3262	3262
N	233	233	233	233	233	233	233	233	233	233	233	233
R²	0.471	0.472	0.472	0.472	0.473	0.474	0.530	0.537	0.542	0.546	0.555	0.568

Source: Authors' calculations.

Table 10. Endogenous check.

Variable	Quality
L.quality	1.897***
	(0.629)
allsophistication	0.482**
	(0.239)
hure	1.344***
	(0.447)
govin	−1.138***
	(0.253)
invfixed	0.053***
	(0.016)
urban	0.824
	(0.726)
fiscal	0.004
	(0.040)
AR(1)	0.008
AR(2)	0.714
Sargan Test	0.271
Obs.	2796

Note: L.quality is one period lag of the explained variable. AR(1), AR(2), and Sargan tests report p-values.
Source: Authors' calculations.

The system GMM is used to deal with the potential bias of the estimation results caused by the possible endogeneity, and the $1 \sim 2$ lag period of import sophistication is taken as the tool variable. Considering that the regional high-quality development situation in the previous period may affect the next period, we introduce the high-quality development index of the lag period as the explanatory variable, that is to say, the empirical model is adjusted to the dynamic panel estimation model. The results of GMM estimation in Table 10 show that the regression coefficient of the core explanatory variable is significantly positive at the level of 5%, and AR(1) and AR(2) show that there is no second-order autocorrelation. Sargan statistics confirms that the tool variables of the model are valid, which once again proves the view that increasing the sophistication of imports can promote the high-quality development of the regional economy from the static panel regression.

5.5. Analysis of impact mechanism

5.5.1. Mechanism test based on the effect of import competition

The increase in import penetration means that domestic enterprises will face more intense import competition, so it is an appropriate index to measure import competition (Cunat & Guadalupe, 2009; Hermalin, 1992). Referring to the practice of Ding et al. (2016), the following formula is used to construct the import penetration rate of prefecture-level cities:

$$IMP_{ut} = \frac{import_{ut}}{import_{ut} + output_{ut} - \exp ort_{ut}} \tag{4}$$

In formula (4), $import_{ut}$ and $export_{ut}$ are the import and export volume of city u in year t, and the $output_{ut}$ is the GDP. The data are from the EPS database and the Wind Financial Terminal. We believe that foreign goods have different competitive

Table 11. Mechanism test based on the effect of import competition.

Variable	(1)	(2)	(3)
sophistication	0.109**	0.314***	−0.005
	(0.043)	(0.085)	(0.030)
sophistication*imp	0.606	−1.297	2.099***
	(0.680)	(0.833)	(0.396)
imp	0.010	0.036**	0.013
	(0.012)	(0.015)	(0.008)
govin	0.041**	0.041**	0.040**
	(0.017)	(0.017)	(0.017)
hure	0.290	0.311	0.293
	(0.245)	(0.257)	(0.246)
urban	0.055*	0.059	0.053
	(0.033)	(0.036)	(0.033)
invfixed	−0.004	−0.004	−0.004
	(0.004)	(0.004)	(0.004)
fiscal	0.006	0.006	0.006
	(0.006)	(0.006)	(0.006)
Region FE	YES	YES	YES
Time FE	YES	YES	YES
Obs.	3262	3262	3262

Source: Authors' calculations.

effects due to different import purposes. Therefore, based on the three aspects of overall, intermediate and final products, this paper adds the interaction between import competition and overall import sophistication, intermediate product import sophistication and final product import sophistication. Columns (1)–(3) of Table 11 show that the mediating role of competition effect is not significant at the level of total import and intermediate goods import, but in the region with greater import competition effect, the increase in the sophistication of final product imports will have a stronger effect on high-quality economic development.

5.5.2. Mechanism test based on import spillover

From a global perspective, developed countries tend to be at the forefront in terms of R&D investment and technological innovation, especially the G7 countries, which are the leaders in international advanced technology. Meanwhile, the import trade volume from the G7 countries accounted for a large proportion of China's total import trade. Therefore, the G7 countries are selected for measuring the import spillover effect. According to the LP model constructed by Lichtenberg et al. (1998), the specific process is as follows:

Foreign R&D capital stock is obtained by referring to the perpetual inventory method of Griliches (1980)

$$S_{jt} = (1-\delta)S_{jt-1} + RD_{jt} \tag{5}$$

In this formula, RD_{jt} is the R&D expenditure of country j in t period. The data is from the OECD database, which is converted into constant price in 2010 with purchasing power parity. The depreciation rate of R&D capital stock δ is assumed to be 5%. The calculation of R&D capital stock in the initial year is shown in formula (6):

$$S_{j2003} = RD_{j2003}/(\delta + \phi) \tag{6}$$

S_{j2003} is the R&D capital stock of country j in 2003, RD_{j2003} is the R&D capital investment of country j in 2003, and φ is the growth rate of R&D investment in country j from 2003 to 2016.

Then we can get the total technology spillover of China's import trade：

$$S_t = \sum_{j=1}^{7} \frac{S_{jt}}{GDP_{jt}} IM_{jt} \qquad (7)$$

In the formula (7), S_t is China's import spillover in year t, and GDP_{jt} is the gross domestic product of country j in year t. The data come from the World Bank's GDP statistics calculated at constant prices in 2010. IM_{jt} is China's total imports from country j in year t, this comes from the statistical database of the China Economic Network and is treated as the constant price. In addition, by replacing IM_{jt} in Equation (7) with China's import trade volume of intermediate or final products from country j, the spillover effect of China's intermediate product imports and the final product imports can also be obtained.

Furthermore, the import trade spillover effect of each city can be measured, the calculation formula is:

$$S_{ut} = \frac{IM_{ut}}{\sum_u IM_{ut}} S_t \qquad (8)$$

In formula (8), S_{ut} represents the import spillover of city u in year t, and IM_{ut} represents the import trade volume of city u in year t. The data come from the EPS statistical database.

The technology spillover effect of imported goods may be different due to the different fields (production or life) and uses, therefore we distinguish the types of products and investigate the impact mechanism of import technology content on high-quality economic development. Columns (1)–(3) of Table 12 show that when the interaction of import sophistication and import spillover at the overall level and

Table 12. Mechanism test based on import spillover.

Variable	(1)	(2)	(3)
sophistication	0.143***	0.273***	0.109*
	(0.044)	(0.079)	(0.062)
sophistication*spill	−0.003	−0.050*	0.146
	(0.014)	(0.030)	(0.170)
spill	−0.001	−0.002	−0.004*
	(0.001)	(0.001)	(0.002)
govin	0.042**	0.044**	0.042**
	(0.017)	(0.018)	(0.017)
hure	0.272	0.286	0.277
	(0.251)	(0.261)	(0.250)
urban	0.057*	0.060*	0.058*
	(0.034)	(0.036)	(0.034)
invfixed	−0.004	−0.004	−0.004
	(0.004)	(0.004)	(0.004)
fiscal	0.006	0.006	0.006
	(0.006)	(0.006)	(0.006)
Region FE	YES	YES	YES
Time FE	YES	YES	YES
Obs.	3262	3262	3262

Source: Authors' calculations.

the final product level are added, they are not significant, while the interaction between intermediate import sophistication and import spillover is significantly negative; this means that in regions where the spillover effect of imported intermediates is higher, increasing the technological content of imported intermediate products will not be conducive to the high-quality development of the local economy.

6. Conclusion and enlightenment

At present, China's economy has changed from a high-speed growth stage to a high-quality development stage, which means that the focus of development should not only be limited to the economic scale and growth rate, the development quality and efficiency need to be taken into consideration. High-quality development is a comprehensive concept with broad extension. It puts forward a full-scale and multilevel development goal. Correctly understanding and grasping the connotation of high-quality development is the premise and basic requirement of theoretical and empirical analysis. At the same time, the implementation of the new long-term strategy of expanding import trade conforms to the requirements of China's internal economic development, and demonstrates China's determination and will to open up to the outside world. In this context, how to grasp the new opportunities of opening up and expand the driving effect of import trade has been the focus of economists and policymakers. Can the technology content of imported products promote the high-quality development of economy? If so, will the promotion effect be affected by the types of imported products and the regions where they are located? The scientific answer to the above questions will provide a scientific and reasonable theoretical basis for the high-quality development promotion effect of import expansion.

Based on the available data, guided by the new development concept, this paper constructs the evaluation index system of China's high-quality development from the five perspectives of green development, people's life, innovation ability, economic vitality and coordinated development, and obtains the economic high-quality development index of 233 cities from 2003 to 2016 with the help of 15 secondary indexes, studies the impact of import sophistication on high-quality development, explores its mechanism, and classifies the imported products and sample cities according to the four standards of commodity type, per capita GDP, location, and high-quality development degree. By changing the index attribute and calculation method, the regional high-quality development index is remeasured to test its robustness, and the possible endogenous problems are solved by using system GMM. The results show that: on the whole, the increase in import sophistication will significantly promote the high-quality development of regional economy, and compared with the final products, the effect of intermediate products is stronger. In regions with higher and lower economic development, eastern areas, and regions with high-quality development above the 90% quantile, the positive impact is significant. In areas with high-quality development below the 10% quantile, the increase in technology content of imported products is obviously not conducive to the high-quality development of local economy. Mechanism analysis shows that the final product import competition effect will promote the high-quality promotion effect of import sophistication. In regions where the

spillover effect of intermediate products is stronger, the increase in the sophistication of imported intermediate products will have a negative impact on the high-quality development of the regional economy. Based on this, this paper puts forward the following suggestions:

China should continue to implement the strategic measure of expanding imports. From the perspective of the overall macroeconomic operation, expanding imports meets the new requirements of high-quality development and is an effective way to achieve high-quality supply. On the one hand, China's expanding and upgrading consumer demand can be met by importing a wide range of high-quality consumer goods; on the other, the inflow of many intermediate goods and capital goods adapts to the trend of domestic enterprises to build a global purchasing network. Through the spillover effect, the competition mechanism and 'learning by doing', enterprises are encouraged to improve the use efficiency of various production resources, including capital, land and labour, so as to promote enterprises' innovation ability and total factor productivity.

The technical content contained in import trade does not always drive all aspects of high-quality economic development. The results of itemized regression show that the increase in import sophistication has no significant effect on people's livelihood and innovation ability, and even has a less obvious negative impact on economic vitality and coordinated development. The disadvantage of importing products with high sophistication to the domestic economy is that some enterprises may form import dependence, relax their emphasis on absorptive capacity and innovation capability, or form a substitution effect on domestic enterprises producing similar products, threatening the survival and development of these enterprises. The survival-of-the-fittest effect of the competition mechanism may also cause the industrial chain to break. Therefore, while expanding the scale of imports, enterprises should pay attention to the matching degree of externally imported technology and internal technology, maintain the awareness of learning and cooperation, learn from each other, and stimulate business vitality through international cooperation to achieve technological progress and efficiency improvement. As the main leader of macro-control, the government can formulate some incentive and guiding policies for the scale and structure of enterprises' imports and strengthen the supervision and restraint of enterprises.

The large differences in the degree of regional development in China determine the different benefit from the increase in imported technology. The results of heterogeneity analysis show that the increase in import sophistication has no significant effect on the high-quality improvement of these cities, including cities with middle economic development, central and western regions. For cities in the 25%, 50%, and 75% quantiles, the increase in technology content in imported products will have a negative impact. Therefore, the government should publicize the concept of sustainable development, introduce relevant preferential and guiding policies focusing on supporting backward areas, break the monopoly of various resources and elements, adjust measures to local conditions, and effectively strengthen the government's systematic leadership over high-quality development, so as to enable all stakeholders to obtain more and more equitable economic benefits in import trade.

Notes

1. In the process of opening up, China has reached a consensus that comprehensive opening up has injected new impetus and added new vitality to economic development in the new era. Therefore, in the primary indexes, we choose "economic vitality" to represent "openness" in the new development concept, which not only contains the characteristics of opening up, but also contains some other indexes that can more accurately measure the vitality of development. The concept of "shared" development mainly examines whether the achievements of development can be shared by all citizens. Therefore, we use the "people's life" in the index system to reflect the distribution of social welfare.
2. Mu is China's unit of land measurement, generally 666.7 square meters.
3. The 233 prefecture-level cities selected in this paper are as follows: Province-level municipality (4): Beijing, Shanghai, Chongqing and Tianjin. Anhui Province (15): Anqing, Bengbu, Bozhou, Chuzhou, Fuyang, Hefei, Huaibei, Huainan, Huangshan, Lu'an, Maanshan, Suzhou, Tongling, Wuhu, Xuancheng. Fujian Province (9): Fuzhou, Longyan, Nanping, Ningde, Putian, Quanzhou, Sanming, Xiamen and Zhangzhou. Gansu Province (3): Jiuquan, Lanzhou, Tianshui. Guangdong Province (18): Chaozhou, Dongguan, Foshan, Guangzhou, Heyuan, Huizhou, Jiangmen, Jieyang, Maoming, Meizhou, Qingyuan, Shanwei, Shaoguan, Yangjiang, Zhanjiang, Zhaoqing, Zhongshan and Zhuhai. Guangxi Province (9): Baise, Beihai, Guilin, Hezhou, Liuzhou, Nanning, Qinzhou, Wuzhou, Yulin. Guizhou Province (2): Guiyang, Zunyi. Hainan Province (2): Haikou, Sanya. Hebei Province (11): Baoding, Cangzhou, Chengde, Handan, Hengshui, Langfang, Qinhuangdao, Shijiazhuang, Tangshan, Xingtai, Zhangjiakou. Henan Province (17): Anyang, Hebi, Jiaozuo, Kaifeng, Luoyang, Luohe, Nanyang, Pingdingshan, Puyang, Sanmenxia, Shangqiu, Xinxiang, Xinyang, Xuchang, Zhengzhou, Zhoukou, Zhumadian. Heilongjiang Province (11): Daqing, Harbin, Heihe, Jixi, Jiamusi, Mudanjiang, Qitaihe, Qiqihar, Shuangyashan, Suihua, Yichun. Hubei Province (11): E'zhou, Huanggang, Huangshi, Jingmen, Jingzhou, Shiyan, Suizhou, Wuhan, Xianning, Xiaogan, Yichang. Hunan Province (10): Changde, Chenzhou, Hengyang, Loudi, Shaoyang, Xiangtan, Yiyang, Yongzhou, Yueyang, Changsha. Jilin Province (6): Baicheng, Jilin, Liaoyuan, Siping, Tonghua, Changchun. Jiangsu Province (13): Changzhou, Huai'an, Lianyungang, Nanjing, Nantong, Suzhou, Suqian, Taizhou, Wuxi, Xuzhou, Yancheng, Yangzhou and Zhenjiang. Jiangxi Province (11): Fuzhou, Ganzhou, Ji'an, Jingdezhen, Jiujiang, Nanchang, Pingxiang, Shangrao, Xinyu, Yichun, Yingtan. Liaoning Province (14): Anshan, Benxi, Chaoyang, Dalian, Dandong, Fushun, Fuxin, Huludao, Jinzhou, Liaoyang, Panjin, Shenyang, Tieling, Yingkou. Qinghai Province (1): Xining. Shandong Province (15): Dezhou, Dongying, Heze, Jinan, Jining, Liaocheng, Linyi, Qingdao, Rizhao, Tai'an, Weihai, Weifang, Yantai, Zaozhuang, Zibo. Shanxi Province (9): Datong, Jincheng, Jinzhong, Linfen, Taiyuan, Xinzhou, Yangquan, Yuncheng, Changzhi. Shaanxi Province (5): Baoji, Hanzhong, Weinan, Xi'an, Xianyang. Sichuan Province (13): Chengdu, Deyang, Guangyuan, Leshan, Luzhou, Mianyang, Nanchong, Neijiang, Panzhihua, Suining, Ya'an, Yibin and Zigong. Yunnan Province (2): Kunming, Yuxi. Zhejiang Province (11): Hangzhou, Huzhou, Jiaxing, Jinhua, Lishui, Ningbo, Quzhou, Shaoxing, Taizhou, Wenzhou and Zhoushan. Xinjiang Autonomous Region (2): Karamay, Urumqi. Inner Mongolia Autonomous Region (6): Bayannaoer, Baotou, Chifeng, Hohhot, Hulunbuir, Ulanqab. Ningxia Autonomous Region (3): Shizuishan, Wuzhong, Yinchuan.
4. The results of the Hausman test show that the original hypothesis should be rejected, so the fixed effect model is used in the research method.

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