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Multi stage portfolio optimization based on differential evolution algorithm

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Abstract. This paper calculates the influence coefficient, the induction coefficient, the production induction amount, the production induction coefficient and the final dependency degree of each industry with the input-output table in 2012, analyzes China's industrial structure from the quantity and puts forward the corresponding conclusion and policy recommendations.

Key words. The influence coefficient, The induction coefficient, The production induction amount, The production induction coefficient, The final dependency degree.

1. Introduction

Due to the existence of intricate links among various industrial sectors, one of technology, product prices, wage levels, demand conditions of a certain industrial sector changing will directly affect the supply and demand quantity and cost and price changes of industrial sectors with direct supply-demand relationship with this industry, and spread to other industrial sectors. This is the spread effect analysis of industry, which is an important part of input-output analysis and applications.

2. Analysis on the spread effect of industry

(1) Analysis on the induction coefficient and influence coefficient

The induction coefficient reflects the extent to which a sector is subjected to the demand induction degree when sectors all increase the end use of a unit, that is, the output value that the sector needs to provide for the production of the various sectors of society.

The inductance coefficient of some industry (row) $= n \sum_j q_{ij} / \sum_i \sum_j q_{ij}$

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It is the row-oriented total average value of all industries in the Leontief inverse matrix divided by the row-oriented summing value of industry in the Leontief inverse matrix. When the coefficient of inductance is greater than or less than 1, it indicates that the production of the sector is affected by other sectors, with the degree greater than or less than the social average.

The influence coefficient reflects the demand spreading degree of the production of the various sectors of the national economy when some sector increases a unit of final product.

The influence coefficient of some industry (column) $= n \sum_i q_{ij} / \sum_i \sum_j q_{ij}$

It is the column-oriented total average value of all industries in the Leontief inverse matrix divided by the column-oriented summing value of industry in the Leontief inverse matrix. When the coefficient of influence is greater than or less than 1, it indicates that the spread effect degree of the production of this sector on other sectors is greater or less than the social average.

The induction coefficient and influence coefficient can be calculated by China's basic flow table in 2012 as shown in Table 1

Table 1. The induction coefficient and influence coefficient

	induction coefficient	influence coefficient
Product and service of agriculture, forestry, animal husbandry and fishery	1.722821412	0.724764407
Coal mining products	1.264968676	0.836648862
Extraction products of Oil and gas	1.446718319	0.744148139
Metal mining products	0.994902146	0.972745089
Non-metallic minerals and other mining products	0.599626004	0.936399482
Food and tobacco	1.368731531	0.985000608
Textile	1.206198012	1.182064376
Textile clothing, footwear, leather, down feather and its products	0.550458845	1.192252012
Wood processed goods and furniture	0.689041568	1.159067593
Papermaking and printing, stationery and sporting goods	0.998633136	1.155720308
Petroleum, coking products and nuclear fuel processed products	1.496674752	1.00230061
chemical product	3.541371106	1.219415715
Non-metallic mineral products	0.85105726	1.123658418
Metal smelting and calendaring processed products	2.966591326	1.206928098
metal products	0.969850045	1.252877195
General equipment	1.037395816	1.268288084
Special equipment	0.686440364	1.25964155
Transportation equipment	0.948268804	1.285115821

Table 1. Continued

Electrical machinery and equipment	1.09384046	1.327530102
Communications equipment, computers and other electronic equipment	1.666084696	1.374843427
Instrumentations	0.564340358	1.26532397
Other manufactured products	0.395620356	1.197475734
Waste products and materials	0.536940769	0.560456429
Metal products, machinery and equipment repair services	0.371343947	1.268137458
The production and supply of electricity, heating power	1.982317355	1.076627755
Gas production and supply	0.419879955	0.978475077
Water production and supply	0.381835119	0.874177544
Constructions	0.483050672	1.153235701
Wholesale and Retail	1.395352253	0.611623196
Transportation, warehousing and postal services	1.569310092	0.948891567
Accommodation and catering	0.65484886	0.866462824
Information transmission, software and information technology services	0.581908901	0.883572362
Finance	1.637764532	0.688331951
Real estate	0.620663903	0.549812194
Leasing and business services	1.128611506	1.032454118
Scientific research and technical services	0.704803947	1.010914144
Water conservancy, environment and public facilities management	0.412627435	0.905065681
Residents services, repairs and other services	0.543102517	0.830378534
Education	0.369572329	0.582896967
Health and social work	0.348669765	0.972278064
Culture, sports and entertainment	0.427446721	0.813156291
Public administration, social security and social organization	0.370314429	0.720842545

We can see from the table that among the 42 industrial sectors, there are 16 sectors with the induction coefficient greater than 1, among which the sector of chemical products (3.541) has the largest degree of inductance, and the metal smelting and calendaring processed products (2.967), the production and supply of electricity and heating power (1.982), etc. are also relatively great. There are 21 sectors with the influence coefficient greater than 1, among which the influence coefficient of the sector of communications equipment, computers and other electronic equipment (1.375) sector is the largest, and the influence coefficient of electrical machinery and equipment (1.328), transportation equipment (1.285) is relatively large.

It can be seen from Table 1 that the industrial sectors with both influence coefficient and induction coefficient greater than 1 are chemical products, finance, smelting and calendaring processed products, communication equipment, computers and other electronic equipment, among which the induction coefficient and influence coefficient of the sectors of communication equipment, computer and other electronic Equipment are all very high. So, this kind of industries play a very important role in China's economic development, which are likely to become the leading industries in China and need to be vigorously developed by country.

(2) Analysis on production induction amount and production induction coefficient

The production induction amount refers to the full production volume of all industries stimulated by the inter-industry spread effect when the final demand in the socio-economic system is increased. Its function is to know the effect of the final demand projects in the economic system on inducing the production of each industry. The production induction coefficient is the ratio of the production induction amount to the total corresponding final demand.

According to the equation of $X = (I-A)^{-1}Y$, by multiplying the value of a row in the Leontief inverse matrix with the column vectors classified by item, including the investment column vector, the consumption column vector and the export column vector respectively, and then get the result of the production volume of the various industries induced by the various final demand projects will be obtained, that is, the production induction value of the final demand, recorded as X_i^s

$$X_i^s = \sum_{k=1}^{n} C_{ik} Y_k^s (i = 1, 2, 3) .$$

In the formula, X_i^s represents the production value of the i-th industry induced by the final demand of item S; C_{ik} refers to the element in $(I-A)^{-1}$; Y_k^s means the final demand amount of item S of the k-th industry; S = 1, 2, 3 respectively represents the three final demand projects of the investment, consumption and export.

The production induction coefficient W_i^s is the value obtained by dividing the total corresponding final demand with X_i^s, the production induction value of various final demand project of some industry, that is

$$W_i^s = \frac{\sum\limits_{k=1}^{n} C_{ik} Y_k^s}{\sum\limits_{k=1}^{n} Y_k^s} = \frac{X_i^s}{\sum\limits_{k=1}^{n} Y_k^s} .$$

In the formula, W_i^s represents the S-th production induction coefficient of the final demand of the i-th industry; $\sum\limits_{k=1}^{n} Y_k^s$ represents the S-th total number of the final demand of various industries.

The production induction amount and production induction coefficient can be calculated by the formula, that is, Table 2, Table 3.

Table 2. Production induction amount

	Consumption	Investment	Export
Product and service of agriculture , forestry , animal husbandry and fishery	265180420.5	83739157.43	9779837.728
Coal mining products	34202.41865	62391.7015	19128.25391
Extraction products of Oil and gas	0	109286.8762	61305.28901
Metal mining products	0	3874.968824	3736.124895
Non-metallic minerals and other mining products	0	-4374.695929	7418.468599
Food and tobacco	69121252.81	3313620.253	5148114.564
Textile	71690.11476	19216.79576	437401.4434
Textile clothing, footwear, leather, down feather and its products	289588.7314	3248.373349	304159.6363
Wood processed goods and furniture	30789.86067	42547.25464	96137.80766
Papermaking and printing, stationery and sporting goods	220208.5446	100688.3561	664687.0206
Petroleum, coking products and nuclear fuel processed products	1196553.106	227520.8932	606202.7252
chemical product	12970769.7	500295.1694	21513115.54
Non-metallic mineral products	33292.18733	-4479.64034	175853.7076
Metal smelting and calendaring processed products	0	48579.59356	1177288.903
metal products	41732.10079	249426.7548	364571.263
General equipment	15438.20891	1293294.439	662756.3759
Special equipment	18038.4049	2739584.788	489492.0634
Transportation equipment	705189.4199	2742955.706	590057.9525
Electrical machinery and equipment	326900.7627	821889.3779	1009244.997
Communications equipment, computers and other electronic equipment	419563.6434	731161.4285	3416819.067
Instrumentations	6290.073242	38031.29702	56438.75452
Other manufactured products	2059.640106	1278.131416	4188.001651
Waste products and materials	0	185.5517802	952.6178666
Metal products, machinery and equipment repair services	0	0	0
The production and supply of electricity, heating power	1357555.065	0	37035.18031
Gas production and supply	14474.63759	660.4499805	0
Water production and supply	4470.49572	0	0
Constructions	0	3152206.6	18902.23813

Table 2. Continued

Wholesale and Retail	5520942.51	2442284.72	5188085.384
Transportation, warehousing and postal services	3687853.693	975289.3849	2497682.188
Accommodation and catering	855134.1863	0	41281.1422
Information transmission, software and information technology services	280081.3676	373155.2125	47384.54637
Finance	4240351.572	0	167125.3398
Real estate	1211105.676	551190.8609	0
Leasing and business services	427760.7926	0	792277.4574
Scientific research and technical services	985326.2678	171446.2312	3762.746483
Water conservancy, environment and public facilities management	131640.6087	0	2993.563016
Residents services, repairs and other services	370875.0984	0	5604.468807
Education	128861.7052	0	269.6806508
Health and social work	47152.82274	0	98.96937094
Culture, sports and entertainment	67255.18263	0	8062.293643
Public administration, social security and social organization	319266.4913	0	616.1027201

Table 3. Production induction coefficient

	Consumption	Investment	Export
Product and service of agriculture , forestry , animal husbandry and fishery	0.097593777	0.033712787	0.007156021
Coal mining products	1.25874E-05	2.51185E-05	1.39964E-05
Extraction products of Oil and gas	0	4.39981E-05	4.48578E-05
Metal mining products	0	1.56003E-06	2.73377E-06
Non-metallic minerals and other mining products	0	-1.76122E-06	5.42818E-06
Food and tobacco	0.025438545	0.00133404	0.003766936
Textile	2.6384E-05	7.73654E-06	0.000320052
Textile clothing, footwear, leather, down feather and its products	0.000106577	1.30777E-06	0.000222557
Wood processed goods and furniture	1.13315E-05	1.71292E-05	7.03452E-05
Papermaking and printing, stationery and sporting goods	8.10429E-05	4.05364E-05	0.000486359
Petroleum, coking products and nuclear fuel processed products	0.000440365	9.15983E-05	0.000443566
chemical product	0.004773604	0.000201415	0.015741398

Table 3. Continued

Non-metallic mineral products	1.22525E-05	-1.80347E-06	0.000128674
Metal smelting and calendaring processed products	0	1.95578E-05	0.000861436
metal products	1.53586E-05	0.000100417	0.000266761
General equipment	5.68169E-06	0.000520671	0.000484947
Special equipment	6.63864E-06	0.001102937	0.000358167
Transportation equipment	0.000259529	0.001104294	0.000431752
Electrical machinery and equipment	0.000120309	0.000330887	0.000738476
Communications equipment, computers and other electronic equipment	0.000154411	0.00029436	0.002500126
Instrumentations	2.31492E-06	1.53111E-05	4.12969E-05
Other manufactured products	7.58005E-07	5.14567E-07	3.06441E-06
Waste products and materials	0	7.47018E-08	6.97042E-07
Metal products, machinery and equipment repair services	0	0	0
The production and supply of electricity, heating power	0.000499618	0	2.70991E-05
Gas production and supply	5.32707E-06	2.65892E-07	0
Water production and supply	1.64527E-06	0	0
Constructions	0	0.001269056	1.3831E-05
Wholesale and Retail	0.002031861	0.000983246	0.003796183
Transportation, warehousing and postal services	0.001357233	0.000392645	0.001827583
Accommodation and catering	0.000314713	0	3.02059E-05
Information transmission, software and information technology services	0.000103078	0.00015023	3.46718E-05
Finance	0.001560567	0	0.000122288
Real estate	0.000445721	0.000221906	0
Leasing and business services	0.000157428	0	0.000579719
Scientific research and technical services	0.000362627	6.9023E-05	2.75325E-06
Water conservancy, environment and public facilities management	4.84474E-05	0	2.19043E-06
Residents services, repairs and other services	0.000136492	0	4.10086E-06
Education	4.74247E-05	0	1.97328E-07
Health and social work	1.73536E-05	0	7.2417E-08
Culture, sports and entertainment	2.47518E-05	0	5.89927E-06
Public administration, social security and social organization	0.000117499	0	4.5081E-07

It can be seen from the production induction amount calculated by the input-

output table in 2012, the industry with the largest production induction amount in terms of consumption is agriculture, forestry, animal husbandry and fishery products and services (2651804.205 million), followed by food and tobacco (691212.5231 million), Chemical products (129707.697 million) and so on, which indicates that the spread effect among industries plays a relatively large stimulation role in these industries when the consumer demand amount grows in the current society. And at this stage, the induction amount of agriculture, forestry, animal husbandry and fishery products and services is huge. In the aspect of investment, the industry with the largest production induction amount is agriculture, forestry, animal husbandry and fishery products and services (837391.5743 million), followed by food and tobacco (33136.20253 million), construction (31522.066 million) and so on, indicating that changes in investment demand leads to relatively large production induction amount for these industries. At this stage, people's investment in the housing construction, equipment and others can promote the production capacity of these sectors, and promote economic development. seen from the export, the industry with the largest production induction amount is chemical product (215131.1554 million), followed by agriculture, forestry, animal husbandry and fishery products and services (97798.37728 million), wholesale and retail (51880.85384 million) and so on, which shows that these industries are more sensitive to changes in export demand and can be developed by increasing export demand.

(3) Analysis on the final dependency degree

The final dependency degree of the production is used to measure the extent to which the production of the each industry sector depends on the final demand project (consumption, investment, export, etc.), including direct dependence and indirect dependence, that is, the direct or indirect impact degree of the final demand on the production of the each industry. The dependency coefficient of the industry on the final demand is obtained by the production induction output value of the final demand project of the i-th industry dividing the sum of the production induction amount of each demand project of the corresponding industry.

$$Z_i^s = \frac{X_i^s}{\sum_{S=1}^{3} Y_i^s} (i = 1, 2, 3 \ldots\ldots n;\ s = 1, 2, 3)\,.$$

The formula represents the dependency coefficient of the i-th industry on the s-th final demand; $\sum_{S=1}^{3} Y_i^s$ means the total number of the production-induced amount of each final demand project of the i industry.

The final dependency degree of the production and the production induction coefficient indicator have different economic implications and roles. Their roles are to understand the dependency degree of the production of each industry on market demand; their economic implications mean how much support does the production of each industry get from the final demand. As the Leontief inverse matrix is used as a computational tool, the final demand dependency degree of the industry takes into account the impacts of not only the direct but also the indirect final demand on industrial production. The industry sector with a large degree of dependence

reflects that this industrial sector is relatively sensitive to the expansion effect of consumption, investment or exports. The calculated final dependency degree is shown as Table4.

Table 4. The final dependency degree

	Consumption	Investment	Export
Product and service of agriculture , forestry , animal husbandry and fishery	0.739283113	0.233452171	0.027264716
Coal mining products	0.295555798	0.539149858	0.165294344
Extraction products of Oil and gas	0	0.640632447	0.359367553
Metal mining products	0	0.509121155	0.490878845
Non-metallic minerals and other mining products	0	-1.437261059	2.437261059
Food and tobacco	0.890933115	0.042710655	0.06635623
Textile	0.135697485	0.036374204	0.827928311
Textile clothing, footwear, leather, down feather and its products	0.4850759	0.005441191	0.509482909
Wood processed goods and furniture	0.181677974	0.251053394	0.567268632
Papermaking and printing, stationery and sporting goods	0.223429522	0.102161119	0.674409359
Petroleum, coking products and nuclear fuel processed products	0.589354688	0.112063981	0.29858133
chemical product	0.370761	0.014300611	0.614938389
Non-metallic mineral products	0.162665738	-0.021887538	0.8592218
Metal smelting and calendaring processed products	0	0.039628715	0.960371285
metal products	0.06364219	0.380380202	0.555977608
General equipment	0.007830735	0.655998803	0.336170462
Special equipment	0.005555209	0.843698043	0.150746747
Transportation equipment	0.174629509	0.679251551	0.14611894
Electrical machinery and equipment	0.151480741	0.380850786	0.467668473
Communications equipment, computers and other electronic equipment	0.0918576	0.160077584	0.748064816
Instrumentations	0.062426215	0.377443925	0.560129859
Other manufactured products	0.273678207	0.169833901	0.556487892
Waste products and materials	0	0.16302647	0.83697353
The production and supply of electricity, heating power	0.973443683	0	0.026556317

Table 4. Continued

Gas production and supply	0.956362989	0.043637011	0
Water production and supply	1	0	0
Constructions	0	0.994039234	0.005960766
Wholesale and Retail	0.419801633	0.185706537	0.39449183
Transportation, warehousing and postal services	0.515004005	0.136197903	0.348798092
Accommodation and catering	0.953948643	0	0.046051357
Information transmission, software and information technology services	0.399761522	0.532606281	0.067632197
Finance	0.962081403	0	0.037918597
Real estate	0.687231491	0.312768509	0
Leasing and business services	0.350612608	0	0.649387392
Scientific research and technical services	0.849027439	0.14773031	0.003242251
Water conservancy, environment and public facilities management	0.977765206	0	0.022234794
Residents services, repairs and other services	0.985113485	0	0.014886515
Education	0.997911579	0	0.002088421
Health and social work	0.99790549	0	0.00209451
Culture, sports and entertainment	0.892955871	0	0.107044129
Public administration, social security and social organization	0.998073972	0	0.001926028

After calculating China's input-output table in 2012, it has found that China's dependency degree on the three kinds of total social demands (consumption, investment, export) are 0.6985,0.197,0.1045 respectively. The overall export-oriented degree of Chinese economy is relatively low, while the degree of dependence of consumption is relatively high.

In terms of consumption, the water production and supply sector has a maximum dependency degree of 1, indicating that it entirely relies on the consumption of society, without investment and export. The final dependency degree of public management, social security and social organization, education, health and social work on consumption is also higher than 99%, indicating that it almost entirely depend on consumption, because these departments are mostly industries serving for the society, with poor flexibility and low innovation. Seen from the results, the financial industry highly relies on the consumption, whose dependency degree is 96.21%. however, with China's economic development, the dependence of this industry on consumption will decline, while the dependence on investment and exports will rise gradually.

Table 5. Different types of industrial clusters divided based on the top ten final dependency degree of each final demand

Types	Included Industries
Consumption-dependent type	Water production and supply (1), public administration, social security and social organizations (0.998), education (0.9979), Health and social work (0.9979), resident services, repairs and other services (0.985), water conservancy, environment and public facilities management (0.9778), production and supply of electricity and heating power (0.973), Finance (0.962), gas production and supply (0.9564), accommodation and catering (0.954)
Investment-dependent type	Constructing (0.999), special equipment (0.844), transportation equipment (0.679), general equipment (0.656), oil and gas extraction products (0.641), coal mining products (0.539), information transmission, software and information technology services (0.533), metal mining products (0.509), electrical machinery and equipment (0.381), metal products (0.380)
export-dependent type	Non-metallic mineral and other mining products (2.437), metal smelting and calendaring processed products(0.960), non-metallic mineral products (0.859), waste products and materials (0.837), textiles (0.828), communications equipment, computers and other electronic equipment (0.748), papermaking and printing, stationery and sporting goods (0.674), leasing and business services (0.649), chemical products (0.615), wood processing and furniture (0.567)

In the aspect of investment, the building's dependence is the highest as 99.4%, indicating that the development of the construction industry is inseparable from people's investment. With the increasing investment activities, the industry will also develop rapidly. The investment dependence of special equipment is as high as 84.4%, which indicates that the production of special equipment is also very dependent on investment activities. It can be found that there are 11 industrial sectors with no dependence on the investment. These industries have no response to the status of investment activities. the industries with negative final dependency degree are non-metallic mineral products (-2.189%) and other mining products (-143.726%), both of which are non-metallic mineral-related industries, with exclusion effect on investment activities.

In terms of exports, non-metallic mineral and other mining products have the highest final dependency degree, which is 243.726%, indicating that this industry needs for export and export plays a vital role in the survival of this industry. So, the country should strongly encourage and support the export of this industry. The dependency degree of metal smelting and calendaring processed products (96.04%), non-metallic mineral products (85.92%), waste product and material (83.7%) is also relatively high, indicating that China's metal and non-metallic mineral products are more inclined to export, rather than home consumption. Similarly, it has found that the final dependency degree of production and supply of gas and water, the real estate industry is 0, because these industrial products cannot be exported to foreign countries.

3. Policy recommendations on China's harmonious economic development based on the spread effect analysis

(1) Shall encourage and support the industries with both high induction coefficient and influence coefficient

When the influence coefficient of a certain industry is large, it will play a obvious role in stimulating other sectors, while the industry with high induction coefficient plays a very important role in balancing the whole economic development because of its high sensitivity to economic development. In the quantitative analysis, as the induction coefficient and influence coefficient of industries like chemical products, metal smelting and calendaring processed products, production and supply of electric and heating power, communications equipment, computers and other electronic equipment, general equipment are higher than the social average level, they should be actively encouraged to develop by the country.

(2) To promote the development of various industries according to the actual situation of production induction amount and production induction coefficient of various industry.

For industries with comparatively large production induction amount and production induction coefficient in consumption aspect, such as agriculture, forestry, animal husbandry and fishery products and services, food and tobacco, chemical products, wholesale and retail, finance, can be stimulate to develop through consumption. However, other industries like computers and other electronic equipment, electrical machinery and equipment, general equipment can be developed by increasing investment, while chemical products, stationery and sporting goods and papermaking and printing and other industries can be promoted by increasing exports.

(3) To develop reasonable measures to promote industrial development according to the various industries' dependence on the consumption, investment and export.

For industries with high dependence on consumption, such as water production and supply, public management, social security and social organization, education, health and social work, the impacts of consumption on the development of these industries should be paid attention to. While the construction special equipment, transportation equipment, general equipment, oil and natural gas extraction products, coal mining products and other industries rely heavily on investment, so, the impacts of investment on the development of these industries should be paid attention to. Non-metallic mineral products and other mining products, metal smelting and calendaring products, non-metallic mineral products, waste products and materials, textiles and other industries depend on exports highly, so the impacts of export on these industries should be noticed.

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