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RESEARCH ARTICLE

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## Abstract

Urban rail transit has provided safe, convenient, fast and comfortable transport services. Its development and construction not only require a huge investment but also have a long industry chain and involve industry sectors of different types. This paper studies backward linkage and forward linkage industries of urban rail transit industry according to input-output tables for urban rail transit of subdivided sectors in 2007 and 2012.

## Keywords

correlation, backward linkage, forward linkage, urban rail transit

## 1 Introduction

Industrial chain is a concept in industrial economics which is based on certain technical and economic relations among the various industrial sectors, and the chain type is formed based on the specific logical relationship and the relationship between the time and space distribution industrial links in the industrial chain occurred mainly between forward correlation and backward linkage (Bao, 2005; Chang and Edward, 2006). Urban rail transit has its own particularity, the industry is highly relevant to construction, metal smelting, equipment manufacturing, electronics, materials, machinery processing, computer and other industrial development, and there is a close relationship between the nontraditional industry and the city real estate (Erik and Hong, 1996). If considering the whole life cycle of city rail transit project as the main line, the rail transportation industry chain can be divided into five parts, planning and design consulting, engineering construction, equipment manufacturing, operation and value added service (Wei et al., 2013). Analysis of industry association, backward linkage industry of the rail transportation mainly included gas production and supply industry, oil processing industry, automobile manufacturing, automobile spare parts and accessories manufacturing, finance, electric power, heat supply and supply, other transportation equipment manufacturing and business services, etc. While forward correlation industry mainly included public management and social organization, aquatic products processing industry, advertising industry, geological survey, education, science technology exchange and promotion services, and tourism, etc. (Li, 2007).

According to the basic principle of the input-output, the backward linkage measure and front linkage measure of the industrial sector is the main index to measure the correlation effect between one industry and other industries. The backward linkage measures the industrial sector depending on intermediate inputs for all industrial sectors as buyers. While forward linkage measuring the impact of traffic department as a seller to all sectors analyze the whereabouts and related degree of department's product' as related link from supply direction. Based on the analysis of domestic and international research

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status, the paper studies backward linkage and forward linkage industries of urban rail transit industry according to input-output tables for urban rail transit of subdivided sectors in 2007 and 2012 (Li, 2007; Yang, 2005).

## 2 Backward and forward linkage measurement models

### 2.1 Place of figures

Index calculation formula of direct backward linkage,

$$\delta_j = \frac{\sum_{i=1}^n a_{ij}}{\frac{1}{n} \sum_{j=1}^n \sum_{i=1}^n a_{ij}} \quad (j = 1, 2, \dots, n) \quad (1)$$

Index calculation formula of complete backward linkage,

$$\bar{\delta}_j = \frac{\sum_{i=1}^n l_{ij}}{\frac{1}{n} \sum_{j=1}^n \sum_{i=1}^n l_{ij}} \quad (j = 1, 2, \dots, n) \quad (2)$$

In the formula,  $a_{ij}$  means the direct consumption coefficient and  $l_{ij}$  refers to the value of element in row  $i$  and column  $j$  in Leontief inverse matrix  $L = (I - A)^{-1}$ .

### 2.2 Forward linkage measurement

#### 2.2.1 Forward linkage and complete forward linkage

Forward linkage aims to measure the influence degree of the department as a seller on all departments. It tries to measure the relationship among departments from the supply direction to investigate where the department products go. For conciseness, forward linkage measurement is worked out according to Leontief price model.

Leontief price model can be written in the following form:

$$P' = P'A + N'\hat{X}^{-1} \quad (3)$$

In the above formula,  $P' = (P_1, P_2, \dots, P_n)$  means the row vector of setting unit price of various departments as the element;  $N' = (N_1, N_2, \dots, N_n)$  refers to the row vector of setting initial input cost of various departments as the element;  $\hat{X}^{-1}$  indicates the diagonal matrix of setting total output of various departments represented by physical quantity as the leading diagonal element. If the form of price index is used, price index of the base period can be set as 1. Therefore,  $P_i$  means the cost for one unit output of department, and it can be divided into intermediate input cost and initial input cost. In another word, Leontief model of the base period is as follows:

$$P'_0 = P'_0A + N'_0\hat{X}^{-1} \quad (4)$$

Through conversion, Leontief model can measure the situation when production didn't change and only the price changed leading to the output value getting changed. Assume that the input-output framework doesn't change, and the quantity of production also doesn't change, but the initial input cost

changed (e.g. The workers want their salaries getting raised). Leontief model of the manufacturing period is changed into:

$$P'_t = P'_tA + N'_t\hat{X}^{-1} \quad (5)$$

At this time, the output of various departments in report period is as follows:

$$P'_t\hat{X} = P'_tA\hat{X} + N'_t = P'_t\hat{X}\hat{X}^{-1}A\hat{X} + N'_t \quad (6)$$

If the row vector of output value in report period is recorded as  $X'_t = P'_t\hat{X}$ , and  $H = \hat{X}^{-1}A\hat{X}$ , then

$$X'_t = X'_tH + N'_t \quad (7)$$

Because,  $A\hat{X} = Z$   
so

$$H = (h_{ij}) = \hat{X}^{-1}Z \quad \text{or} \quad h_{ij} = \frac{z_{ij}}{X_i} \quad (8)$$

Here  $h_{ij}$  is called output coefficient or distribution coefficient, meaning the proportion of the quantity sold to department  $j$  in the total output of department  $i$ . Therefore, it shows the direct dependence of department  $i$  as a seller on department  $j$  as a buyer. Direct forward linkage of department  $i$  can be defined as:

$$F_i = \frac{\sum_j z_{ij}}{X_i} = \sum_j h_{ij} \quad (9)$$

This is the well-known Gaussian supply-driven input-output model. It describe the relationship between the initial input and the total output, its equivalent variation form is as follows:

$$X' = N'(I - H)^{-1} \quad (10)$$

$G = (g_{ij}) = (I - H)^{-1}$ , so  $G$  is called Gaussian inverse matrix.

Complete forward linkage can be expressed with the row sum of Gaussian inverse matrix  $G$ . In another word, complete forward linkage of department  $i$  can be defined as:

$$\bar{F}_i = \sum_j g_{ij} \quad (11)$$

In order to form a contrast with Leontief row demand-driven model,  $\bar{F}_i$  is also known as input multiplier or supply multiplier.

#### 2.2.2 Calculation for forward linkage measurement of urban rail transit industry

The relative value of weighted direct forward linkage and weighted complete backward linkage is as follows:

$$\theta_i = \frac{F_i}{\sum_i \alpha_i F_i} = \frac{\sum_j h_{ij}}{\sum_j \alpha_j h_{ij}} \quad (12)$$

$$\bar{\theta}_i = \frac{\bar{F}_i}{\sum_i \gamma_i \bar{F}_i} = \frac{\sum_j g_{ij}}{\sum_i \sum_j \gamma_i g_{ij}} \quad (13)$$

In the above formula,  $\alpha_i$  means the proportion of total output of department  $i$  in total output of urban economy, i.e. the total product mix coefficient;  $\gamma_i$  refers to the proportion of the initial input of department  $i$  in initial input of urban economy, i.e. the initial input mix coefficient  $\gamma_i = \frac{n_i}{\sum_i n_i}$

### 2.3 The investment multiplier model

Under certain condition of marginal propensity to be consumed, when total investment is increased (or decreased), leading to  $K$  times increased (or reduced). Assumed the national income increment being  $\Delta Y$ , the invest increment being  $\Delta I$ , the consumption increment being  $\Delta C$ , multiplier being  $K$ , marginal propensity to consume being  $b = \Delta C / \Delta Y$ , then:

$$\Delta Y = \Delta I + \Delta C \quad (14)$$

$$K = \frac{\Delta Y}{\Delta I} = 1 / \left( \frac{\Delta Y - \Delta C}{\Delta Y} \right) = 1 / (1 - b) \quad (15)$$

Usually, marginal propensity  $b < 1$ , multiplier  $K < 1$ , the infinite series expansion is carried out:

$$K = 1 + b + b^2 + b^3 + \dots + b^n \quad (16)$$

Thus, when total investment  $\Delta I$  is increased, the total increased amount  $\Delta Y$  is as following:

$$\Delta Y = K \Delta I = \Delta I + b \Delta I + b^2 \Delta I + \dots + b^n \Delta I \quad (17)$$

Thus, investment benefit formula of urban rail transit is as following (18),

$$B_r = K_r \times I_r \quad (18)$$

Where,  $B_r$  is multiplier contribution effect value of rail transportation investment to national economy,  $I_r$  is the invest value,  $K_r$  is the investment multiplier, this multiplier is the key parameter to calculate the investment multiplier effect.

### 3 Correlation analysis of China's urban rail transit industry. Backward linkage analysis of China's urban rail transit industry

Backward linkage measurement and complete backward linkage measurement of China's urban rail transit industry are worked out by utilizing direct consumption coefficients and complete consumption coefficients in input-output tables for China's urban rail transit of subdivided sectors in 2007 and 2012, and applying industrial linkage theory in input-output analysis. See from Table 1 to Table 4 for the specific results.

Backward linkage measurement considering equal weight reflects the dependence degree of urban rail transit industry as

a buyer on intermediate input of other industry sectors; complete backward linkage measurement considering equal weight reflects how the change of ultimate demand influences the total output of China's industry sectors. According to backward linkage measurement and complete backward linkage measurement results in 2007 (Table 1 and Table 2) and 2012 (Table 3 and Table 4), some upstream industries closely related to urban rail transit industry can be obtained, such as Metal product industry, Metal processing machinery manufacturing industry, Instrument industry, Other electric apparatus and equipment manufacturing industry, Steel rolling industry, Automobile industry, Auto parts and accessories manufacturing industry, Petroleum and nuclear fuel processing industry, Other flexible unit manufacturing industry, Communication device manufacturing industry.

Forward linkage measurement considering equal weight reflects the dependence degree of urban rail transit industry as a buyer on intermediate input of other industry sectors; complete backward linkage measurement considering equal weight reflects how the change of ultimate demand influences the total output of China's industry sectors. According to backward linkage measurement and complete backward linkage measurement results in 2007 (Table 5 and Table 6) and 2012 (Table 7 and Table 8), some downstream industries closely related to urban rail transit industry can be obtained, such as Catering industry, Commercial service industry, Petroleum and natural gas exploration industries, Papermaking and paper product manufacturing industry, Animal husbandry, Professional Technical Services, Road transport, Telecommunications and other information transmission services.

### 4 Conclusion

Based on the input-output tables for urban rail transit of subdivided sectors in 2007 and 2012, this paper studies backward linkage and forward linkage industries of urban rail transit industry. Some upstream industries closely related to urban rail transit industry can be obtained, such as Metal product industry, Metal processing machinery manufacturing industry, Instrument industry, Other electric apparatus and equipment manufacturing industry, Steel rolling industry, Automobile industry, Auto parts and accessories manufacturing industry, Petroleum and nuclear fuel processing industry, Other flexible unit manufacturing industry, Communication device manufacturing industry. Some downstream industries closely related to urban rail transit industry can be obtained, such as Catering industry, Commercial service industry, Petroleum and natural gas exploration industries, Papermaking and paper product manufacturing industry, Animal husbandry, Professional Technical Services, Road transport, Telecommunications and other information transmission services.

**Table 1** Backward linkage measurement of China's urban rail transit (2007)

Industry sector	Backward linkage measurement
Steel rolling industry	1.4297
Iron making industry	1.3835
Feed processing industry	1.3718
Rubber product industry	1.3646
Electronic component manufacturing industry	1.3641
Ramie textile, silk textile and finishing industry	1.3473
Other electric apparatus and equipment manufacturing industry	1.3419
Wire, cable, optical cable and electrical equipment manufacturing industry	1.3330
Cotton, chemical fiber textile and printing & dyeing industry	1.3187
Wool manufacturing and dyeing & finishing industry	1.3175
Petroleum and nuclear fuel processing industry	1.3172
Knitwear, knitting and relevant product manufacturing industry	1.3170
Automobile industry	1.3075
Non-ferrous metal rolling industry	1.3047
Other food manufacturing industry	1.2104
Other food processing industry	1.2081
Tobacco industry	1.2048
Grain grinding industry	1.1985
Daily chemical product manufacturing industry	1.1949
Vegetable oil processing industry	1.1926
Other nonmetal mineral product manufacturing industry	1.1893
Boiler and prime motor manufacturing industry	1.1862
Ceramic product manufacturing industry	1.1831
Instrument industry	1.1829
Metal processing machinery manufacturing industry	1.1825
Other dedicated device manufacturing industry	1.1803
Textile clothing, shoes and hat manufacturing industry	1.1800
Papermaking and paper product manufacturing industry	1.1776
Press and publishing industry	1.1730
Special chemical product manufacturing industry	1.1570
Ship and floating device manufacturing industry	1.1468
Catering industry	1.1453
Chemical fiber manufacturing industry	1.1401
Alcohol and wine manufacturing	1.1374
Special machinery manufacturing industry for agriculture, forestry, animal husbandry and fishery	1.1339
Accommodation industry	1.1221
gas production and supply industry	1.1108
Glass and glass product manufacturing industry	1.0978
Railway transport equipment manufacturing industry	1.0859
Commercial service industry	1.0725
Sugar industry	1.0395
Coking industry	1.0303
Warehousing industry	1.0154
Fertilizer manufacturing industry	1.2228
Other electric apparatus and equipment manufacturing industry	1.2166

**Table 2** Complete backward linkage measurement of China's urban rail transit (2007)

Industry sector	Complete backward linkage measurement
Home audio and video equipment manufacturing industry	1.3808
Rubber product industry	1.3760
Steel rolling industry	1.3428
Wire, cable, optical cable and electrical equipment manufacturing industry	1.3316
Automobile industry	1.3308
Electronic component manufacturing industry	1.3254
Wool manufacturing and dyeing & finishing industry	1.3179
Other electric apparatus and equipment manufacturing industry	1.3089
Leather, fur, feather (down feather) and product industry	1.3071
Plastic product industry	1.3058
Electronic computer manufacturing industry	1.3058
Knitwear, knitting and relevant product manufacturing industry	1.2923
Communication device manufacturing industry	1.2872
Synthetic material manufacturing industry	1.2657
Machine building industry for culture and office	1.2514
Cultural, educational and sporting goods manufacturing industry	1.2429
Made-up textile product industry	1.2346
Instrument industry	1.2275
Other transportation equipment manufacturing industry	1.2223
Cotton, chemical fiber textile and printing & dyeing industry	1.2180
Textile clothing, shoes and hat manufacturing industry	1.2065
Ramie textile, silk textile and finishing industry	1.1971
Pesticide industry	1.1892
Metal processing machinery manufacturing industry	1.1813
Iron making industry	1.1774
Cement, lime and gypsum manufacturing industry	1.1703
Paints, inks, paints and similar products manufacturing industry	1.1665
Other dedicated device manufacturing industry	1.1625
Non-ferrous metal rolling industry	1.1622
Insurance industry	1.1622
Metal product industry	1.1620
Fertilizer manufacturing industry	1.1581
Basic chemical raw material manufacturing industry	1.1385
Papermaking and paper product manufacturing industry	1.1281
Ship and floating device manufacturing industry	1.1272
Ceramic product manufacturing industry	1.1190
Chemical fiber manufacturing industry	1.1157
Other drinks manufacturing industry	1.1142
Daily chemical product manufacturing industry	1.1095
Press and publishing industry	1.1077
Other nonmetal mineral product manufacturing industry	1.1054
Railway transport equipment manufacturing industry	1.0907
Boiler and prime motor manufacturing industry	1.0899
Other food manufacturing industry	1.0770
Glass and glass product manufacturing industry	1.0693
Special machinery manufacturing industry for agriculture, forestry, animal husbandry and fishery	1.0669
Accommodation industry	1.0579
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.0468
Alcohol and wine manufacturing	1.0452
Feed processing industry	1.0356
Special chemical product manufacturing industry	1.0258
Electricity, heat production and supply industry	1.0206
Tobacco industry	1.0176
Warehousing industry	1.0145
Other flexible unit manufacturing industry	1.0065
Gas production and supply industry	1.0056
Commercial service industry	1.0056

**Table 3** Backward linkage measurement of China's urban rail transit (2012)

Industry sector	Backward linkage measurement
Chemical fiber manufacturing industry	1.3088
Petroleum and nuclear fuel processing industry	1.3072
Grain grinding industry	1.2904
Wire, cable, optical cable and electrical equipment manufacturing industry	1.2851
Paints, inks, paints and similar products manufacturing industry	1.2813
Non-ferrous metal rolling industry	1.2754
Steel rolling industry	1.2675
Other electric apparatus and equipment manufacturing industry	1.2648
Basic chemical raw material manufacturing industry	1.2631
Home appliance manufacturing industry	1.2571
Synthetic material manufacturing industry	1.2549
Feed processing industry	1.2540
Vegetable oil processing industry	1.2520
Vegetables, fruits, nuts and other agricultural food processing industry	1.2482
Aquatic product processing industry	1.2476
Slaughter and meat processing industry	1.2469
Machine building industry for culture and office	1.2426
Cotton, chemical fiber textile and printing & dyeing industry	1.2404
Special chemical product manufacturing industry	1.1794
Plastic product industry	1.2232
Electric manufacturing industry	1.2192
Knitwear, knitting and relevant product manufacturing industry	1.2181
Metal product industry	1.2166
Iron alloy smelting industry	1.2132
Pesticide industry	1.2130
Rubber product industry	1.2117
Electronic component manufacturing industry	1.2078
Fertilizer manufacturing industry	1.2040
Other dedicated device manufacturing industry	1.1836
Papermaking and paper product manufacturing industry	1.1831
Other transportation equipment manufacturing industry	1.1792
gas production and supply industry	1.1743
Other food production	1.1723
Communication device manufacturing industry	1.1673
Boiler and prime motor manufacturing industry	1.1595
Other flexible unit manufacturing industry	1.1556
Instrument industry	1.1480
Metal processing machinery manufacturing industry	1.1443
Ceramic product manufacturing industry	1.1409
Made-up textile product industry	1.1362
Warehousing industry	1.1329
Glass and glass product manufacturing industry	1.1293
Furniture manufacturing industry	1.1245
Daily chemical product manufacturing industry	1.1229
Cement, lime and gypsum manufacturing industry	1.0964
Leather, fur, feather (down feather) and product industry	1.0949
Ship and floating device manufacturing industry	1.0773
Other nonmetal mineral product manufacturing industry	1.0745
Sugar industry	1.0657
Other drinks manufacturing industry	1.0491
Coking industry	1.0154
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.2025
Ramie textile, silk textile and finishing industry	1.2007
Home audio and video equipment manufacturing industry	1.1998
Automobile and parts and components manufacturing industry	1.1906

**Table 4** Complete backward linkage measurement of China's urban rail transit (2012)

Industry sector	Complete backward linkage measurement
Chemical fiber manufacturing industry	1.3138
Wire, cable, optical cable and electrical equipment manufacturing industry	1.3017
Machine building industry for culture and office	1.2928
Home appliance manufacturing industry	1.2886
Other electric apparatus and equipment manufacturing industry	1.2771
Home audio and video equipment manufacturing industry	1.2759
Electronic component manufacturing industry	1.2654
Electric manufacturing industry	1.2573
Plastic product industry	1.2550
Paints, inks, paints and similar products manufacturing industry	1.2509
Knitwear, knitting and relevant product manufacturing industry	1.2439
Non-ferrous metal rolling industry	1.2369
Communication device manufacturing industry	1.2321
Automobile and parts and components manufacturing industry	1.2256
Other transportation equipment manufacturing industry	1.2183
Other dedicated device manufacturing industry	1.2103
Synthetic material manufacturing industry	1.2061
Metal product industry	1.2050
Instrument industry	1.1969
Pesticide industry	1.1963
Rubber product industry	1.1863
Boiler and prime motor manufacturing industry	1.1841
Chemical fiber manufacturing industry	1.3138
Wire, cable, optical cable and electrical equipment manufacturing industry	1.3017
Machine building industry for culture and office	1.2928
Home appliance manufacturing industry	1.2886
Metal processing machinery manufacturing industry	1.1763
Cotton, chemical fiber textile and printing & dyeing industry	1.1716
Steel rolling industry	1.1619
Fertilizer manufacturing industry	1.1582
Basic chemical raw material manufacturing industry	1.1562
Ship and floating device manufacturing industry	1.1414
Furniture manufacturing industry	1.1248
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.1121
Daily chemical product manufacturing industry	1.0978
Glass and glass product manufacturing industry	1.0929
Iron alloy smelting industry	1.0903
Papermaking and paper product manufacturing industry	1.0898
Ceramic product manufacturing industry	1.0764
Ramie textile, silk textile and finishing industry	1.0726
Leather, fur, feather (down feather) and product industry	1.0600
Cement, lime and gypsum manufacturing industry	1.0413
Other food industry	1.0330
Slaughter and meat processing industry	1.0307
Other nonmetal mineral product manufacturing industry	1.0162
Made-up textile product industry	1.1830
Other flexible unit manufacturing industry	1.1823
Special chemical product manufacturing industry	1.1794

**Table 5** Forward linkage measurement of China's urban rail transit (2007)

Industry sector	Forward linkage measurement
Agriculture	7.0144
Electricity, heat production and supply industry	6.6084
Electronic computer manufacturing industry	5.5695
Petroleum and nuclear fuel processing industry	4.8684
Electronic component manufacturing industry	4.5196
Steel rolling industry	4.4783
Papermaking and paper product manufacturing industry	3.8560
Animal husbandry	3.8503
Commercial service industry	3.7279
Road transport	3.7050
Plastic product industry	3.3778
Special chemical product manufacturing industry	3.0181
Metal product industry	2.8657
Cotton, chemical fiber textile and printing & dyeing industry	2.8584
Fisheries	2.7376
Basic chemical raw material manufacturing industry	2.6029
Catering industry	2.4530
Mining and Dressing of Ferrous Metals	2.1148
Leather, fur, feather (down feather) and product industry	1.8498
Textile clothing, shoes and hat manufacturing industry	1.8308
Chemical fiber manufacturing industry	1.8256
Other food production	1.6156
Telecommunications and other information transmission services industry	1.5559
Accommodation industry	1.4944
Automobile industry	1.4917
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.4774
Cement, lime and gypsum manufacturing industry	1.4574
Instrument industry	1.4130
Rubber product industry	1.2741
Non-ferrous metal rolling industry	1.0644
Nonferrous Metals Mining and Dressing	1.0193
Banking	2.3390
Synthetic material manufacturing industry	2.2459

**Table 6** Complete forward linkage measurement of China's urban rail transit (2007)

Industry sector	Complete forward linkage measurement
Electricity, heat production and supply industry	6.7487
Steel rolling industry	3.4602
agriculture	3.4340
Electronic component manufacturing industry	3.1489
Basic chemical raw material manufacturing industry	3.1075
Petroleum and nuclear fuel processing industry	3.1040
Papermaking and paper product manufacturing industry	3.0418
Electronic computer manufacturing industry	2.8520
Road transport	2.7383
Plastic product industry	2.6566
banking	2.5747
Special chemical product manufacturing industry	2.5509
Cotton, chemical fiber textile and printing & dyeing industry	2.5374
Synthetic material manufacturing industry	2.2602
Animal husbandry	2.1558
Commercial service industry	1.9943
Petroleum and natural gas exploration industries	1.6609
Nonferrous Metals Mining and Dressing	1.5165
Catering industry	1.4401
Textile clothing, shoes and hat manufacturing industry	1.4050
Mining and Dressing of Ferrous Metals	1.3736
Chemical fiber manufacturing industry	1.3382
Instrument industry	1.2550
Automobile industry	1.2334
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.1774
Rubber product industry	1.1511
Other food manufacturing industry	1.1488
Telecommunications and other information transmission services industry	1.1020
Other nonmetal mineral product manufacturing industry	1.0541
Non-ferrous metal rolling industry	1.0329
Accommodation industry	1.0248
Fisheries	1.8017
Metal product industry	1.7163



**Table 7** Forward linkage measurement of China's urban rail transit (2012)

Industry sector	Forward linkage measurement
Agriculture	6.9279
Electronic component manufacturing industry	5.3441
Steel rolling industry	4.0220
Basic chemical raw material manufacturing industry	3.4636
Road transport	3.2882
Metal product industry	3.1940
Cotton, chemical fiber textile and printing & dyeing industry	3.0698
Animal husbandry	2.8799
Plastic product industry	2.7821
Commercial service industry	2.6904
Special chemical product manufacturing industry	2.5584
Other flexible unit manufacturing industry	2.4605
Non-ferrous metal rolling industry	2.3865
Synthetic material manufacturing industry	2.2614
Papermaking and paper product manufacturing industry	2.2274
Petroleum and natural gas exploration industries	2.0203
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.7422
Automobile and parts and components manufacturing industry	1.5866
Grain grinding industry	1.4183
Chemical fiber manufacturing industry	1.3841
Mining and Dressing of Ferrous Metals	1.3230
Vegetable oil processing industry	1.2227
Fisheries	1.2036
Catering industry	1.0951
Professional Technical Services	1.0728
Telecommunications and other information transmission services industry	1.0644
Rubber product industry	1.0061

**Table 8** Complete forward linkage measurement of China's urban rail transit (2012)

Industry sector	Complete forward linkage measurement
Agriculture	4.3573
Electronic component manufacturing industry	3.7752
Basic chemical raw material manufacturing industry	3.7398
Petroleum and natural gas exploration industries	3.6126
Steel rolling industry	2.8963
Special chemical product manufacturing industry	2.3203
Road transport	2.2511
Metal product industry	2.2140
Synthetic material manufacturing industry	2.1962
Cotton, chemical fiber textile and printing & dyeing industry	2.1693
Plastic product industry	2.1044
Agriculture	4.3573
Electronic component manufacturing industry	3.7752
Non-ferrous metal rolling industry	1.9435
Commercial service industry	1.8068
Other flexible unit manufacturing industry	1.7706
Mining and Dressing of Ferrous Metals	1.6649
Papermaking and paper product manufacturing industry	1.6564
Animal husbandry	1.6026
Automobile and parts and components manufacturing industry	1.4930
Wood processing and wooden, bamboo, rattan, palm and straw-made article industry	1.3105
Nonferrous Metals Mining and Dressing	1.2499
Chemical fiber manufacturing industry	1.1678
Fertilizer manufacturing industry	1.0386
Non-ferrous metal rolling industry	1.9435
Commercial service industry	1.8068

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