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## Article

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Article

# Effects of Cost Factors on National Manufacturing Based on Global Perspectives

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**Abstract:** Currently, the real economy is the important basis for the development of a country, especially after the global financial crisis in 2008. Given that the manufacturing industry is the main part of the national real economy, many developed and developing countries have paid considerable attention to its significance. This study focused on cost factors given that they influence national manufacturing development. Initially, this study proposed two elements, namely, manufacturing development scale and manufacturing development level, to evaluate national manufacturing development from two aspects: quantity and quality. Subsequently, we extracted a series of cost factors on the basis of the theoretical framework and literature, including labor costs, financing costs, tax and rental costs, energy and raw materials, foreign trade exports and business environments. On the basis of the data of 13 main manufacturing countries around the world from 2000 to 2015, we tested the influence degree of each cost element index on the scale and level of national manufacturing industry development through a two-way fixed effects model and incorporated it with the development of China's manufacturing industry as a case study. Finally, we deduced the future development trend of the manufacturing industry by specifically analyzing the cost factors affecting the development of this industry and provided policy suggestions. The main innovation and contribution of this study including: to comprehensively evaluate the national manufacturing development from two aspects, namely, "quantity" and "quality"; to identify the impact of national cost of the six elements; to demonstrate and determine the extent of its impact on the development trend of manufacturing sector and carry out pre-judgment through empirical research on each indicator; to provide policy recommendations targeted for each of the indicators.

**Keywords:** national manufacturing scale (NMS); national manufacturing level (NML); national cost factor; global perspectives; two-way fixed-effects model

**JEL Classification:** L60

## 1. Introduction

Currently, real economy is the important basis for the development of a country, especially after the global financial crisis in 2008. Given that the manufacturing industry is the main part of the national real economy, many developed and developing countries have paid considerable attention to its significance. The United States and Britain have proposed manufacturing returning; Germany and Japan have also proposed a reinforcing manufacturing strategy; and China, India and other developing countries are currently developing domestic manufacturing. This study focused on cost factors given that they influence national manufacturing development.

The state of the manufacturing industry is an effective indication of the national economic development and national employment and a direct reflection of a country's productivity level. The Statistics Division of the United Nations Department of Economic and Social Affairs defined manufacturing as the processing of materials or ingredients into finished products through physical and chemical processes (Department of Economic and Social Affairs Statistics Division 2008). Generally, manufacturing includes product manufacturing, design, raw material procurement, warehousing and transportation, order processing, wholesale operations and retail. Enterprises (units) are primarily involved in product manufacturing and in the assembly and installation of machinery and equipment for product sales.

This study will analyze the following questions from a global perspective. (1) What is the development level of the national manufacturing industry? (2) What indicators should be used for evaluation? (3) What are the major problems that hinder the development of the national manufacturing industry?

### 1.1. Global Manufacturing Development

We evaluated the development of the national manufacturing industry from two aspects, namely, quantity and quality (Miller 1982). The quantity of the national manufacturing industry refers to indicators that include the total output and proportion of an economy, such as manufacturing value added (MVA) and the share of world MVA. Meanwhile, the quality of the national manufacturing industry refers to indicators that include MVA per capita and exports per capita. Hence, quantity reflects the overall size, whereas quality reflects the per capita level. The impact of MVA on national economic development is critical. (Guisan 2008) presented a comparative analysis of the evolution of manufacturing real value-added per capita and its positive impact on the real value-added of services and economic development. For the better part of three decades, Latin America, Eastern Europe and most of Asia have been viewed as low-cost regions. the U.S., Western Europe and Japan have been viewed as having high costs. But this worldview now appears to be out of date. Years of steady change in wages, productivity, energy costs, currency values and other factors are quietly but dramatically redrawing the map of global manufacturing cost competitiveness. The new map increasingly resembles a quilt-work pattern of low-cost economies, high-cost economies and many that fall in between, spanning all regions. China would now be a higher cost country for manufacturing because of its rapid rising wages and other costs — some factories have been moving to Southeast Asia to seek lower costs (James and Movshuk 2004; Sirkin et al. 2014).

### 1.2. National Cost Factors

Drawing on the literature and corporate research, we divided our study into the following six parts (Sirkin et al. 2014; James and Movshuk 2004; Ceglowski and Golub 2011; Bhanawat 2010). The first is the labor costs. The traditional manufacturing industry is labor-intensive and the number of laborers and the skills of workers have a certain rigid demand (Shahidul and Syed Shazali 2011). The second is the financing costs. The scale of the development of manufacturing enterprises will inevitably face cash flow. Interest rate is the most representative indicator (Cooper 2010). The third is the government tax and land rental costs. Although each country's tax policy is different but for the manufacturing enterprises is also a relatively fixed cost (Xu et al. 2017). The fourth is the technology and energy costs. Different countries have different scientific and technological strengths; thus, the gap between developed and developing countries remains evident (Gopinath and Upadhyay 2002). The fifth is the cost of inventory. Logistics, import and export, in the era of globalization, are essential parts of the real economy (Xu and Zhang 2014). The sixth is the business environment cost of the enterprise, which reflects a country's investment environment, administrative efficiency and social corruption (Lall and Mengistae 2005).

The cost of manufacturing is extremely complex and involved in a wide range of research areas. Shortcomings and deficiencies in the main cost elements are some of the limitations of this study. This study will comprehensively evaluate the national manufacturing development from two

aspects, namely, quantitative aggregate and output per capita; and identify the impact of six elements of national manufacturing costs. Meanwhile, for the costs factors, the extent of its impact on the development trend of manufacturing sector will be demonstrated. Furthermore, pre-judgments will be carried out through empirical research on each indicator and policy recommendations targeted for each of the indicators will be provided.

The rest of this paper is structured as follows. Section 2 reviews the literature on manufacturing development and costs and discusses China's manufacturing from the literature's point of view. Section 3 focuses on the research design, data resources and methodology. Section 4 describes the results of using principal components analysis and panel data to estimate the effects of national manufacturing variables and cost factors toward manufacturing competitiveness. Section 5 concludes this paper and describes the next development trends of manufacturing and costs.

## 2. Literature Review

The literature review is divided into three parts, namely, the development of the manufacturing industry research, the cost of manufacturing for the study and China's manufacturing industry cost for the study.

### 2.1. Manufacturing Development

Developed countries are capital-oriented, they have experienced a certain degree transfer strategy to pursue low-cost raw materials and labor in the later stage of industrialization. After the 2008 financial crisis, developed countries paid considerable importance to the importance of manufacturing for the national economy and propose corresponding policy to help reinstate their manufacturing industry. The United States plans to reshape the dominance of manufacturing through a series of policies to achieve local "re-industrialization" and transition to the real economy (Executive Office of the President of the United States 2009). The UK develops manufacturing tax incentives to achieve manufacturing reflux while focusing on the development of high-tech industries, advanced manufacturing and creative design industry (Government Office for Science and Department for Business, Innovation & Skills 2013).

Developed and developing countries have proposed a series of industrial policies to promote the development of the high-tech manufacturing industry to seek considerable influence in the future. In 2010, Germany developed the "German High Technology Innovation Strategy 2020" and proposed the Industrial 4.0 strategy, focusing on climate change and energy, health and nutrition, mobile, security and communications (Lasi et al. 2014). In 2013, Japan released the "Japan re-strategy" and established a robot technology innovation to drive the structural transformation of the manufacturing sector. Japan believed that the manufacturing industry actively plays the role of IT and proposed the use of Big Data services for the next generation of manufacturing (Ministry of Economy, Trade and Industry of Japan 2015). Indonesia put forward *Mid-term development plan in 2010–2014*, prompting fast rising of manufacturing output per capita and the added value. It showed that the policy that improving industrial added value and encouraging small and medium-sized enterprise played an important role in increasing GDP.

Therefore, the current international manufacturing industry has shown two major trends, namely, the return of domestic manufacturing and the promotion of high-tech manufacturing development.

Based on global manufacturing development status and trends, the following indicators can be used to measure the development level of a country's manufacturing industry. We evaluated the development of the national manufacturing industry from the quantity and quality aspects. Indicators 1–5 reflect the development scale of the manufacturing sector, which is quantity. Indicators 6–7 reflect the development level of the manufacturing sector, which is quality. The indicators are follows. (1) MVA—the net output of the manufacturing sector after adding up all outputs and subtracting intermediate inputs, which is explained by the World Bank. MVA is calculated without making deductions for the depreciation of fabricated assets or the depletion and degradation of natural resources. (2) Manufacturing value output (MVO)—defined in economics as the total value

of goods or services produced in manufacturing in a given period. (3) Manufacturing value cost (MVC)—the cost of goods or services produced in manufacturing in a given period. (4) Share of world MVA—the percentage of the country's MVA in the world. (5) Share in world manufacturing exports—the percentage of the country's manufacturing export in the world. (6) MVA per capita—the ratio of MVA to the total population. (7) Manufacturing export per capita—the ratio of manufacturing exports to the total population.

## 2.2. National Cost Factors

The composition of national costs is extremely complex, involving people, finances, materials and other aspects (Seshaiah and Sarma 2007). Factors that affect the cost of national manufacturing not only mentioned above but also related to export, business environment and so on. National cost factors are the sum of all resources consumed in the process of making a product. The cost is classified into three categories: direct material cost, direct labor cost and manufacturing overhead (Ostwald and McLaren 2003). Drawing on literature research, we proposed one of the following frameworks to reflect the cost elements of manufacturing. Merchandise trade is not a direct cost of manufacturing but it can also reflect the competitiveness level of national manufacturing to some extent. Costs of manufacturing are divided into direct costs and indirect costs. Direct costs include labor costs, financing costs and energy and raw material costs; indirect costs include foreign trade exports and business environment.

**Labor cost** Direct labor cost is a part of the wage-bill or payroll that can be specifically and consistently assigned to, or associated with, the manufacturer of a product, a particular work order, or the provision of a service (Ostwald and McLaren 2003; Kanawaty 1992). Labor cost per unit<sup>1</sup> is equal to the ratio of compensation levels to labor productivity and refers to the total labor costs per unit of production or costs to be paid by each unit of output for labor. Labor cost per unit generally measures a country's manufacturing trade good production price or the cost of production from the perspective of production (or cost). Menzler-Hokkanen (1989) elucidated that unit labor cost (ULC) measures the average cost of the labor per unit of output and is calculated as the ratio of the total labor costs to the real output. (Ceglowski and Golub 2007) provided a new perspective on Chinese international competitiveness in manufacturing using relative unit labor costs. Van Ark et al. (2010) focused on the comparisons of productivity, (unit) labor cost and industry-level competitiveness for Chinese and Indian manufacturing. The lower the unit labor costs, the higher the country's product price competitiveness. Compensation levels refers to the sub-discipline of human resources, which focuses on employee compensation and benefit policy-making. Labor productivity (Bureau of Labor Statistics 2017) is the measure of productivity (and all that this measure considers) that helps explain the principal economic foundations necessary for economic growth and social development. Generally, labor productivity is equal to the ratio between a measure of output volume (gross domestic product or gross value added) and a measure of input use (the total number of hours worked or the total employment). Employer's social security contribution rate is a compulsory contribution as a percentage of an income equal to GDP per capita.

**Financing costs** Financing cost, also known as the cost of finances, refers to the cost, interest, and other charges involved in the borrowing of money to build or purchase assets. Yeo and Grant (2017) asserted that financial factors significantly influence manufacturing sales growth performance. Interest rate spread is the interest rate charged by banks on loans to private sector customers minus the interest rate paid by commercial or similar banks for demand, time, or savings deposits. The terms and conditions attached to these rates differ by country, however, limiting their comparability. (International Monetary Fund, International Financial Statistics and Data Files).

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<sup>1</sup> Labor cost in per unit = Compensation levels/Labor productivity.



**Tax and rental costs** Corporate tax rate on profit, also called corporation tax or company tax, is a direct tax imposed by a jurisdiction on the net profit of corporations or analogous legal entities. [Duve \(2012\)](#) analyzed the utilization of tax incentives in the manufacturing sector and argued that, if developing countries were able to offer sufficient tax incentives, they might be able to increase domestic and foreign investments in the sector, which is good for the growth in the manufacturing. We have selected office rents as a representative indicator based on the IMD database.

**Energy and raw material costs** Energy intensity is a measure of the energy efficiency of a nation's economy and is calculated as units of energy per unit of GDP (UN Department of Economic and Social Affairs). [Liu et al. \(2014\)](#) analyzed the relationship among energy efficiency, industrial structure factor and MVA per capita. [Miketa \(2001\)](#) provided the generation of an industrial energy intensity database that includes the estimates of industrial energy prices for different countries. They discuss the development of energy intensity over time and its relationship with sectoral economic development. [Kepplinger et al. \(2013\)](#) corroborated that industrialized countries with a high value of GDP (gross domestic product) per capita tend to have a low energy intensity, thereby indicating that efficiency in energy use is achieved along with the technological advancement.

**Total natural resource rent** % of GDP is the sum of oil, natural gas, rents (hard and soft), mineral and forest rents. Estimates are based on sources and methods described in "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" ([World Bank 2011](#)). [Stoneman \(Battisti and Stoneman 2007\)](#) explored the patterns and determinants of the prices of raw material and intermediate inputs (MIIs) to UK manufacturing as measured by the net (n) and gross (g) producer price indexes of materials and fuels (PIMF). [Chisik et al. \(2014\)](#) asserted that a less equal distribution of the natural resource rents can generate manufacturing sector stagnation and low long-run growth even for a country with a small resource base and (initially) high manufacturing productivity.

**Inventory change** Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales and "work in progress". [Zhang and Huang \(2012\)](#) provided a series of business environment indicators, which can affect the manufacturing outsourcing in China, including oil prices and transportation costs.

**Foreign trade exports** [Ragacs and Vondra \(2009\)](#) investigated Austria's manufacturing competitiveness and its influence on changes in the export market shares of domestic manufacturers. Thus, domestic manufacturers' export reflects the level of development and competitiveness of their manufacturing industries.

**Manufacture exports** (% of merchandise exports) is the ratio of manufacture exports to merchandise exports. Manufactures comprise commodities in SITC sections 5 (chemicals), 6 (basic manufactures), 7 (machinery and transport equipment) and 8 (miscellaneous manufactured goods), excluding division 68 (non-ferrous metals). The World Bank staff estimates through the WITS platform from the Comrade database maintained by the United Nations Statistics Division.

**Manufacture imports** (% of merchandise imports) is the ratio of Manufactures imports to merchandise imports. Manufactures comprise the commodities in SITC sections 5 (chemicals), 6 (basic manufactures), 7 (machinery and transport equipment) and 8 (miscellaneous manufactured goods), excluding division 68 (nonferrous metals). The World Bank staff estimates through the WITS platform from the Comrade database maintained by the United Nations Statistics Division.

**Business environment** The Corruption Perceptions Index (CPI) generally defines corruption as "the misuse of public power for private benefit". [Transparency International \(2011\)](#) has published the CPI since 1996, annually ranking countries "by their perceived levels of corruption, as determined by expert assessments and opinion surveys". The CPI currently ranks 168 countries "on a scale from 100 (very clean) to 0 (highly corrupt)". [Roudaut \(2006\)](#) analyzed the influences of the business environment on manufacturing firms. [Kato and Sato \(2014\)](#) investigated the effects of corruption on the performance of the manufacturing sector at the state level in India. Their results confirm that corruption reduces gross value added per worker and the total factor productivity and that the adverse effects of corruption are highly salient in industries with a small average firm size.

Some scholars had carried on the comprehensive research on manufacturing costs, [Seshaiah and Sarma \(2007\)](#) analyzed the Cost structure of Indian manufacturing sector. This analysis is done by estimating a translog cost function in which capital, labor, energy, materials and liberalization index (a proxy for technology, reduced trade restrictions, technology penetration) are the input determinants. Further, factors influencing cost of Indian manufacturing sector have also been identified. [Van Ark et al. \(2010\)](#) compared the Cost Competitiveness of Manufacturing in China and India. They focus on comparisons of productivity, unit labor cost and industry-level competitiveness for Chinese and Indian manufacturing. Result finds that labor productivity and unit labor cost has great influence on manufacturing development. Other researchers' studies have only focus on the impact on manufacturing from a single cost factor, such as [Ceglowski and Golub \(2011\)](#), ([Ceglowski and Golub 2007](#)) analyzed labor cost of manufacturing of China, [Bhanawat \(2010\)](#) and [Chisik \(Chisik et al. 2014\)](#) analyzed the influence of raw material cost on manufacturing. Although they have studied and analyzed multiple cost factors, the cost factor is not comprehensive and has not analyzed the impact of cost factors on manufacturing from both scale and levels. This study evaluates manufacturing from quantitative aggregate and output per capita and comprehensively analyzes the six elements of costs factors impacting on manufacturing development.

### 2.3. China's Manufacturing and Cost

Since the beginning of the development of China's market economy, manufacturing in the southeast coastal areas and economic development zones have been greatly developed. According to the United Nations Industrial Development Organization data, China's MVA accounted for the proportion of the global MVA increase year by year, whereas manufacturing exports accounted for the proportion of increased global manufacturing exports. The total output of China's manufacturing industry has accelerated since 1995. In 2013, China's MVA reached 2857 billion US\$ that accounted for 17.5% of the global MVA, shown in Figure 1; exports accounted for 16.8% of global exports based on the World Bank database. However, with the rapid development of the manufacturing scale, the total cost of manufacturing has soared, such that the growth rate of manufacturing growth is far lower than the total output of the manufacturing sector and the total cost of growth. [Van Ark et al. \(2010\)](#) validated that China has increased its labor productivity to a level above that of India. Nonetheless, due to a high compensation level, China is still at a disadvantage in terms of unit labor cost in manufacturing. However, China's relative unit labor costs indicate a substantially smaller cost advantage than that implied by a comparison of wages alone ([Ceglowski and Golub 2007](#)). The rapid rising of cost is the disadvantage of manufacturing in China, some reasons can be draw from research. The growth rate of manufacturing main business income slowdown but the growth of cost is faster than income growth, thus overall manufacturing cost competitiveness is declining—manufacturing profit growth has fallen sharply, the decline of the manufacturing enterprise profitability increases the cost predicament—labor wages are rapidly rising, its growth is greater than the business income of manufacturing enterprises ([Ceglowski and Golub 2011](#)).

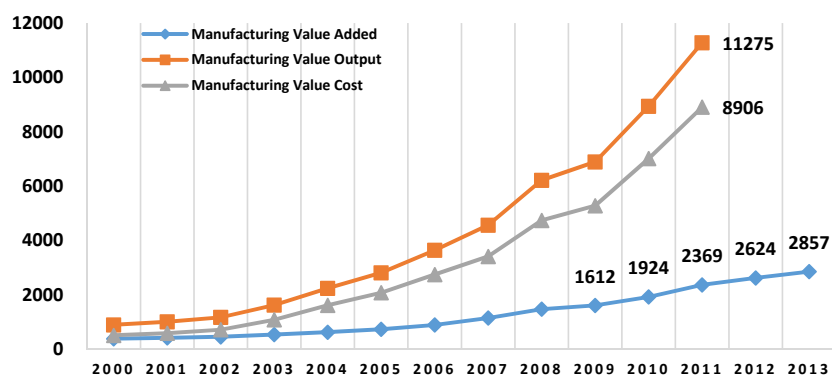
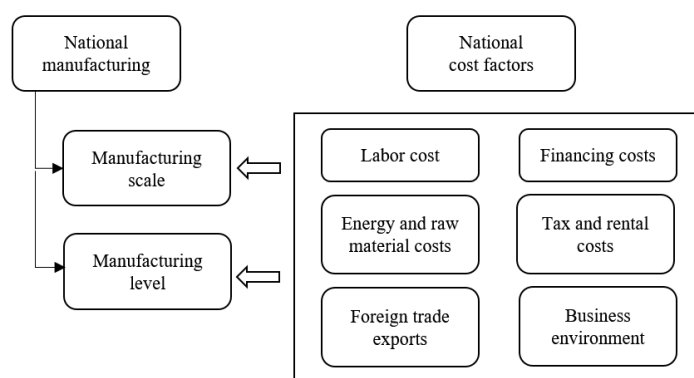


Figure 1. China's manufacturing value added, output and cost. Source: [UNIOD \(2017\)](#).

### 3. Research Design

Drawing on the literature review, we first proposed a measure of the status of the national manufacturing development path from the perspective of scale and level. The scale of manufacturing shows the total amount of manufacturing in the country, including MVA, MVO, MVC and the percentage of MVA and manufacturing exports in the world. The development level of the manufacturing industry, divided by population size, can reflect the per capita situation of the national manufacturing industry, including MVA per capita and manufacturing export per capita. In view of the cost of national manufacturing, we designed a cost factor framework for national cost through the research of literature and the research of the enterprise field, shown in Figure 2. The cost of production costs including labor costs, financing costs, tax and rental costs, energy and raw material costs, foreign trade exports, business environments and the corresponding indicators (Table 1). On the basis of the development status assessment and national cost elements of the manufacturing industry, we will identify the cost factors that affect the development of the national manufacturing industry through different countries' continuous panel data and the two-way fixed effects model. On the basis of the global perspective, according to the next manufacturing trend and cost trends, we will discuss China's manufacturing industry to make the next step recommendations and paths.



**Figure 2.** Conceptual framework.

**Table 1.** National cost factor framework and indicators.

Factor	Indicator	Reference
Labor costs	Labor cost in per unit Employer's social security contribution rate	Menzler-Hokkanen 1989 Kanawaty 1992 Ostwald and McLaren 2003 Ceglowski and Golub 2007 Van Ark et al. 2010
Financing costs	Interest rate spread	Yeo and Grant 2017
Tax and rental costs	Corporate tax rate on profit Office rent	Duve 2012
Energy and raw material costs	Energy intensity Total natural resource rent (% of GDP) Inventory change (current dollar)	Miketa 2001 Battisti and Stoneman 2007 Zhang and Huang 2012 Kepplinger et al. 2013 Chisik et al. 2014 Liu et al. 2014
Foreign trade exports	Merchandise trade (% of GDP) Manufacture exports (% of merchandise exports) Manufacture imports (% of merchandise imports)	Ragacs and Vondra 2009
Business environments	Corruption Perceptions Index	Transparency International 2011 World Bank 2011 Roudaut 2006 Kato and Sato 2014



## Data and Methods

On the basis of the database of IMD World Competitiveness Yearbook, World Bank, United Nations Industrial Development Organization and Transparency International, we have selected 13 representative countries with the most complete data and 6 developed countries—Australia, Netherlands, the US, Japan, Germany and the UK—and seven developing countries—Brazil, Russia, Malaysia, Mexico, India, Indonesia and China. The data spanned from 2000 to 2015.

We aimed to extract two key indicators that reflect the scale and the level from a series of indicators that reflect the scale and level of manufacturing development through principal component analysis (PCA) and to simply and clearly assess the manufacturing situation of the sample countries. With the PANEL procedure, we used the balanced panels and two-way fixed effects model to evaluate the most significant cost targets for a country's manufacturing industry.

## 4. Results

### 4.1. Factors of National Manufacturing Development

Factors that impact national manufacturing development are divided into quantity and quality. The quantity factor is extracted by certain national manufacturing scale indicators, whereas the quality factor is extracted by certain national manufacturing level indicators.

Through literature research and data collation, we used PCA to identify the underlying factors affecting national manufacturing from a series of indicators. The Kaiser-Meyer-Olkin (KMO) and Bartlett tests, the KMO value reached 0.66 and Bartlett's test of sphericity was highly significant ( $p$  value < 0.00), demonstrating that the data with high validity were suitable for PCA. Extraction key information aims to construct the latent factor on the basis of high validity, using PCA as the extraction method and varimax with Kaiser Normalization as the rotation method. A total of seven indicators, after PCA extraction, the information accumulated to 91.42%, two eigenvalues greater than 1, which are 4.80 and 1.60 separately. The first principal component contains the national manufacturing scale indicator, namely, the national manufacturing quantity factor, whereas the second principal component contains the national manufacturing level indicator, namely the national manufacturing quality factor. In accordance with the number of indicators and sample size, factor loadings of indicators must be over 0.4 (Hair et al. 1998) to ensure that the extracted factors are reliable; factor loading greater than 0.4 is considered effective in social sciences. Indicators with high cross-loading should be removed to avoid interference from ambiguity. Through the reliability consistency test, Cronbach's  $\alpha$  of national manufacturing quantity factor is 0.82 based on 5 indicators and the national manufacturing quality factor is 0.66 based on 2 indicators, showing that each factor had good internal consistency (Hair et al. 1998).

We select a large sample of countries mainly including developed countries and the larger developing countries, data of the least developing countries/was difficult to obtain. But the quality of the data is the lack of credibility even gets some data from the World Bank website. So, this study does not focus on the least developing countries. What we mainly want to study is measuring the cost factor's influence on the competitiveness of different countries. By sorting countries into different groups according to levels of competitiveness, the lowest competitiveness level country is also a developing country that has a certain scale of manufacturing but not the least developed countries. For the least developed countries, they should keep eyes on how the costs factors affect the manufacturing development and avoid rapidly rising costs hindering the development of manufacturing, at the same time, they should keep balance between manufacturing growth and cost growth.

The horizontal axis represents the quantity factor and reflects the manufacturing scale, whereas the vertical axis represents the quality factor and reflects the manufacturing level. Without consideration of the national population, 13 sample countries are located in the four regions. I. The United States, Japan and Germany (DEU) are the most prominent representative countries of scale and level;

II. China's manufacturing scale is large but the per capita level is relatively backward; III. Britain, the Netherlands (NLD), Australia, Malaysia (MYS) and Mexico belong to the high per capita level but the overall size is not prominent; and IV. Russia, Brazil, India (IND) and Indonesia (IDN) do not have an advantage in manufacturing scale and per capita.

#### 4.2. Effects of Cost Factors on National Manufacturing

Based on the redundant fixed effects-likelihood ratio, the probabilities of cross-sections F and Chi-square are less than 0.01, which confirms that the pooled model is invalid. Compared with the two-way fixed effects regression model and the two-way random effects regression model, the correlated random effects Hausman test rejects the null hypothesis ( $p$  value  $< 0.01$ ), likely due to the correlation between individual effects and regression variables. Considering the effects of independent variables as fixed effects is a relatively reasonable option because the individuals or members in the sample are not randomly selected.

Following models were constructed with the linear model:  $y_{it} = \alpha_0 + \alpha_i + X_{it}\beta + u_{it}$ ,  $i = 1, 2, \dots, 13$  and  $t = 1, 2, \dots, 15$ , where  $y$  is the dependent variable that is observed for individual  $i$  at time  $t$ ,  $\alpha_0$  is the population-average intercept,  $\alpha_i$  is a random intercept term indicating unobserved time-invariant individual effects,  $X_{it}$  is the time variant  $1 \times k$  independent vector,  $\beta$  refers to the fixed effects and  $u$  is the error term.

With the panel data of 13 countries, we chose the national population and GDP per capita as the control variables, which reflect the size and economic level of the countries. According to the 6 aspects of cost factor (Table 1), the 12 cost indicators are selected as independent variables and the national manufacturing quantity and quality factors as the dependent variables separately, which are tested via the two-way fixed effects model. Table 2 shows the results.

In addition, we did a series of model test, the results did not change much, so there is no more to consider the lag effect. May be no war or economic crisis happened in recent year, so the international panel data changes are not obvious. Stable standard error indicates careful and rigorous measurement. We did a robust test when dealing with the data, and the heteroscedry test was not significant, so we did not use the robust SE.

##### Models 1 and 2

In Model 1, the quantity factor as the dependent variable, it was to determine the effects from control variables, R-squared reached 0.887. On the basis of Model 1, Model 2 added 12 cost indicators as the independent variables. R-squared of Model 2 reached 0.982, increased by 10.71% than the Model 1, the enhanced effect is significant. Among them, 12 added cost indicators remain significant, which can fully prove the cost of the impact on the scale of manufacturing.

##### Models 3 and 4

In Model 3, the quality factor as the dependent variable, it was to determine the effects from control variables, R-squared reached 0.883. On the basis of Model 3, Model 4 also added 12 similar cost indicators as the independent variables. R-squared of model 2 reached 0.983, increased by 11.33% than the Model 3, to enhanced effect is significant. However, the 12 added cost indicators are not significant at all and the effective 9 indicators can still fully prove the cost of the impact on the development level of manufacturing.

The impact of GDP per capita on the manufacturing is positive, regardless of scale or development level; however, the results of total population are inconsistent. A large population is integrated with a high manufacturing development level but the size of population is negatively correlated with the development level, which indicated that some of the large population of a country's manufacturing industry per capita development level is relatively backward.

**Table 2.** Test of the effects of cost factors on national manufacturing based on the panel dataset via the two-way fixed effects model.

Cost Factors	National Manufacturing Scale		National Manufacturing Level	
	Model 1	Model 2	Model 3	Model 4
Labor cost per unit		0.9630 *** (0.1410)		1.2510 *** (0.0945)
Employer's social security contribution rate		0.0071 ** (0.0017)		0.0158 *** (0.0022)
Interest rate spread		−0.0239 *** (0.0029)		−0.0172 *** (0.0016)
Corporate tax rate on profit		0.0094 * (0.0040)		0.0065 (0.0040)
Office rent		−0.2550 *** (0.0255)		−0.2240 *** (0.0246)
Energy intensity		0.2150 ** (0.0641)		−0.2140 ** (0.0540)
Total natural resource rent (% of GDP)		−0.0119 ** (0.0039)		−0.0045 (0.0033)
Inventory change (current dollar)		0.0043 *** (0.0006)		0.0015 * (0.0005)
Merchandise trade (% of GDP)		−0.3890 *** (0.0253)		−0.0599 (0.0314)
Manufacture exports (% of merchandise exports)		0.2270 *** (0.0521)		0.4990 *** (0.0349)
Manufacture imports (% of merchandise imports)		1.2430 *** (0.2200)		0.4620 * (0.1650)
Corruption Perceptions Index		−0.0097 *** (0.0014)		−0.0085 *** (0.0013)
Total population	0.9600 *** (0.0365)	0.7830 *** (0.0289)	−0.2550 *** (0.0360)	−0.4070 *** (0.0245)
GDP per capita	1.1560*** (0.0373)	0.9890 *** (0.0300)	0.7750 *** (0.0441)	0.4520 *** (0.0307)
2000 year–2015 year	/	/	/	/
Constant	−28.84 *** (0.953)	−28.48 *** (1.334)	−2.766 * (0.984)	1.421 (0.866)
R-squared	0.887	0.982	0.883	0.983

*Country = 13 and observation = 208. \*\*\* p value < 0.01; \*\* p value < 0.05; \* p value < 0.1.*

### 4.3. Key Cost Factor Analysis

**Labor cost per unit** Labor cost per unit has a significant impact on the national manufacturing scale and level. In fact, labor cost per unit is the ratio of compensation levels and labor productivity. The low level of pay and high labor productivity may be extra competitive in the national manufacturing industry because of low labor cost per unit. However, empirical research confirmed that the low level of the national manufacturing industry corresponds to low technical content (Subramanian and Soh 2010). Low labor cost per unit of manufacturing is not advantageous because it only relies on low-cost labor. Labor cost per unit in many manufacturing power countries has a high level of pay. However, in terms of labor productivity and technology value, low-cost labor has several advantages.

**Employer's social security contribution rate** Employer's social security contribution rate also has a significant impact on the national manufacturing scale and level. Social security system sound country, although the labor costs will be high, in fact will lead to the development of a mature and competitive industry.

Labor costs are not the lowest possible. This low labor cost is not helpful in improving the development level of the national manufacturing industry such that its manufacturing industry does not have the advantage. For example, the United States, Germany and Japan are the world's leading countries in the manufacturing industry. Their labor costs are high and social security systems were already constructed many years ago.

**Interest rate spread** Interest rate spread is an indicator representative of financing costs. We confirmed that a low interest rate spread indicates that financing costs of enterprises are low. Hence, the development of the national manufacturing industry evidently needs help. For national policies, reducing financing costs is an extremely powerful path with which to promote the development of national manufacturing.

**Corporate tax rate on profit** Corporate tax profits will promote development at a national manufacturing scale. However, the impact on the level of manufacturing development is insignificant.

**Office rent** We used office rent as a measure because the indicators that directly reflect the cost of land were difficult to obtain. Evidently, the lower the office rent, the more conducive it is to the development of national manufacturing at the scale and development level.

**Energy intensity** The results prove that energy intensity is positively related to the size and negatively correlated with the level of development of the national manufacturing sector. With China, India, Brazil and other developing countries, the demand for energy experienced an urgent increase with the rapid development of manufacturing. However, the energy intensity is often low in developing countries, with relatively low levels of science and technology and energy consumption at the manufacturing scale. Relatively speaking, developed countries have high manufacturing level, high technological content and low energy intensity. Energy intensity has a strong correlation with the level of science and technology (Tao 2011). Enhancing the level of science and technology, reducing energy intensity and promoting the level of the manufacturing industry are the ultimate correct processes.

**Total natural resources rent (% of GDP)** The high cost of natural resources, which indicates the high cost of raw materials, will inevitably affect the scale of domestic manufacturing and the development level. However, the origin of raw materials and natural resources are owned by a country's objective existence of resources with controllability on the limitations.

**Inventory change (current dollar)** Inventory change helps promote the scale and level of development of a country's manufacturing industry. The higher the inventory change, the higher the activity of the entire economy.

**Merchandise trade (% of GDP)** This factor is negatively related to the size and level of manufacturing due to the fact that certain countries with large international trade are not manufacturing or major. However, manufacture exports and imports have positive correlations with the size and development level of manufacturing. These correlations suggest that imports and exports contribute to the development of their manufacturing industries.

**Corruption Perceptions Index** Controlling corruption helps promote the development of manufacturing.

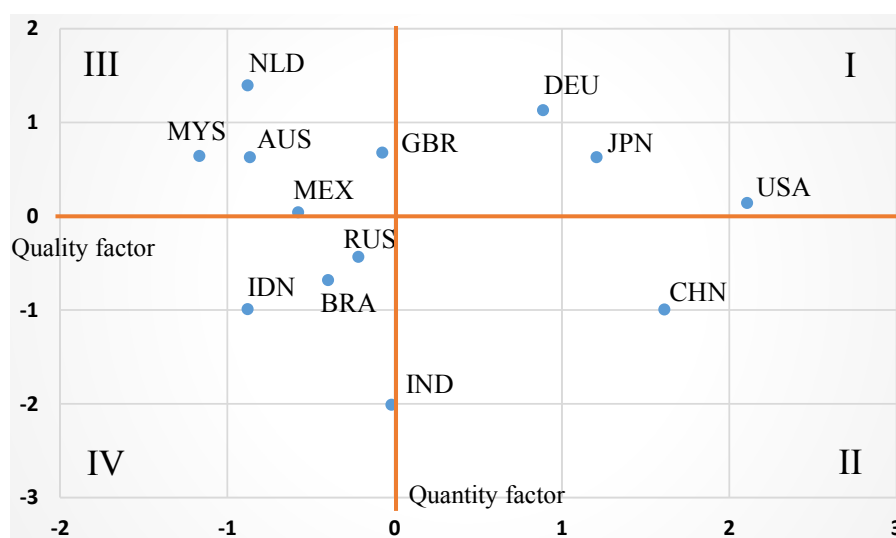
## 5. Discussion and Conclusions

### 5.1. Manufacturing Development Trends

The current international manufacturing industry has shown two major trends, namely, the return of domestic manufacturing and the promotion of high-tech manufacturing development. The manufacturing industry is an important foundation of national economy. Since the 1980s, although the proportion of the MVA of gross domestic product decreased, the manufacturing industry still occupies an important position in the national economy. From the point of developing countries, such as China and Malaysia, the importance of the manufacturing industry in the national economy gradually increases. Moreover, an inevitable rise in cost factors, such as workers' salary and upgrade of manufacturing production line, also causes a rise in manufacturing total costs. From the point of view of developed countries, many developed countries keeping advantages in manufacturing technology and are aware of its significant role in the national economy over the recent years.

On the manufacturing scale, developing countries still have certain disadvantages compared with developed countries. Figure 3 illustrates that only China has certain advantages on the manufacturing scale depending on its advantages from the economic dimension. The rest of the developing countries still have great gap in the manufacturing scale compared with developed countries, such as the United States and Japan. However, with the rise of manufacturing in developing countries, Russia, Indonesia and other developing countries are close to the level of the traditional developed countries, such as the Netherlands and the UK.

From the point of view of the national manufacturing level, an evident differentiation of the world's leading manufacturing countries exists: developed countries' manufacturing level is apparently at a dominant position. On the one hand, the United States, Germany and other manufacturing powers are well known to almost monopolize high-technical manufacturing. However, other developing countries are mainly engaged in low-technical manufacturing enterprises. On the other hand, manufacturing workers in developed countries have good training high labor productivity. These facts result in great superiority for the developed countries in manufacturing production and product trade. In fact, developing countries are seeking to promote technology to break the technological monopoly of developed countries by increasing investment in research and design and by enhancing the irreplaceability of manufacturing products. Given that many countries realize the importance of manufacturing, predictably, the manufacturing level of the world's leading manufacturing countries will gradually improve in the future and be highly competitive.



**Figure 3.** Matrix analysis of the world's major manufacturing countries based on quantity and quality factors.

The model calculation results affirm that labor cost per unit has a significant impact on the national manufacturing scale and level. However, low labor cost per unit of manufacturing does not have the advantage if it only relies on low-cost labor. Labor cost per unit in many manufacturing power countries has a high level of pay. However, in terms of labor productivity and technology, value has advantages. In the long term, improving labor productivity and increasing the workers' wages at the same time are effective ways of solving this problem.

Interest rate spread is an indicator representative of financing costs in manufacturing. We corroborated that interest rate spread has an evident influence on the national manufacturing scale and level. A low interest rate spread indicates that a country's financing costs are low. Hence, low interest rate spread brings additional financing opportunities and low interest payments for manufacturing enterprises. Once the interest rate spread decreases, scaling up is helpful for manufacturing companies.

Tax and rental costs are important components of costs because tax has a huge effect on enterprise running. We confirmed that corporate tax profits will promote the development of the national manufacturing scale. However, its impact on the level of manufacturing development is insignificant. We used office rent as a measure because the indicators that directly reflect the cost of land were difficult to obtain. Evidently, low office rent is a good condition with which to expand the scale of enterprise. The lower the office rent, the more conducive it is to the development of national manufacturing in the scale and development level.

Energy and raw material costs are especially vital in manufacturing given that this industry is engaged in the manufacture of material or ingredients into new products using physical and chemical processes. Energy and raw materials are essentially in abundance; thus, the efficiency of energy consumption and price of raw materials will greatly affect the profit of manufacturing enterprises. The results verify that energy intensity is positively related to the scale and negatively correlated with the level of the national manufacturing industry. In China, India and other developing countries, the rapid development of manufacturing results in the urgent increase of energy demand. However, the energy intensity of these countries is relatively low because of the low level of science and technology. Promoting the level of science and technology is the ultimate means to promote the level and scale of the manufacturing industry. Furthermore, inventory change helps promote the scale and level of development of a country's manufacturing industry. High inventory change reflects high activity of the manufacturing production.

Foreign trade exports are a direct embodiment of prosperity for an industry. High import and export trade values will stimulate the degree of activity of manufacturing enterprises and promote the scale and level of the manufacturing industry. Manufacture exports and imports have positive correlations with the size and development level of manufacturing, which suggests that imports and exports contribute to the development of their manufacturing industries.

Business environment has a relationship with the establishment and development of manufacturing enterprises. A good business environment improves the production efficiency of manufacturing enterprises and reduces hidden costs. The Corruption Perceptions Index helps realize the business environment in a country. This index has a significantly negative influence on the national manufacturing scale and level. Controlling corruption promotes the development of manufacturing in a country.

The United States, Germany, Britain and other developed countries have completed their industrialization in the middle of the 20th century. However, these countries began to reach deindustrialization in the 1970s and focused on finance and services. Until the financial crisis in 2008, these developed countries realized the importance of a real economy and refocused on manufacturing industry and reindustrialization. Developing countries, such as India, Malaysia and Mexico, have always persisted on and supported the development of the manufacturing industry. However, the development of manufacturing in developed countries neither stagnates nor decline. After the industrialization in developed countries, with the development of the industry in developing countries, certain manufacturing enterprises transferred to developing countries due to their labor and resource cost advantages. Developed countries focus on the development of the high technology manufacturing industry and use this technological advantage to monopolize profit. In addition, such countries provide policy support to encourage domestic manufacturing enterprises to invest in research and design.

The MVA of China has been rapidly developing and became the world's biggest manufacturing country. This change can affect the industrial policies in the development of the secondary industry. However, with the disappearance of demographic dividends and growth of labor cost, traditional manufacturing that depends on the path of human development has experienced a narrow walk. Moreover, intelligent equipment manufacturing represented by industrial robots has brought a revolutionary industry change on the traditional mode of production equipment manufacturing and logistics and other related industries. China is looking for transformation of manufacturing as well as driving force for long-term development.

## *5.2. Policy Suggestion to Improve China's Manufacturing Competitiveness*

In China, the fact that the salary growth rate is higher than that of labor productivity with rising labor costs per unit remains. Currently, the increasing compensation level in China is undeniable. Considering the increased demand of the national income, enterprise labor costs for manufacturing must be controlled from the perspective of the enterprise social security burden. In addition,



increasing investment on research and design and improving labor productivity are effective ways to solve this problem. The results confirm that the reasonable manufacturing and this labor cost per unit rise will contribute to the expansion of the manufacturing industry and improvement of manufacturing efficiency. The ways to control labor costs are to reasonably reduce wage growth and reduce manufacturing enterprise social security burden.

For national policies, reducing financing costs is an extremely powerful path to promote the development of national manufacturing. Controlling interest rate spread will be good for manufacturing enterprises to reduce the cost of financing and manufacturing enterprises' capital barriers to entry and promoting the growth of the manufacturing scale and efficiency. Improving financing conditions, particularly in emerging industries, gradually reduces the interest burden level of the enterprise loan and intermediate financing costs.

According to the result and analysis, office rent is the significant factor that influences the scale and level of national manufacturing. With the rapid growth of China's real estate industry, commercial housing and land prices rise rapidly, causing the rapidly rising land costs for manufacturing enterprises. The rising land cost of manufacturing has hindered the development of the manufacturing industry in China. The government should regulate the rapid rise in land cost and provide preferential policies to manufacturing land.

Compared with that of developed countries, China's energy intensity is higher. However, in terms of energy-saving technologies and work, China's energy intensity has begun to decline. Although this decline will inhibit the increase of the scale of China's manufacturing industry, energy intensity decrease has a positive effect to improve manufacturing efficiency. China began to implement the energy conservation law in the 1980s and also issued a series of laws and regulations for energy conservation and emission reduction. Advancing energy saving work has gradually reduced China's energy intensity. Emphasizing the energy saving policy will continue to reduce the energy cost of manufacturing in China.

High import and export trade values will promote the scale and level of the manufacturing industry and China has huge advantages in import and export trade of manufacturing. As a suggestion on Chinese manufacturing: to expand exports, restrict imports and increase domestic manufacturing of market opportunities. Moreover, learning from policies and measures adopted by the United States, France and Japan, such as expanding export credit and relaxing export controls to promote foreign investment and other measures to increase the export of industrial competitiveness and increase the protection of domestic market, is worth noting. In addition, manufacturing imports at the beginning of the manufacturing development phase is conducive to domestic manufacturing upgrade and technological innovation. China is still in a period of manufacturing imports of dividends. Keeping the manufacturing imports is beneficial to development. However, manufacturing should limit the import of low-end manufacturing goods and encourage high technology manufacturing imports.

Finally, China should focus on improving the domestic business environment, regulate all aspects of business management and standardize the market order to create fair competition in the market economy environment. Furthermore, government corruption problems and Corruption Perceptions Index should also be reduced.

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