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The Researches on China's Export Technology Sophistication of Manufacturing : Added-Value tax

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Abstract. This paper used the method of Wang et al. (2014) to measure the domestic value added from 1995 to 2014 based on the WIOD databas, then revised and measured the sophistication and dynamic changes of manufacturing among 39 nations including China, and further to explore the influential factors of China, found that although the growth rate of China's export technology sophistication the of manufacturing is higher, but the overall sophistication level lags far behind the other countries; In terms of intensity, China's knowledge-intensive manufacturing shows stronger growth than labor-intensive and capital-intensive manufacturing; As for influencing factors, human capital, labor costs, economic freedom have significant positive effect to improve sophistication, but the intensity of R&D, the number of enterprises, infrastructure are not significant.

Introduction

With the development of economic globalization, the production of goods has gradually been laid out globally. As the largest developing country, China has continuously embedded in the GVCs, making the scale of processing trade rapidly developing. However, it makes the data under traditional trade statistics tend to be overestimated by neglecting the high added-value contribution of foreign intermediate inputs. Based on this, scholars have taken the new division of labor system as a new research point to restore the true situation of trade.

Export technology sophistication(ES) gradually become an important index to measure changes in technical structure of the export. Michaely (1984) first proposed the definition, he thought the per capita GDP determined the technical level. Lall et al.(2006) constructed the TSI index and calculated the value of each country's exports as a share of the world's total exports. However, it's easy to ignore the different export size between countries. Considering the defects, Rodrik (2006), Hausmann et al. (2007) constructed the EXPY index, and calculated the ratios of the RCA index of a country to the RCA index of all the countries to avoid the errors in different export sizes.

With the development of value-added trade statistics, the measurement of ES is constantly revised by excluding the impact of processing trade. Yao et al.(2008) calculated the domestic technical sophistication, but without considering indirect consumption. Based on the HIY method, Ding et al.(2013) excluded the direct and all indirect contribution of imported intermediate inputs. Later researches (eg.Liu et al.,2017;Cheng et al.,2017) improved the measurement of ES in combination with the improvement of measurement of value-added.

We finally choosed a time series from 1995 to 2014,covering 39 economies[1] and 13 manufacturing industries[2].The main contribution is using the newer, longer data and latest measurement of value-added, then revising the index to measure the dynamic ES changes among 39 nations, and further to explore the influencing factors of China to provide some suggestions.

Methodology

Refering to the method of Wang et al.(2014) based on the World Input-output Database(WIOD),the exports of a country under the two-state model can be decomposed into four parts: I. the domestic value-added absorbed by foreign countries (DVA);II. the returned and absorbed domestically term(RDV);III. pure foreign double counted term (PDC);IV. the implied foreign value added (FVA).

Considering the new division of labor, we revised the existing measurement(eg. Hausmann et

al.,2007) based on the latest mesurement of value added, and constructed the new ES index:

$$ES_j = \sum_{i=1}^{k}[\frac{ne_{ij}}{NE_j} * TSI_i], \text{Where } TSI_i = \sum_{j=1}^{n}[\frac{ne_{ij}/NE_j}{\sum_{j=1}^{n} ne_{ij}/NE_j} * Y_i]$$

Where ne_{ij} is the DVA of Sector i of Country j; NE_j is the total amount of the DVA for manufacturing in Country j; Y_i is the GDP per capita (PPP) from IDA; TSI_i is actually a weighted average of per capita GDP in each country; ES_j is the export technology sophistication of a country's manufacturing industry.

Analysis

Overall Analysis. Table 1 shows the average ES of the world's manufacturing was steadily increasing, from 14955 in 1995 to 34413 in 2014,by 130% in 20 years,mainly because the reorganization of the GVCs under the new division of labor, enabled all countries to occupy a more advantageous position. Elements, resources can be more effectively integrated and allocated .

From the perspective of countries, the ES showed these trends:(1)From the overall level, GBR, IRL, USA, LUX, DNK, FRA, SWE were at the leading level in the world from 1995 to 2014,while CHN, TUR, LTU, IND, IDN, GRC, BGR were in the low-end levels. Because developed economies have more initiative in GVCs, while emerging economies being chronically locked in the low-end of the GVCs;(2)Comparing the growth rates within 20 years, CYP, CHN, IDN, LVA, LTsU, GRC, EST, IND had a faster growth than others. Among them, CYP grew by 169% from 13589 to 36615,CHN increased by 136% from 14129 to 33343,while USA, RUS, JPN, FIN, CAN increased by less than

Table 1 The ES of each country' manufacturing

country years		1995	2014	country years		1995	2014	country years		1995	2014
1	AUS	14828	34686	14	FIN	15940	34945	27	LVA	13698	33784
2	AUT	15572	34916	15	FRA	15624	34982	28	MEX	15519	33999
3	BEL	15219	35025	16	GBR	15707	35090	29	MLT	15433	35105
4	BGR	14857	34103	17	GRC	13734	32971	30	NLD	15276	34686
5	BRA	15068	34312	18	HUN	15013	34693	31	POL	14558	34337
6	CAN	15751	34712	19	IDN	13422	33281	32	PRT	14082	33426
7	CHN	14129	33343	20	IND	13734	32789	33	ROU	14163	33316
8	CYP	13589	36615	21	IRL	15551	36458	34	RUS	15327	33433
9	CZE	15036	34476	22	ITA	15103	34261	35	SVK	15173	34173
10	DEU	16026	34773	23	JPN	16246	34509	36	SVN	14988	35464
11	DNK	15240	35903	24	KOR	15230	34167	37	SWE	16025	34905
12	ESP	15581	34383	25	LTU	13653	33259	38	TUR	13742	32706
13	EST	13981	33585	26	LUX	15493	35830	39	USA	15940	34703
									Mean	14955	34413

Source: WIOD database; author's calculations

120%;(3)From the worldwide ranking change within 20 years, CYP, DNK, AUS, BEL, SVN showed significant growth advantages, especially CYP which had been in the top three since 2010;MLT, BGR, CAN presented the trend of "rising after declining"; Meanwhile, DEU, ESP, JPN, MEX, RUS, USA were still at a high ranking but with a continuous declining; Other countries were relatively stable, eg. China's world rankings were in [28,35] range.

Factor-Intensive Analysis. Table 2 shows the ES under different factor intensities: labor-intensive manufacturing(LM),capital-intensive manufacturing (CM) and knowledge-intensive manufacturing(KM).World average ES both showed an obvious upward trend, with the highest KM,

followed by CM, and the lowest in LM.

From 1995 to 2014, the ES growth under different intensive type were different: (1)From the LM, the growth rates of IRL, MLT, BGR, RUS, NLD were over 150%; while GRC(-71.23%), KOR(-37.5%), CYP(-31.2%) fell sharply, mianly because the shift of labor comparative advantage; The ES of China from 46.3 in 1995 rose to 64.74 in 2014, increasing only by 40%,probably because the early release of the population led to a large base, or the rising costs of the labor deprived it of its advantages;(2) From the CM, all countries showed a growth trend, among which MLT increased by five times, while JPN, PRT, LVA and IDN all increased by more than 2 times, while CHN, HUN, SVK, ROM and CZE grew by less than 70 percent;(3)From the KM, CYP, GRC, ROM, CHN, LUX, IND, CZE have greatly improved, most notably CYP and GRC increased by 1635% and 1138% respectively; CHN also grew faster than most countries, rising by 279% from 52.49 to 199;RUS, ESP, CAN, USA, BGR, JPN increased by less than 100%, which were below the world level; While some countries were far behind, the growth rates of MLT, AUS were below 40%.

Table 2 The ES under different factor intensities

	country	LM	CM	KM	country	LM	CM	KM	country	LM	CM	KM
1995	AUS	1301	9126	4402	FIN	1464	7942	6535	LVA	5474	4303	3921
2014		2061	26544	6081		2680	16492	15773		11695	14016	8074
1995	AUT	1817	5587	8167	FRA	1122	4875	9627	MEX	1873	3605	10041
2014		3180	13703	18034		2471	10002	22508		3029	9648	21323
1995	BEL	1497	6225	7498	GBR	929	4314	10464	MLT	2533	2406	10493
2014		2026	15763	17237		2163	9911	23016		8154	14851	12100
1995	BGR	1420	7359	6079	GRC	3896	9375	463	NLD	816	7106	7354
2014		4525	16878	12701		1121	26122	5728		2111	15078	17498
1995	BRA	1464	8492	5112	HUN	1460	6868	6684	POL	2926	6187	5446
2014		3044	21337	9930		1873	10954	21866		4104	15482	14751
1995	CAN	1535	6426	7790	IDN	4829	6170	2423	PRT	4801	4210	5071
2014		3472	16618	14621		5778	19350	8153		7020	15881	10524
1995	CHN	4630	4249	5249	IND	5791	4558	3386	ROU	3962	5632	4569
2014		6474	6969	19900		7825	13130	11834		5848	9400	18068
1995	CYP	4850	7764	974	IRL	446	7260	7846	RUS	428	9250	5649
2014		3337	16368	16910		3652	13238	19568		1281	23273	8879
1995	CZE	2233	6809	5994	ITA	2947	4220	7936	SVK	1631	7761	5782
2014		2405	11570	20501		5639	10828	17794		2931	11978	19265
1995	DEU	792	4040	11193	JPN	383	2698	13164	SVN	3187	4851	6951
2014		1946	8375	24452		675	8113	25721		3462	12217	19785
1995	DNK	1676	6686	6878	KOR	2379	2473	10378	SWE	1066	5423	9536
2014		2869	12660	20375		1487	5822	26859		2223	12421	20261
1995	ESP	1294	5188	9099	LTU	3701	6594	3359	TUR	5230	5139	3373
2014		2967	14645	16771		8626	16826	7806		8979	13457	10270
1995	EST	4511	5567	3902	LUX	1225	11284	2984	USA	826	3856	11258
2014		10745	12961	9879		2447	22788	10595		1790	11051	21862
1995									Mean	2419	5946	6591
2014										4054	14275	16084

Source: WIOD database; author's calculations

Comparing world ranking changes under different intensive type of different countries within 20 years, we found:(1)From the LM, LVA, EST, CHN, IND, TUR were ranking among the top 10 in the world; But the advantages of USA, DEU, JPN and RUS were not obvious; BGR, IRL increased significantly, while the rankings of GRC, KOR were declining;(2) From the CM, AUS, LUX, RUS, GRC, BRA ranked the top ten in the world; KOR, JPN, MEX, DEU, USA ranked relatively backward in the world; Although CHN continued to grow in the sample period, its world ranking showed the trend of declining and gradually stabilizing in the lower ranking;(3)From the KM, USA, JPN, DEU, GBR, FRA, KOR ranked the top ten in the world in 20 years; Some countries such as

LTU, LUX, GRC, LVA, TUR, AUS ranked high in the LM or CM, their ranking in the KM continued to fall behind; In the meantime, the world rankings of CAN, ESP, MLT declined frequently; While CHN, CYP, CZE and ROM showed tremendous growth potential, having gradually promoted to upper level due to the technology spillover effect.

Econometric Analysis of the Influencing Factors in China

Variables and **The Econometric Model.** Combined with the practice of existing scholars, we define a set of variables:(1)Export Technology Sophistication (ES) is calculated according to WIOD Database; (2)R&D Intensity(RD) is the ratio of R&D expenditure to main business income;(3)Human Capital(HC) is the ratio of R&D researchers to the total number of workers; (4)Number of enterprises in the industry(NUM) is from China Statistical Yearbook on Science and Technology;(5)Labor Costs(LC) is per capita wage level;(6)Economic Freedom(REEDOM) is 1 minus the ratio of total assets of state-owned enterprises to total assets of the whole industry;(7)Infrastructure(INFRA) is the sum of railway mileage and highway mileage.

We constructd the following econometric model to analyze the influencing factors of ES in China:

$$ES_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 HC_{it} + \beta_3 NUM_{it} + \beta_4 LC_{it} + \beta_5 FREEDOM_{it} + \beta_6 INFRA_{it} + TE + \nu_i + \varepsilon_{it}$$

where i and t denote the manufacturing sub-industry and time respectively; ν_i is the individual fixed effect variable in the industry; ε_{it} is the random errorterm; TE is the time trend item.

Econometric **Results.** The FGLS results of gradually adding the variable are presented on Table3.As can be seen, the coefficient of RD mostly fails to pass the significance test of 10% due to

Table 3 FGLS results of gradually adding the variable

	（1）	（2）	（3）	（4）	（5）	（6）
RD	0.000463 （0.00175）	-0.00888** （0.00367）	-0.00447 （0.00329 ）	-0.00297 （0.00319）	-0.00309 （0.00319）	-0.00327 （0.00321）
HC		0.0484*** （0.00520）	0.0392*** （0.00527 ）	0.0345*** （0.00571）	0.0360*** （0.00564）	0.0363*** （0.00567）
NUM			0.00890** （0.00422 ）	0.00627 （0.00410）	0.00635 （0.00390）	0.00643 （0.00392）
LC				0.0330** （0.0134）	0.0324** （0.0132）	0.0325** （0.0132）
FREEDOM					0.00974** （0.00486）	0.00946* （0.00504）
INFRA						0.00164 （0.00611）
TE	0.00653*** （0.000129 ）	0.00558*** （0.000245 ）	0.00539*** （0.00031 ）	0.00435*** （0.00057）	0.00393*** （0.00059）	0.00384*** （0.000664）
_cons	-13.02*** （0.259）	-11.12*** （0.490）	-10.73*** （0.615）	-8.655*** （1.146）	-7.815*** （1.185）	-7.636*** （1.327）

Notes: Standard errors in parentheses,*p < 0.1, **p < 0.05, ***p < 0.01

the inadequate R&D investment or unreasonable investment structure, causing the low utilization rate of funds, the inconspicuous technology spillover effect. The coefficient of HC is positive due to

the converting of personal knowledge, ability and experience to productivity, efficiency, the improving ability of R&D and absorbing new technology, which can improve the ES.NUM hasn't passed the 10% significance test, maybe due to the small size of industry under monopoly or oligopoly market structure, the competition is not fierce enough, only in the price competition for homogeneous products rather than technical competition. LC has a positive effect on ES of China, because the rising costs make lower profits, lower market competitiveness, forcing enterprises to innovate to achieve labor substitution, promote industrial restructuring and upgrading. The economic freedom also has positive effect, because more freedom of opening means the higher marketization degree, the free flow of quality factors, the optimized allocation of resources, the competition effect, and can avoid dominant monopoly of non-market mechanism, reduce the rent-seeking activities, force the domestic enterprise to innovate. The regression coefficient of INFRA fails to pass the significance test of 10%, indicating that the improvement of the infrastructure is still to be further improved.

Conclusions

Between 1995 and 2014, total ES world rankings of China's manufacturing were lagging behind; However, the growth rate of China itself showed a faster growth rate than other countries; From different factor intensities, the ES of LM and CM were close, but were all lagging behind the KM; The growth rates of LM and CM in China were also lagging behind other countries and KM in the sample period; In terms of the world ranking, the ES of LM was in the top ten in the world within 20 years, CM gradually stabled in the lower ranking after first decline, while KM continued to rise; From the influencing factors, the HC, LC, FREEDOM had a significant positive promoting effect on ES in China's manufacturing, the promotion effect of RD, NUM and INFRA have not been developed.

The conclusions of this paper not only help to better understand the ES changes of countries, the positioning in the world and the influencing factors, but also have important guiding significance for improving the ES in Chin. First of all, the government should provide appropriate innovation supporting mechanism involving atmosphere, funds, talents and guide R&D investment structure rationally. Enterprises should also increase investment in R&D, use funds effectively, strengthen the ability of innovation or absorption by cooperation with affiliated enterprise, colleges and universities. Second, the industry should avoid rent-seeking under monopoly and low efficiency problem, and try to increase market openness, make full use of the competition effects and technology spillover effects, and build sufficient and equal competition mechanism. In addition, it also can promote infrastructure construction to improve efficiency, reduce cost, achieve the effective allocation of resources, and promote the scale economies effect.

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[1] AUS; AUT; BEL; BGR; BRA; CAN; CHN; CYP; CZE; DEU; DNK; ESP; SET; FIN; FRA; GBR; GRC; HUN; IDN; IND; IRL; ITA; JPN; KOR; LTU; LUX; LVA; MEX; MLT; NLD; POL; PRT; ROU; RUS; SVK; SVN; SWE; TUR; USA.

[1] C1 Food,Beverage and Tobacco Manufacturing; C2 Textiles, Clothing and Leather Products Manufacturing;C3 Manufacture of Wood, Wood Products and Cork Products; C4 Paper, Printing and Publishing; C5 Manufacture of Coke and Refining petroleum products;C6 Manufacture of chemicals and chemical products; C7 Manufacture of rubber and plastic products; C8 Manufacture of other non-metallic mineral products;C9 Manufacture of basic metals; Manufacture of metal products, except machinery and equipment; C10 Manufacture of machinery and equipment nec; C11 Manufacture of electrical and electronic equipment; C12 Manufacture of transport equipment;C13 Other Manufacturing Industries.