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An analysis of composition and structural transformation of exports of China

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Abstract
The paper analyzes export performance of China over the period of 1992 to 2014. The entire manufacturing exports have been segregated into four categories using Lall (2000) classification on the basis of their technological characteristics. SITC-3 digit data has been used as a proxy for export industries. The study tests whether there has been a structural change in exports across all four groups in the form of increase or decrease in specialization during the period of study i.e. 1992 to 2014 which is further segregated into two sub-periods 1992 to 2002 and 2002 to 2014 to assess the impact of China's WTO accession in 2001 on structural change of its exports. The study also tests the new trade theory which states that the pattern of comparative advantage changes with the technology accumulation and with the change in resource endowment over the period of time, i.e. specialization in high-tech exports increase and in low-tech exports decrease. The paper uses Revealed Comparative Advantage index, Revealed symmetric comparative advantage index, Wald test and regression analysis for drawing inferences. Based on the analysis, this paper supports the prediction of the new trade theory.

Keywords: Structure of exports, Revealed Comparative Advantage (RCA), Symmetric Revealed Comparative Advantage (RSCA), Galtonian Regression Model, Structure of exports.
JEL Classification: F13, F14, F15.

1. Introduction
China is among the fastest growing economies of the world. Prior to 1978, commodity trade in China was determined entirely by economic planning. This system was gradually dismantled in 1980s and was largely abandoned by 1990s. Except few important commodities, there has been decentralization of trade through granting of increased autonomy to local authority and enterprises. Several crucial reforms were adopted over the time in this regard, such as reduction of direct trade controls in terms of imposing tariff, quotas and licensing requirement. Over the time the government substantially devalued domestic currency, adopted market-clearing rate and rebate the indirect taxes and duties etc. The impact of these reforms is evident through the fact that china is growing at very fast rate.

China's export oriented development has become a matter of concern for labour-intensive manufacturers globally as it has changed the picture of comparative advantage in the world market. It has posted a threat to many developing countries whose exports are mainly labour-intensive in nature. According to classical trade theory, opening of international trade would lead to specialization in products that have comparative advantage, i.e. labour intensive products should be produced in developing countries as they are rich in labour endowment and cost of labour is relatively low while capital intensive goods should be produced in rich and developed countries because cost of capital is relatively low over there.

Studies are available analyzing structure and structural change of exports over time for China. Bagaria and Ismail (2017) [6] have analyzed the structure of exports of China in terms of export diversification, composition and degree of Intra-Industry trade. Qureshi and Wan (2008) [22] in their paper concluded that the structure of China's exports has been changing with increasing share of skill intensive, medium to high-technology products and decreasing share of labour-intensive products which means competition from China in labour intensive products may decrease in long run. Several other studies have been conducted to look for trends in comparative advantage i.e. whether it is more dynamic or static. Sharma (2007) [25] in his study analysed Chinese manufacturing export performance and observed that pattern of specialization is emerging across all manufactured exports especially within the low technology manufactured exports. Several other studies have been conducted examining the changes in comparative advantage after occurrence of deeper trade integration in the global market such as Laursen (2000) [20], Imbs and Wacziarg (2003) [17], Sharma and Dietrich (2004) [24], Laursen (2015) [21], etc.

To the best of our understanding, there is no study analyzing dynamics of comparative advantage of China over the period of 1992 to 2014. Based on the above background the present study undertakes an analysis of the dynamics of comparative advantage of China over the period 1992–2014 in the global market across four different categories of products based on technological characteristics. To assess structural change in exports of China over the study period, a detailed regression analysis using Revealed Symmetric Comparative Advantage RSCA indices has been performed. The study also examines the stability of comparative advantage using suitable wald test.

The paper is organized as follows. Section 2 provides the data and research methodology used in this study. Section 3 presents the empirical results of the study and conclusion is presented in section 4.

2. Data and Methodology

2.1 Data

The analysis is based on SITC-3 digit level data, classifying exports into four categories based on technological characteristics, i.e. high technology, medium technology, low technology and resource based using Lall (2000) [18] classification. Data source is UN-COMTRADE, extracted from World Integrated Trade Solution (WITS) database. The analysis is made for the time period 1992 to 2014 which is further segregated into two sub-periods that are 1992 to 2002 and 2002 to 2014 to assess the impact of China's accession to WTO on structural change of exports.

2.2 Methodology

2.2.1 Change in share of China's exports in world exports

In this change in share of China's exports of all four categories mentioned above in the entire world exports of all four technological categories is calculated seprately over the period of 1992 to 2014 using Lall (2000) [18] classification.

2.2.2 Revealed Comparative Advantage (RCA)

Revealed comparative advantage index has been used as an indicator of country's export potential. This is assumed to "reveal" the comparative advantage of a country provided that the commodity pattern of trade reflects the inter-country differences in relative cost and non-price factors.

To explore the dynamics of export specialization in China, we first calculate the Balassa index of Revealed Comparative Advantage (RCA) (Balassa 1965) [7] to measure the relative performance of commodities classified in four separate categories i.e. Resource based, low technology, medium technology and High technology products. It is defined as a country's share of world exports of a commodity divided by its share of total world exports. The index formula is as follows:

$$RCA_{ij} = \left(\frac{X_{ij}}{X_{wj}}\right) \Big/ \left(\frac{X_i}{X_w}\right)$$

Where, X_{ij} denotes export of product j from country i , X_{wj} denotes export of product j from the world w, X_i denotes the total exports of country i and X_w denotes the total world exports. This index compares the share of a sector in a country's total export with the share of the same sector in world's total exports. A value of RCA greater than unity indicates that the country specializes in a product j whereas a value of less than unity implies that the country has a revealed comparative disadvantage in product j.

2.2.3 Revealed Symmetric Comparative Advantage (RSCA)

Dalum, Laursen, *et al*. (1998) [13] provided a symmetrical index which we call revealed symmetric comparative advantage. As RCA indices can't be compared on both side of its neutral value that is 1, it is made symmetrical using following formula:

$$\text{RSCA}_{ij} = \frac{RCA_{ij} - 1}{RCA_{ij} + 1}$$

RSCA index takes the value between -1 and 1, ($-1 \le RSCA \le 1$). If RSCA_{ij} value is greater than 0, it implies that country 'i' has comparative advantage in product 'j', on the contrary if the value is less than 0, it implies that country 'i' do not have comparative advantage in product 'j'.

2.2.4 Galtonian Regression Model

To examine the change in structure of revealed comparative advantage of exports and its stability, the methodology has been briefly mentioned here, for detailed insight readers may refer Dalum, Laursen *et al*. 1998 [13] or Cantwell 1989 [11]. The change in comparative advantage structure of exports can be tested using the following regression equation:

$$RSCA_{t2\,j} = \alpha_j + \beta_j RSCA_{t1\,j} + \varepsilon_j \qquad (1)$$

Where, subscript t1 and t2 refer to beginning and final year, respectively. The dependent variable is revealed symmetric comparative advantage (RSCA) in the final year for product j and independent variable is revealed symmetric comparative advantage for the initial year for product j, αj and βj are standard linear regression parameters and ε_j is a residual term. β is used to measure stability of a country's specialization pattern between the two periods. Lower value of β represents high degree of turbulence in comparative advantage of products during the period under consideration, but if β is not significantly different from 1 then the pattern is considered to be unchanged. β/R (where R is regression correlation coefficient) measures whether the level of specialization has increased or decreased between two periods (an increase or a decrease in the spread of specialization). Decrease in specialization is termed as de-specialization. In case β/R>1, implies specialization has increased whereas if β/R<1, then it implies that specialization has decreased. In this exercise RSCA is used in place of RCA for estimating the equation because RCA might result in biased estimates (Crafts and Thomas 1986) [12]. Balassa index has the risk of lack of normality in its distribution because it ranges between zero to infinity. As a result, there is a possibility of violation of assumption of normality of the error term in regression analysis and producing unreliable t-statistics in a skewed distribution.

The procedure for estimating changes in the variance of distribution over time follows from Hart (1976) [16] and Cantwell (1989) [11]. Using equation (1), if variance of revealed symmetric comparative advantage index at t2 is defined as $\left(\sigma^{t2}\right)^2$ then:

$$\left(\sigma^{t2}\right)^2 = \beta_j^2\left(\sigma^{t1}\right)^2 + \sigma_\varepsilon^2 \quad (2)$$

Where, β_j^2 is square of regression coefficient (equation 1), $\left(\sigma^{t1}\right)^2$ is the variance of RSCA at time t1 and σ_ε^2 is the variance of error term (equation 1). The coefficient of determination R_j^2 is given by:

$$R_j^2 = 1 - \left(\frac{\sigma_\varepsilon^2}{\left(\sigma^{t2}\right)^2}\right) = \left(\left(\sigma^{t2}\right)^2 - \sigma_\varepsilon^2\right)\left(\frac{1}{\left(\sigma^{t2}\right)^2}\right) \quad (3)$$

Combining equation (2) and (3) gives us:

$$\left(\sigma^{t2}\right)^2 - \sigma_\varepsilon^2 = \beta_j^2\left(\sigma^{t1}\right)^2 = R_j^2\left(\sigma^{t2}\right)^2 \quad (4)$$

Equation (4) can be rewritten to show the relationship between the variance of two distributions as follows:

$$\frac{\left(\sigma^{t2}\right)^2}{\left(\sigma^{t1}\right)^2} = \frac{\beta_j^2}{R_j^2} \quad (5)$$

Equation (5) can be simplified to:

$$\frac{\sigma^{t2}}{\sigma^{t1}} = \frac{|\beta_j|}{|R_j|} \quad (6)$$

Where R_j is the square root of the coefficient of determination, obtained from regression equation (1). From equation (6) we can see that degree of export specialization rises when β >R and it falls when β<R. Using the estimated values of regression, the extent of specialization rises if $\beta/R > 1$ whereas if $\beta/R < 1$ specialization decreases. Various other studies measuring export specialization have used this method. In the context of specialization, it was first applied by Cantwell (1989) [11] and then by Laursen (1998) [19]. Laursen (2000) [20] analyzed the extent to which 19 OECD countries and sectors display stable specialization patterns over time, both in terms of exports and technology for the period of 1971to 1991, Setyari, Widodo *et al*. (2015) [23] analyzed change in the comparative advantage structure of Indonesian export products., Laursen (2015) [21] measures export competitiveness of a small economy Lithuanian in 2000-2007 and compare it with the other small Baltic states and analyze the pattern of export specialization and shift of export specialization.

3. Empirical findings

3.1 Change in share of exports in world exports

3.1.1 High-technology based Exports

"High technology products have advanced and fast changing technologies and the complex skill needs" (Lall, 2000) [18]. Looking at the share of China's exports of high-technology based products in world total exports of high-technology based products, it is found that China's share has been continuously increasing over the time. China forms a significant part of world exports of high technology products, its share has increased from 1.28 percent in 1992 to approximately 24.20 percent of total world exports in 2014 (Table 1). The growth of China's exports of high technology based products is commendable.

3.1.2 Medium-technology based Exports

"Medium technology products generally have complex but not fast-changing technologies and moderate levels of R&D expenditure" (Lall, 2000) [18]. In case of Medium technology based exports the country has made a remarkable growth over the study period, its share has increased from 1.12 percent in 1992 to 11.37 percent in 2014 (Table 1).

3.1.3 Low-technology based exports

Stable, well-diffused technologies mainly embodied in capital equipment, low R&D expenditures and skill requirements, and low-scale economies are the basic characteristics of Low-technology exports (Lall, 2000) [18]. Looking at the share of low-technology based exports of China in total world exports, it is found that China's share in world exports of low-technology based products has increased over the time from 7.33 percent in 1992 to 31.35 percent in 2014 (Table 1).

3.1.4 Resource based exports

Resource based products can be simple and labour-intensive or capital, scale and skill intensive (Lall, 2000) [18]. Calculation reveals that that China is not very significant player in world market of resource based exports. China's exports share has increased from 1.61 percent in 1992 to 6.30 percent in 2014 (Table 1). China's growth looks impressive.

Table 1: Share of China's exports in world exports of each technological category

Product Group	1992	1996	2000	2004	2008	2012	2014
High technology manufactures	1.28	2.38	4.10	10.88	17.73	23.37	24.20
Medium technology manufactures	1.12	1.70	2.70	4.76	7.96	10.52	11.37
Low technology manufactures	7.33	8.95	11.93	15.64	22.16	29.04	31.35
Resource-based manufactures	1.61	2.16	2.56	3.69	4.79	5.50	6.30

3.2 Structure of Exports (RCA)

3.2.1 High-technology manufactures

Table 2 provides RCA of High technology manufactures for maximum 10 products out of total 19 products assigned to this classification. Analysis reveals that the country has comparative advantage in 11 products out of total 19 products in this category in 2014, though China didn't possess comparative advantage in many of these products in 1992 but over time the situation has improved.

Table 2: RCA of High technology manufactures

SITC Code	High technology manufactures	1992	2002	2014
752	Automatic data processing machines, n.e.s.	0.16	2.22*	3.60*
764	Telecommunication equipment, n.e.s.; & parts, n.e.s.	0.8	2.03*	2.90*
751	Office machines	0.87	4.06*	2.87*
871	Optical instruments & apparatus, n.e.s.	1.43*	1.94*	2.66*
761	Television receivers, whether or not combined	1.73*	1.43*	2.27*
771	Electric power machinery, and parts thereof	1.39*	2.89*	2.19*
778	Electrical machinery & apparatus, n.e.s.	0.75	1.67*	1.72*
759	Parts, accessories for machines of groups 751, 752	0.4	1.97*	1.70*
716	Rotating electric plant & parts thereof, n.e.s.	1.36*	1.58*	1.49*
712	Steam turbines & other vapour turbin., parts, n.e.s.	0.07	0.22	1.27*
776	Cathode valves & tubes	0.17	0.6	1.16*

Source: Authors' calculation using WITS database

* RCA greater than one indicates that the Country has comparative advantage in that good.

3.2.2 Medium technology manufactures

Table 3 provides RCA of Medium technology manufactures for maximum 10 products out of total 71 products assigned to this classification. For China, among top five products in 2014 "Sound recorders or reproducers" didn't have comparative advantage in 1992 but improved over time. Apart from this there are number of products which have gained comparative advantage over time.

Table 3: RCA of Medium technology manufactures

SITC Code	Medium technology manufactures	1992	2002	2014
813	Lighting fixtures & fittings, n.e.s.	2.36*	4.56*	4.31*
653	Fabrics, woven, of man-made fabrics	2.15*	2.82*	3.41*
763	Sound recorders or reproducers	0.77	4.22*	2.86*
775	Household type equipment, electrical or not, n.e.s.	1.22*	2.84*	2.71*
786	Trailers & semi-trailers	2.00*	4.39*	2.59*
785	Motorcycles & cycles	1.72*	2.64*	2.28*
762	Radio-broadcast receivers, whether or not combined	4.52*	4.13*	2.22*
711	Vapour generating boilers, auxiliary plant; parts	0.65	0.86	1.91*
593	Explosives and pyrotechnic products	6.24*	4.85*	1.84*
724	Textile & leather machinery, & parts thereof, n.e.s.	0.49	0.91	1.58*

Source: Authors' calculation using WITS database

* RCA greater than one indicates that the Country has comparative advantage in that good

3.2.3 Low-tech manufactures

Table 4provides RCA of Low technology manufactures for maximum 10 items out of total 44 products assigned to this classification. In China not much difference is found in goods having comparative advantage over 1992 to 2014.

Table 4: RCA of Low technology manufactures

SITC Code	Low technology manufactures	1992	2002	2014
666	Pottery	5.48*	5.83*	4.68*
844	Women's clothing, of textile, knitted or crocheted	2.93*	3.98*	3.76*
658	Made-up articles, of textile materials, n.e.s.	7.17*	4.41*	3.56*
697	Household equipment of base metal, n.e.s.	1.90*	4.04*	3.53*
652	Cotton fabrics, woven	5.41*	3.72*	3.41*
843	Men's or boy's clothing, of textile, knitted, croche.	3.42*	3.90*	3.40*
831	Travel goods, handbags & similar containers	7.94*	7.02*	3.34*
894	Baby carriages, toys, games & sporting goods	6.05*	6.36*	3.31*
846	Clothing accessories, of textile fabrics	3.31*	3.31*	3.29*
655	Knitted or crocheted fabrics, n.e.s.	2.67*	2.79*	3.12*

Source: Authors' calculation using WITS database

* RCA greater than one indicates that the Country has comparative advantage in that good.

3.2.4 Resource-based manufactures

Table 5 provides RCA of Resource-based manufactures for maximum 10 items out of total 67 products. In case of China, among top five products in 2014, "Clay construction, refracto. Construction materials" didn't have comparative advantage in 1992, but gained comparative advantage over time.

Table 5: RCA of Resource-based manufactures

SITC Code	Resource-based manufactures	1992	2002	2014
662	Clay construction, refracto. construction materials	0.36	1.04*	2.59*
689	Miscellaneous no-ferrous base metals for metallur.	3.24*	2.84*	2.04*
325	Coke & semi-cokes of coal, lign., peat; retort carbon	2.63*	7.56*	1.99*
37	Fish, aqua. invertebrates, prepared, preserved, n.e.s.	1.34*	3.09*	1.85*
661	Lime, cement, fabrica. constr. mat. (excludingglass, clay)	2.38*	1.99*	1.78*
531	Synth. organic colouring matter & colouring lakes	1.25*	1.92*	1.76*
523	Metallic salts & peroxysalts, of inorganic acids	1.99*	2.62*	1.57*
634	Veneers, plywood, and other wood, worked, n.e.s.	0.15	0.6	1.55*
625	Rubber tyres, tyre treads or flaps & inner tubes	0.37	0.97	1.49*
56	Vegetables, roots, tubers, prepared, preserved, n.e.s.	3.36*	2.18*	1.49*

Source: Authors' calculation using WITS database

* RCA greater than one indicates that the Country has comparative advantage in that good.

3.3 Structural Change in China's exports

Over the time with the accumulation of technology and changes in resource endowment, it is generally expected that the pattern of comparative advantage would also change, i.e. specialization in high-technology based exports may increase and low-technology based exports may decrease. Following results are used to assess whether the specialization (measured in terms of increase in comparative advantage among goods over time) has increased, decreased or remained stable over the time period under consideration across all four categories of exports.

In Table 6, β turned out to be less than 1 in all cases during the time period into consideration. But statistically significantly difference from 1 has been observed only in case of High Technology (1992-14) and Resource based (2002-14) exports. Hence we can say that there has been turbulence in RCA over the time, i.e. the product groups having high RCA are losing competitiveness whereas commodity groups having low competitiveness are gaining the comparative advantage over time.

β/R ratio turned out to be lesser than one in case of Low tech commodities throughout the period under consideration hence de-specialization has been observed in low technology based product and greater than one in case of resource based products throughout the period under consideration hence specialization has increased in case of resource based products. In case of high technology based products, specialization has increased in the sub-period 1992-02 and the period 1992-2014 whereas decreased in sub-period 2002-14. In medium technology based products too specialization has decreased for both the periods 1992-14 and 2002-14 whereas increased in case of 1992-02 though the increase was not significant. Significant de-specialization has been observed in case of Low Technology based products (2002-14, 1992-14) and Medium Technology based products (2002-14)

Table 6: Regression results for China

Product Group	Year	β	β/R	Jarque-Bera test (p-value)
HT	1992-02	0.76	1.14	0.85
	2002-14	0.75	0.91	0.97
	1992-14	0.33*	1.04	0.54
LT	1992-02	0.82	0.89	0.84
	2002-14	0.39	0.47*	0.09
	1992-14	0.32	0.41*	0.07
MT	1992-02	0.86	1.03	0.41
	2002-14	0.64	0.76*	0.95
	1992-14	0.43	0.76	0.06
RB	1992-02	0.76	1.02	0.12
	2002-14	0.92*	1.05	0.89
	1992-14	0.58	1.08	0.63

*denotes significantly different from unity at the 5% level.

4. Conclusion

The present study finds that China is a major player in world export market of low technology and medium technology based exports with tremendous growth over time. In low technology based exports, China's share in world exports has increased from 7.33 percent in 1992 to 31.35 percent in 2014 whereas in case of medium technology based exports it has increased from 1.28 percent in 1992 to 24.18 percent in 2014. The study further concludes that specialization has increased in high technology and resource based exports whereas decreased in case of low-technology and medium-technology based exports though the change is significant only in case of low technology based exports. Hence it can be concluded that though the share of low-technology based export in world exports has increased but specialization has significantly decreased whereas share of high-technology based exports in world exports has increased along with the increase in specialization. Significant decrease has been observed in case of Significant de-specialization has been observed in case of Low Technology based products and Medium Technology based products after China's WTO accession.

One significant finding is that China's share as well as specialization in high technology based exports has increased overtime. Theoretically speaking the sophistication of a country's exports is determined by the country's technology and capital endowment in producing the exported goods. But in case of China it is believed that rapid growth of high technology based exports is mainly result of two factors that are processing trade and foreign

direct investment (Gilboy 2004, Branstetter and Lardy 2006) [14, 9], though there are evidences both in favor as well as against this argument. Wang and Wei (2010) [25] found that improvement in human capital and government policies in the form of tax-favored high-tech zones have been the key determinant of China's increasing export sophistication; Bin and Jiangyong (2009) [8] also favor this argument. Felipe, Kumar, *et al*. (2013) [13] have stated that the key factor behind china's success in terms of its fast growth in last fifty years is its ability to learn and implement new and complex capabilities which can be seen in increase in its diversification and sophistication. China has achieved revealed comparative advantage in both labour-intensive and sophisticated products followed by factor abundance and learning respectively. All the same, if China's export sophistication is driven by processing trade, the question arises if there is any skill upgrading in China's value added (Bin and Jiangyong 2009) [8]. As per basic Heckscher-Ohlin type ideas as well as impact of learning by doing effect it can be argued that skill up-gradation takes place over two-periods for a given country when we observe greater specialization in medium technology based and high technology based exports in an economy. Our results corroborates this argument, we have observed increase in specialization in high technology based exports in China between 1992 and 2014.

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