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China's outward foreign direct investment and bilateral export sophistication: a cross countries panel data analysis

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Abstract

Purpose – China's outward foreign direct investment (OFDI) has risen remarkably over the past two decades. Does such increase affect the sophistication of Chinese exports, is a significant issue that has surprisingly remained unaddressed? The purpose of this study is to investigate the impact of Chinese OFDI on bilateral export sophistication of China and its OFDI receiving partner countries during 2003–2017 by applying Poisson pseudo-maximum likelihood approach based on gravity model.

Design/methodology/approach – The analysis has been performed for total sample, region-wise grouped sample (Europe and Central Asia, Middle East and North Africa, Latin America and Caribbean, East Asia and Pacific, South Asia, North America and sub-Saharan Africa) and income-wise grouped sample (high income, upper middle income, lower middle income and lower income group sample).

Findings – The results confirmed the significant and positive effect of Chinese OFDI on bilateral export sophistication in total sample, regions-wise and income groups sample.

Originality/value – The study provides a helpful suggestion regarding policy towards achieving more sophistication in export and thus to achieve comparative advantage in trade.

Keywords Export sophistication, OFDI, PPML, Gravity model, China

Paper type Research paper

1. Introduction

Since its opening with the world three decades ago, China sustained a steady growth due to comparative advantage in export and became the world major exporter which led researchers to consider China as highly sophisticated country regarding export (Su *et al.*, 2020; Lectard and Rougier, 2018). The isolated position of China, since its opening with export of even less than 10%, changed to a more integrated one with export of approximately 39% of gross domestic product (GDP) (Zheng *et al.*, 2019; Fan *et al.*, 2018).

Export sophistication captures the aggregate productivity of an economy's export basket where each commodity is recognized by a certain productivity level. A nation is considered as a more sophisticated exporter if its export basket contains additional commodities with improved productivity. In orthodox models, an economy's sophistication of export is determined by its economic essentials (like market size, natural resources, physical and human capital) (Fan *et al.*, 2018; Rehman and Ding, 2019).

Schmitz and Helmberger (1970) have described the theoretical mechanism of the impact of outward foreign direct investment (OFDI) on export sophistication of the partner countries such that when capital intensified country invests in the labour abundant and or natural resource abundant country in order to take advantage of the relative low factor cost, it enhance the flow of capital goods to the host country making the host country efficient as a

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result. The host country get the benefit of spillover effect of technology and the home country get the benefit of low cost and enhanced export varieties. Modern production process involves different production stages that are performed in different region of the world because of low factor cost or the technology may be specific to that region. Such process diffuses technology amongst the regions and requires foreign investment.

Hausmann *et al.* (2007) called export sophistication index as a measure of export productivity and is weighted average income associated with export bundle. If a country's exports are sophisticated it means that the country is capital intensive where producer has comparative advantage and earn high profit, labours are highly productive and receive high wages (Jarreau and Poncet, 2012). Also Xu and Lu (2009) suggested that export sophistication is highly associated with per capita income. As the structure of Chinese economy shifted to capital intensive economy, its exports is expected to be remarkably sophisticated and contribute significantly to the growth rate (Rehman *et al.*, 2020d; Lectard and Rougier, 2018).

Sophisticated of export bundle plays the role of catalyst in encouraging the growth of Chinese economy (Jarreau and Poncet, 2012). China's OFDI considerably increased and proved as a source of FDI for the world by increasing the level OFDI from $26.7bn in 2007 to a remarkable high level of 196.2bn in 2016 (UNCTAD, 2017). Rehman and Ding (2019) argued that one can expect that such progress of Chinese OFDI will bring greater connectivity of the domestic firm with the globe and can assist these domestic firms to achieve confidence and competitiveness. The economic literature including the work of Kellman and Shachmurove (2011), Xu and Lu (2009) and Amiti and Freund (2010), has linked export sophistication with the determinants like human capital, gross capital formation and foreign direct investment inflow but none of the studies has explored the role of outward FDI in making export more sophisticated.

In contrast to the previous studies, this study empirically explores the role of OFDI in enhancing the level of sophistication of Chinese export. A significantly larger portion of Chinese OFDI is in transport, energy, financial, telecommunication sector. Transport infrastructure enhances physical connectivity amongstt the countries which helps in transporting goods at low cost. Financial sector enhances the ease of business and lowers transection cost (Rehamn *et al.*, 2020c). Telecommunication sector promote digital connectivity and enhance knowledge availability about market and product awareness and the energy sector promotes capital intensive production techniques which results in improving productivity. Furthermore, such connectivity on wide based results in technological spill over amongst the domestic firm and firms of the partner countries (Rehamn *et al.*, 2020b). These entire factors make export more sophisticated and assist to make producers more competitive in the world market. Besides, comparative advantage is more likely to be achieved by investing in research and development (R&D sector) as such investment promotes production of those goods and services which required high skills and technological requirements (Rehman *et al.*, 2020a; Lichtenberg, 2001; Gözgör and Can, 2016).

The existing economic literature is confined to micro level aspect of Chinese OFDI such as the link between OFDI and asset seeking (Hong and Sun, 2006), and market efficiency (Ramasamy *et al.*, 2012), but is silent on the influence of OFDI on aggregate level such as export sophistication, export diversification and how these factor contribute to comparative advantage of China. However, the recent time series study of Rehman and Ding (2019) explored bidirectional causality between China's export sophistication and its OFDI but ignored the influence of OFDI of China on export sophistication of FDI receiving partner country. Their study did not answer the question whether or not comparative advantage through sophistication of export relies more on foreign investment and connectivity than the domestic investment. This study considers how Chinese investment outside the country can add to the comparative advantage of partner country and China itself through bilateral export sophistication of China and FDI receiving partner.

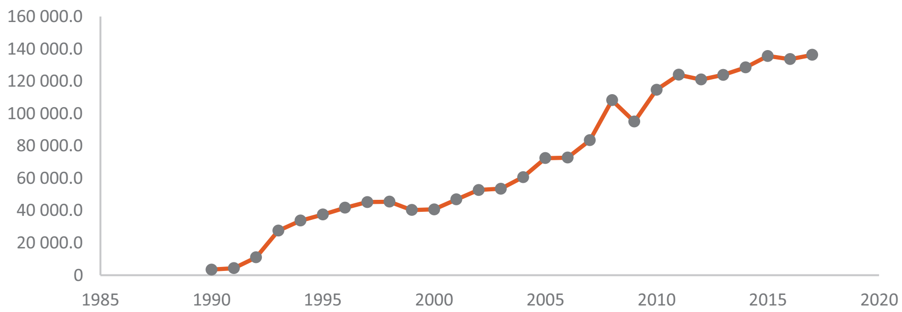
The rest of the paper is organized as follows: the overview of Chinese OFDI is explained in Section 2. The theoretical linkage between OFDI and export sophistication is discussing in Section 3. Construction of bilateral export sophistication, data description and methodology is shown in Section 4. Section 5 displays results and discussions. Section 6 presents robustness check with alternative methodology. Conclusion and policy recommendations are accommodated in the last Section 7.

2. China's OFDI: an overview

Before 1980s, China's OFDI was negligibly low but immediate development took place in the mid of 1980s and continuously accelerated in 1990s which enhanced connectivity and proved a key factor for Chinese firm to enlarge business in high value-adeded goods around the world (Kolstad and Wiig, 2012). Government of China adopted "Going Out" policy in 2001 and stimulated OFDI during the following years which accelerated from 40,714m US$ in 2000 to 108312m US$ in 2008 and reached to a remarkably high limit of 136320m US$ in 2017. Currently China is the 4th largest investor in the world with 1.10tn US$ stock of investment in the world in 2015 (Liu *et al.*, 2020; Asif *et al.*, 2019) (see Figure 1).

Accompanied by rising economic growth, the openness of China to the world market observed high growth, as presented in Table 1 that China's contribution to the world in term of OFDI increased from 1.23% in 2007 to 6.71% in 2012 and then to 9.23% in 2014. Despite the current economic crisis, China share was 8.65% in the world foreign investment (Qingqing *et al.*, 2020).

The primarily focussed region of Chinese OFDI is Asia which accounted for 69% of the total OFDI of China. In the Asian block, Korea, Macao, Honk Kong, Cayman Islands and the



Source(s): UNCTAD

Figure 1. China's overall OFDI (US$ million) during 1990–2017

Table 1. China's OFDI and its share in world market

Years	OFDI values in million of (US$)	Share in the world market (%)
2007	26,506	1.23
2008	55,907	3.29
2009	56,529	5.15
2010	68,811	4.94
2011	74,654	4.80
2012	87,804	6.71
2013	107884	8.23
2014	123120	9.23
2015	127560	8.65

Source(s): UNCTAD

British Virgin Island are the major FDI receiving partners of China. The larger share by these countries may be attributed to closer cultural similarities, geographic closeness and low operational cost. Since 2009, China outward FDI is becoming much globalized and geographically diversified. Latin American region is the 2nd largest recipient which accounted for 13% during 2003–2015 followed by Europe 7%, North America 5%, Africa 3% and Oceania 3% (Mingrui *et al.*, 2020; Rehman and Ding, 2019) (see Figure 2).

3. Theoretical background

The classical international trade theories have discussed how the linkages of economies affects the flow of capital and how it influences the production process of the economies. Vernon (1966) proposed the product life cycle theory which state that invention and innovation requires high skill labour and higher cost and the comparative advantage sustained with the innovative country in the initial stages and then shifts to other country as production of the product becomes common and transfers the country with low factor prices. Such transfer of production process from the innovative country to the host country has aggregate economic consequences. For example, it has influences on export of, both, the innovative and the host country, relative factor price differences in both countries and comparative advantage. All this mechanism is the result of foreign investment when economies are linked together and the linkage itself is determined by foreign investment (see Figure 3).

The specialisation just starts in stage I where the innovative country is sufficient to fulfil the domestic demand only. Specialisation becomes perfect in stage II with the passage of time

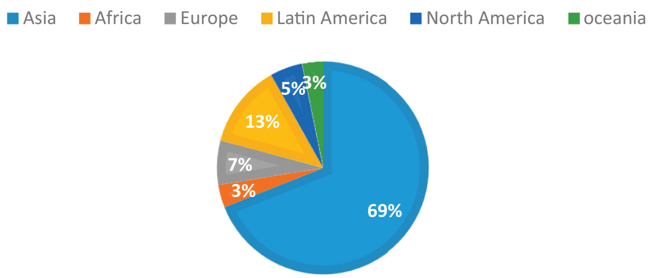


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Figure 2.
Share of Chinese OFDI to the world markets

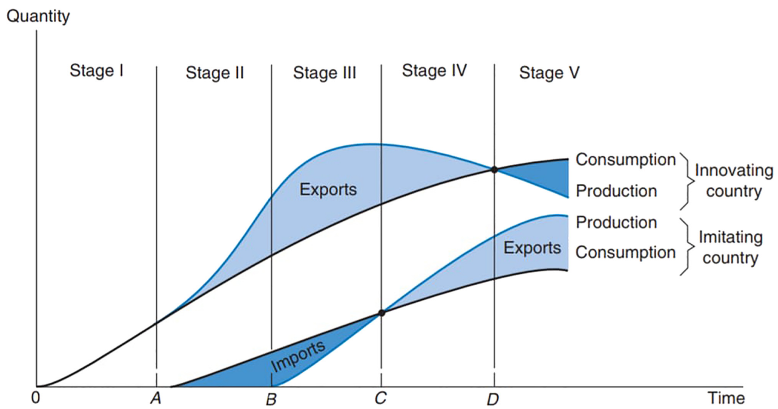

Figure 3.
Temporal shift of comparative advantages

which enables the innovative country to sustain comparative advantage and become leading exporter of the product. Stage III is characterized by a period where the technology and skill required for producing the product becomes standardized and the production process shifts from innovative country to imitating country because now the product requires less skill labours and the skilled labours and technology of the innovative country will be diverted to other innovations. The comparative advantage shifts to the imitating country in stage IV and further standardization of technology and skills reverse the trade pattern in stage V where the imitating country becomes exporter and innovative country becomes importer of the product. Such transfer of comparative advantage is the result of foreign investment by innovative country in the imitative country to seek low cost and keep the comparative advantage with itself or investment by imitating country in the innovative country to get the skill and technology for producing the product (Rehman and Ding, 2019).

However, some international trade theories postulate that most of the gain in the form of improved term of trade from investing in the low skilled labour abundant economy goes to the advanced and capital intensive economy as less developed economies export almost basic raw materials and traditional commodities to the developed economies (Zhang and Zhang, 2016).

Heckscher–Ohlin model of international trade advocates that the relative differences in factor endowment and factor price are the bases for trade and that the trade equalizes factor price in the trading countries. It means that a country will specialize and thus will have comparative advantage in the production of the commodity intensive in its abundant and cheap factors. In this regard, foreign investment performs the role of catalyst in taking advantage of differences in relative factor price but the decision of whether to investment in the home country or to invest in the foreign depends on the relative differences in the interest rate of home and foreign country. The home country will invest in the foreign country when the rate of interest in foreign country is higher than that of the home country's interest rate. Foreign investment will bring interest rate parity which stabilizes production and causes spill over effect regarding technology and innovation (Salvatore, 1995).

In a nut shell, different factors whether these are difference in relative factor cost, factor endowment of resources, technology and interest rate are the base of foreign investment which, in return, causes diffusion of technology, low cost factors, copying of innovative models amongst the regions and bring efficiency in both countries (Sekkat and Veganzones-Varoudakis, 2007). Test for the alternative hypothesis of cointegration is being considered.

H1. There is a positive effect of China's outward foreign direct investment on bilateral export sophistication of OFDI receiving partner economies.

3.1 Mechanism of OFDI and bilateral export sophistication

The existing literature of OFDI like Rehman and Ding (2019), Asif and Rehman (2019) and Rehman *et al.* (2020d) has explained the mechanism through which it has impact on the export sophistication of the host and the home country. The broad main aspects of the mechanism are connectivity of the economies, the existing technological and capital intensity gape, differences in labour and natural resources endowment, spillover effect and the externalities.

One of the major advantages of OFDI, for both partner countries, is the resulting greater connectivity of the economies. When an industry or firm has a substantial enhancement of exports, it is more likely to invest in marketing, distribution and managerial framework around the world. Production without such a sound framework is deficient to retain a comparative advantage, to satisfy customers' needs and to deliver the best services in the host markets (Krautheim, 2013; Kellman and Shachmurove, 2011). Digital, financial and physical connectivity amongst economies increases as a result of investing in foreign countries that have further bilateral effects for, both, the host and home country as more innovative business models, efficient production process can be copied and low cost labour can diffuse in the economies (Rehman and Ding, 2019; Li *et al.*, 2019).

The sophistication of home and host countries' exports through FDI depends on the existing gap of technology between them. The greater the technological difference between the two, the lower will be the productivity enhancing effect for firms in the host country and vice versa. However, when the technological gap between both countries is larger, only well-established indigenous firms have larger productivity enhancing effect in presence of foreign firms (Lesher and Miroudot, 2008; Hamida and Gugler, 2009).

The mechanism proposed by Rehman and Ding (2019) has some similarities to the one described above, but instead of relative differences in technology and capital intensity, it is based on labour and natural resource differences. The stated that the endowments level of natural resources and labour inputs are unique to each nation which the resource-seeking multinational companies (MNCs) take into consideration when making investment decisions. The capital intensive MNCs, when capitalize such features of the host country which are deficient in the home country, significantly enhance their productivity and make efficient distribution of resources which results in competitive advantage and more sophisticated export. Moreover, such investment on intensifying the feature of host country has simultaneously positive externality to the host country regarding productivity enhancing. Similarly, Banga (2018) and Twomey (2000) suggest that OFDI facilitate export sophistication of home and host country through a joint venture. For example, a firm-specific advantage over the others, in the context of expertise in knowledge, technology, management know-how, marketing and R&D results in positive externalities in the exportable commodities for both countries.

One of the key drivers of contribution to the overall OFDI worldwide are MNCs whose activities are specifically efficiency seeking. Dunning (2000) finds that the specialisation and division of labour by MNCs has a spillover impact on the export of developing countries and, in return, for the whole world. The technologically advanced countries, taking advantage of low-cost labour, resources and other inputs, enhance the range of exportable commodities at competitive costs and thereby retain the comparative export advantage. The arguments of Hale *et al.* (2007) in the case study of China is, however, contrary. He argued that based on the total factor efficiency model, there are no major spillover effects from OFDI because firms in the home country refrain from adapting emerging technology primarily due to insufficient access to finance and other constraints on the financial and labour market. Their results raise questions on the findings that the OFDI's productivity enhancing effect is subjected to the technological gap between the partner countries. Using instrumental variable regression on provincial data, Zhang and Chen (2020) investigated that in the overall sample and less developed inland regions, OFDI has no significant impact on China's export sophistication but a significant positive impact in the developed coastal region. In addition, using the panel threshold model, they investigated that when the per capita GDP, R&D, human and physical capital intensity reaches a particular level, the effect of China's OFDI on its export sophistication can further be accelerated. Instead of considering the bilateral case, their analysis was limited to Chinese export sophistication only.

4. Data description and methodology

To access the impact of OFDI on bilateral export sophistication, this study uses the time span during 2003–2017. The data on Chinese OFDI, measured in million US dollar, has been taken from the statistical bulletin of China's OFDI (2017). The data on other control variables like human capital (HC), population (POP), GDP and trade openness (TO) is collected from World Development Indicators (WDI). The relative differences in the level of human capital (HC), based on secondary school enrolment, are measured as HC of China divided by HC of partner country. Population and the level of infrastructure of China and its partner countries are scaled likewise HC for the same reason. The data of infrastructure are the composite index of telecommunication, energy, transport and financial infrastructure which was constructed by Donaubauer*et al.* (2015). Trade openness is the ratio of the sum of export and import of country i to their GDP. Furthermore, we use the composite index of institutional quality and the data on indicators of institutional quality are taken from International Country Risk Guide. The detail about this index can be found in Rehman and Ding (2019). Finally, for the dependent variable of the study which is export sophistication, we rely on the method of Haussmann *et al.* (2007) who devised the index of export sophistication

4.1 Construction of bilateral export sophistication index

Export sophistication index represents the exports quality of an economy and is the weighted average income associated with the export bundle of the country. Exporting quality product leads to comparative edge and brings more income to home country.

Haussmann *et al.* (2007) devised the index of export sophistication as a weighted average of PRODY, where PRODY is.

$$\mathrm{PRODY}_k = \sum_i \frac{(x_{ki}/X_i)}{\sum_i (x_{jk}/X_i)} Y_i \quad (1)$$

Where (x_{ki}/X_i) is the share of the value of the product "k" to the value of aggregate export of country i and Y_i is the per capita GDP. PRODY_k, in Eq. (1), reflects the comparative advantage of a country i in exporting product "k" and is the weighted average of GDP per capita. The variable of PRODY is then incorporated in calculation of the following index of export sophistication.

$$\mathrm{Exs}_i = \sum_k \left[\left(\frac{X_i^k}{X_i} \right) \mathrm{PRODY}^k \right] \quad (2)$$

Here Exs_i is export sophistication index which is the weighted average of the PRODY where the weight is the value share of product "k" in the country i aggregate value of exports. The export sophistication of partner country can be calculated in a similar manner and then the values of indices of both countries are simply added to devise the bilateral export sophistication index.

4.2 Gravity model and econometric methodology

Tinbergen (1962) and Pöyhönen (1963) were the initiators using augmented gravity model to empirically investigate international trade flows. Afterwards, the model gained popularity in empirical analysis of the flows of economic variables such as FDI, migration and trade flows. Traditional gravity model had lack of theoretical support and was confined to the trade flows as a function of economies sizes usually taken as GDP and distance. Examples of such theories are the work of Berstrand (1985), Helpman (1987), Soloaga and Winters (1999) who modified the model by incorporating the bilateral variable other than trade flow. Based on the modified form of gravity model, this study investigate the impact of China's OFDI on the bilateral exports sophistication of China and its corresponding partner country.

$$\mathrm{EXS}_{ci} = I_{ci} M_i K_i S_c \quad G_i \varnothing_{ci} \quad (3)$$

Where EXS_{ci} is bilateral export sophistication of China and its partner country, I_{ci} is OFDI from China to country i. M_i represents specific factors of country i that shows the potential of how the economy is prepare (Institutional Quality IQ_i) to provide a base for adopting new technology. K_i and S_c represent the size (GDP) of country i and the Chinese economy, respectively. G_i is a variable that belong to country i and represents how the country is liberalized to the world as its export sophistication process is not confined to the country's openness to only China. Finally, $\varnothing_{ci}$ represents China's ease of access to country i market which is the inverse of the trade costs between China and partner countries. In general, to capture transaction costs and liberalisation, a variety of variables are used. Empirical studies usually proxy bilateral distance (D) for trade costs and TO for liberalisation.

Donaubauer *et al.* (2018) augmented the above model based on the argument that the extent to which both partner countries get benefit in the form of productivity from digital and physical connectivity through OFDI depends on their relative differences in factors endowments such as infrastructure (financial, transport, telecommunication and energy), human capital and population. Let F_{ci} represents China and country i differences in such factors, this would give the following equation.

$$\mathrm{EXS}_{ci} = I_{ci}M_iK_iS_c\ F_{ci}\ G_i\varnothing_{ci} \tag{4}$$

F_{ci} in Eq. (4) represents the ratios of the values of China's human capital index, infrastructure index and population to the value of the same indices for country i to capture the relative differences in factors endowments.

By adding the multilateral resistance term (MRT), Anderson and van Wincoop (2004) further augmented the gravity model because they argue that merely considering trade costs would produce a biassed estimator. Considering transportation cost or distant as constant, a bilateral flow variable may significantly vary due to MRT which is based on the rationale that, ceteris paribus, two nations surrounded by other major trading nations, such as the Netherlands and Belgium, surrounded by Germany and France, respectively, are less likely to trade with each other than if they were surrounded by oceans such as New Zealand and Australia. Let γ_i represent the multilateral resistance term, the Anderson and van Wincoop augmented gravity model becomes as follow.

$$\mathrm{EXS}_{ci} = I_{ci}M_iK_iS_c\ F_{ci}\ G_i\ \left[\frac{\varnothing_{ci}}{\gamma_i}\right]^{1-\rho} \tag{5}$$

Where $\varnothing_{ci}$ is the inverse of trade cost and γ_i is the multilateral resistant term and $\rho > 1$ is the elasticity of substitution. Two practices are common, in the literature on gravity model, for controlling MRT effect based on whether the interest of research is in the coefficient of variable or in country specific effect. In the first case, including dummy for country i will give an unbiased estimators. While in the second case of country-specific effect which is although very slow but may vary over time, one can insert a set of control variables and other variables of interest to this simple equation such as the quality of institutions, the quality of infrastructure and the quality of population (HC) and the population itself.

Considering the multiplicative nature of the gravity equation, the standard practice for estimating a gravity equation is simply taking the natural logarithms to obtain a log-linear equation which is obviously simpler than the non-linear estimation techniques and can be estimated through ordinary least square (OLS) technique. In Eq. (5), variables on the right hand side are written in single alphabet case for simplicity reason and to avoid confusion. These are now replaced with the variable's short form which these alphabets actually represent. For example I_{ci} means outward foreign investment from China to country i so I_{ci} is replaced with OFDI_{ci}. In the same token, M_i with IQ_i, K_i and S_c with GDP_i and GDP_c, G_i with TO_i, F_{ci} (relative difference in factor endowment) with INF_{ci}, HC_{ci} and POP_{ci} (measured as the ratio of values of these indices for China to the respective indices' values for country I. The inverse of trade cost $\varnothing_{ci}$ is replaced with the distance from country i to China (D_{ci}) and γ_i with dummy = 1 for county I otherwise 0. Taking natural and replacing the variable would give the final model.

$$\begin{aligned}\ln EXS_{ci} = \beta_0 + \beta_1 \ln OFDI_{ci} + \beta_2 \ln IQ_i + \beta_3 \ln GDP_i + \beta_4 \ln GDP_c + \beta_5 \ln TO_i \\ + \beta_6 \ln INF_{ci} + \beta_7 \ln HC_{ci} + \beta_8 \ln POP_{ci} + +\beta_9 \ln D_{ci} + \beta_6 + \beta_7 \gamma_i\end{aligned} \quad (6)$$

Where $\beta_6 = 1 - \rho$ and $\varnothing_{ci}$ is the inverse of trade cost.

In case of trade and other types of bilateral flows, Santos *et al.* (2006), suggested of using Poisson pseudo-maximum likelihood (PPML) estimation in gravity model. Firstly, it can tackle biasness which arises in the case when the gravity model is in logarithmic form and error term is heteroskedastic. Secondly, as tested by Santos *et al.* (2006), it gives satisfactory results even when the dependent variable is suffering from measurement error or having missing values. Thirdly, as suggested by Gourieroux *et al.* (1984), it is robust to misspecification and allow continuous variable to be used as a dependent variable. Lastly, as we deal with pseudo-maximum likelihood estimator, it is not mandatory that the data must follow Poisson distribution.

5. Results and discussions

Before proceeding to assess the long-run impact of Chinese OFDI on its export sophistication, it is essential to report some econometric tests. The existing literature suggests numerous techniques for panel-unit roots including Levin *et al.* (2002); Maddala and Wu (1999) and Im *et al.* (2003), etc. This study relies on Im *et al.* (2003) and Levin *et al.* (2002) because it provides more consistent results.

Table A1 provides the results of Levin–Lin–Chu and Im–Pesaran test and confirmed that all the variables are stationary at first difference, at constant as well as intercept and trend. Table 2 presents the descriptive statistics. Table 3 provide the Pearson correlation

Table 2.
Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
$\ln OFDI_{ci}$	938	9.88	1.225	0	10.989
$\ln D_{ci}$	938	8.202	1.165	0	9.379
$\ln GDP_{ci}$	924	752.675	108.182	0	918.074
$\ln POP_{ci}$	938	1.24	0.19	0	1.611
$\ln HC_{ci}$	915	0.978	0.164	0	1.802
$\ln TO_{ci}$	938	4.083	0.764	0	6.04
$\ln OFDI_{ci}$	767	3.508	2.772	−4.605	11.405
$\ln IFRA_{ci}$	938	0.285	0.283	−0.466	1.128
$\ln IQ_i$	938	1.952	0.666	0	4.22

Table 3.
Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln OFDI_{ci}$	1.000							
$\ln D_{ci}$	0.811	1.000						
$\ln GDP_{ci}$	0.757	0.672	1.000					
$\ln POP_{ci}$	0.679	0.600	0.586	1.000				
$\ln HC_{ci}$	0.485	0.557	0.776	0.472	1.000			
$\ln TO_{ci}$	0.049	0.368	0.050	0.138	0.170	1.000		
$\ln IFRA_{ci}$	0.231	0.514	0.305	0.313	0.436	0.942	0.941	1.000

coefficients amongst all the selected variables and confirmed that there is strong positive correlation between the export and all others explanatory variables. In the subsequent regression, multicollinearity is examined and the results confirm no severe problem of multicollinearity in the chosen variables.

The results of PPML estimations in Table 4 show that OFDI have significant positive impact on export sophistication at 1% level of significance. It shows that Chinese OFDI promotes export sophistication of the selected host countries. The results are consistent with the idea that; first, the turnout effect of technological spill over of OFDI will boost up the productivity in the domestic economy, hence increasing the capacity of the home economy to produce and export more sophisticated commodities (Lichtenberg, 2001); second, China outward investment in business services, financial services, manufacturing sector, transport and information transmission is 24.9, 16.6, 13.7, 7.9 and 4.7%, respectively (Rehman and Noman, 2020a). These sector are conducive to production and thus export sophistication as investment in business services enlarge trade volume, better financial infrastructure decreases transaction cost and enhances the ease of business. Similarly, investment in manufacturing sector in the foreign helps to acquire cheap labour, transport sector lowers cost of transportation and last but not the least information transmission facilitate product marketing and awareness at low cost. Population (POP), HC, TO, infrastructure (INFR), institutional quality (IQ) and GDP, taken as control variables, have also significant positive impact on export sophistication of the domestic economy which strengthen the impact of OFDI on export sophistication. Only distance, one of the control variables, has significant negative impact on export sophistication which is consistent with the literature on bilateral trade flow, for example, (Donaubauer *et al.*, 2018; Anderson and Wincoop, 2004). Distance increases transportation cost and considered as a barrier in the way of trade and decline the flow of bilateral trade and thus export sophistication (Rehman and Noman, 2020b).

The empirical results in Table 5 show the outcomes of the PPML heterogeneous panel procedure. The result exhibits notable variations subject to the method of estimation. The result of PPML estimation shows that a plausible long-run impact of OFDI on export sophistication is positive and significant at 1% level in all region-wise regressions (i.e. r- = 1, $r = 2$, $r = 3$, $r = 4$, $r = 5$, $r = 6$). The results are performed in such a way that all the regions, namely, Europe and Central Asia, Middle East and North Africa, Latin America and Caribbean, East Asia and Pacific, South Asia, North America and sub-Saharan Africa are analysed separately which gives robust results. Similarly, this study also estimates income-wise (high income, upper middle income, lower middle income and low income) results. It can be seen from Table 4 that the impact of OFDI on export sophistication is positive and significant at 1% significance level in all income groups. Furthermore, the selected control variables have also positive and significant positive impact on export sophistication.

6. Robustness check with alternative methodology

The data set of the present study is a panel of 67 countries from various geographic regions having differences in the economic structure and hence is more likely to be suffered from unobserved heterogeneity. The GMM estimator, as recommended by Arellano and Bond (1991) and further augmented by Blundell and Bond (1998), is widely used when the panel is heterogeneous because it gives consistent and efficient estimator. To tackle with the dynamic endogeneity, GMM adopts instrumental variable approach where the instruments are first difference of the selected variables. However, efficiency of GMM estimator under instrumental approach may suffer due to the fact that lagged levels are considered as weak instrument of first differences. To avoid this problem, the system GMM as suggested by

Table 4.
Regional-wise PPML estimator results

	$r = 1$	$r = 2$	$r = 3$	$r = 4$	$r = 5$	$r = 6$
$\ln OFDI_{ci}$	8.185***	6.149***	4.127*	8.140***	7.131***	4.059*
S.E	(3.73)	(2.036)	(2.471)	(3.154)	(1.312)	(1.517)
$\ln D_{ci}$	−0.001	−0.003	−0.014***	0.065***	−0.013**	0.018***
S.E	(0.57)	(0.82)	(0.005)	(0.004)	(0.006)	(0.008)
$\ln GDP_{ci}$	3.114*	5.125***	2.093**	2.884***	3.783***	1.683*
S.E	(1.054)	(2.042)	(1.669)	(0.605)	(0.958)	(0.691)
$\ln POP_{ci}$	0.084	0.035**	0.019	0.064***	0.025	0.045**
S.E	(0.005)	(0.011)	(0.051)	(0.002)	(0.042)	(0.013)
$\ln HC_{ci}$	2.134***	1.162***	0.967	0.685***	0.739	0.418**
S.E	(0.782)	(0.301)	(0.476)	(0.042)	(0.945)	(0.076)
$\ln TO_{ci}$	1.090**	0.783**	0.810**	1.110***	0.902	0.584
S.E	(0.031)	(0.043)	(0.497)	(0.803)	(0.776)	(0.348)
$\ln IQ_{i}$	0.123***	0.138*	0.127	0.172***	0.147***	0.192
S.E	(0.096)	(0.092)	(0.164)	(0.033)	(0.049)	(0.089)
$\ln IFRA_{ci}$	1.700***	1.515***	1.284*	2.495***	1.369**	0.512*
S.E	(0.378)	(0.396)	(0.730)	(0.706)	(0.928)	(0.295)
Constant	2.295***	2.130***	2.369***	1.405***	2.197***	2.152***
	(0.981)	(1.070)	(0.848)	(0.680)	(0.284)	(0.945)
Observations	142	281	75	83	27	52
R-squared	0.644	0.732	0.598	0.756	0.764	0.701

Note(s): ***, ** and * denote the significance at 1%, 5% and 10%, respectively. All variables are in natural log form. *R*1, *r*2, *r*3, *r*4, *r*5 shows East Asia & Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, North America, South Asia, respectively. For the countries used in this study, refer to Table A2

Blundell and Bond (1998) combines the estimator of first differences with the estimator in level to form a reliable efficient system estimates. These models are capable of dealing with above-diagnosed issues attributable to PPML. The results are reported in Table 6, which are consistent with main model.

Variables	(1) $\ln EXS_{ci}$ High income	(2) $\ln GDP_{ci}$ Low income	(3) $\ln GDP_{ci}$ Lower middle income	(4) $\ln GDP_{ci}$ Upper middle income
$\ln OFDI_{ci}$	9.605*** (1.735)	2.943*** (0.386)	4.127*** (1.471)	8.140*** (1.154)
$\ln D_{ci}$	−0.082** (0.028)	−0.041 (0.026)	−0.195** (0.017)	−0.101** (0.090)
$\ln GDP_{ci}$	4.218* (1.856)	3.125*** (0.942)	2.784** (0.869)	3.984*** (0.703)
$\ln POP_{ci}$	0.408*** (0.062)	0.745 (0.679)	0.588 (0.556)	0.627** (0.249)
$\ln HC_{ci}$	3.634*** (0.682)	1.862*** (0.701)	1.977 (0.376)	1.575*** (0.492)
$\ln TO_{ci}$	2.790** (0.031)	0.883** (0.443)	1.810** (0.897)	1.110*** (0.403)
$\ln IQ_{i}$	0.111*** (0.072)	0.513* (0.398)	0.876 (0.970)	0.464 (0.584)
$\ln IFRA_{ci}$	3.319*** (1.262)	1.784*** (0.178)	1.658*** (0.896)	1.099*** (0.184)
Constant	2.156*** (0.175)	2.429*** (0.799)	2.298*** (0.423)	2.153*** (0.556)
Observations	377	39	130	178
R-squared	0.720	0.687	0.518	0.694

Note(s): ***, ** and * denote the significance at 1%, 5% and 10%, respectively. All variables are in natural log form. For the countries used in this study, refer to Table A3

Table 5. Income-wise PPML estimator results

Variables	PPML	GMM
$\ln OFDI_{ci}$	9.165***	9.014***
S.E	(2.60)	(2.031)
$\ln D_{ci}$	−2.18***	−2.026***
S.E	(0.164)	(0.782)
$\ln GDP_{ci}$	4.145***	4.695***
S.E	(1.571)	(1.209)
$\ln HC_{ci}$	3.015***	3.163**
S.E	(1.949)	(1.043)
$\ln TO_{ci}$	2.013***	2.131***
S.E	(0.345)	(0.806)
$\ln IQ_{i}$	0.904***	0.832**
S.E	(0.109)	(0.213)
$\ln IFRA_{ci}$	3.009***	3.819***
S.E	(0.924)	(0.819)
Constant	2.664***	2.196***
S.E	(0.328)	(0.427)
$R2$	0.627	0.604
Observations	724	724
J-stat	NA	0.30
AR1	NA	0.67
AR2	NA	0.43
Wu Huauman Test (P)	NA	0.13
J. stat (P)	NA	0.28
Sargen Test (P)	NA	0.18

Note(s): ***, ** and * denote the significance at 1%, 5% and 10%, respectively. All variables are in natural log form. P shows probability values

Table 6. GMM results (aggregate sample)

7. Conclusion and policy implications

According to the best of our knowledge, previous empirical studies, like Rehman and Ding (2019), Fan *et al.* (2018), totally ignored to examine the bilateral export sophistication for China and its OFDI receiving countries. The aim of this study is to fill this gap by applying macroeconomic panel data to understand how Chinese OFDI promotes bilateral export sophistication of China and its partner countries. We used PPML estimator on panel data during 2003–2017 to assess the impact of Chinese OFDI on the bilateral export sophistication. The results of this study demonstrated that the Chinese OFDI significantly promotes export sophistication (i.e. the impact of OFDI on export sophistication is positive and significant in the long run). This is good news for policymakers in China who want to catch up with the advanced economies and reduce the gap between China and developed countries, particularly in exporting high-tech products. The findings also negate the claim of Branstetter and Lardy (2006) that Chinese firms do not contribute to export sophistication. Rather, the result shows that Chinese firms today are more skill intensive and confident to encourage export sophistication in China. This also suggests that Chinese OFDI is a way to bring ideas and technical know-how back to home. Besides the main variables, the control variables like IQ, INFRA, POP, TO and HC have also positive and significant impacts on the export sophistication, which means opening of the Chinese economy, institutional reforms, infrastructure, high quality education system are also important for the upgrading of export structure of China.

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Appendices

	Level		First difference	
Variables	Levin–Lin–Chu Test	IM–Pesaran test	Levin–Lin–Chu test	IM–Pesaran test
LNEXY	−12.41***	−8.92***	−17.26***	−10.78***
LNOFDI	−11.51***	−3.12***	−16.48***	−10.86***
LNTO	−2.90***	0.080	−13.01***	−9.10***
LNIQ	−3.94***	−1.65**	−13.71***	−8.89***
LNINFR	−7.61***	−1.29*	−14.18***	−13.06***
LNPOP	−10.61***	−3.51***	10.67***	9.44***
LNGDP	−16.85***	−5.56***	−3.81***	0.86

Note(s): ***, ** and * denote the significance at 1%, 5% and 10%, respectively. All variables are in natural log form. The results are based on intercept and trend

Table A1. Unit root test results

Table A2.
Region-wise countries list with codes

Europe and Central Asia (1)	Middle East and North Africa (2)	Latin America and Caribbean (3)	East Asia and Pacific (4)	South Asia (5)	North America (6)	Sub-Saharan Africa (7)
Albania	Algeria	Argentina	Australia	Bangladesh	Bulgaria	Madagascar
Armenia	Israel	Brazil	China	India	Canada	Mozambique
Austria	Morocco	Chile	Hong Kong	Pakistan	USA	Nigeria
Belarus	Oman	Colombia	Indonesia	Sri Lanka		South Africa
Belgium	Saudi Arab	Mexico	Japan			Uganda
Croatia	Tunis	Uruguay	Korea			
Czech	UAE		Malaysia			
Denmark			Mongolia			
Estonia			New Zealand			
Finland			Philippines			
France			Singapore			
Germany			Thailand			
Hungary			Vietnam			
Ireland						
Italy						
Latvia						
Lithuania						
Luxembourg						
Netherlands						
Norway						
Poland						
Portugal						
Romania						
Russia						
Spain						
Sweden						
Swiss						
Turkey						
UK						

Source(s): World Development Indicators (WDI)

High income	Upper middle income	Lower middle income	Lower income
Australia	Albania	Bangladesh	Madagascar
Austria	Algeria	India	Mozambique
Belgium	Argentina	Indonesia	Uganda
Bulgaria	Armenia	Mongolia	
Canada	Belarus	Morocco	
Chile	Brazil	Nigeria	
Croatia	China	Pakistan	
Czech	Colombia	Philippines	
Denmark	Malaysia	Tunis	
Estonia	Mexico	Vietnam	
Finland	Romania		
France	Russia		
Germany	South Africa		
Hong Kong	Sri Lanka		
Hungary	Thailand		
Ireland	Turkey		
Israel			
Italy			
Japan			
Korea Rep			
Latvia			
Lithuania			
Luxembourg			
Netherlands			
New Zealand			
Norway			
Oman			
Poland			
Portugal			
Saudi Arab			
Singapore			
Spain			
Sweden			
Swiss			
UAE			
UK			
Uruguay			
USA			

Source(s): World Development Indicators (WDI)

Table A3. Income group-wise countries list

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