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FDI, EXPORT SOPHISTICATIONS, AND EXPORT UPGRADING IN EMERGING ECONOMIES: EVIDENCE FROM CHINESE MANUFACTURINGS

ABSTRACT

Export upgrading, reflecting improved export sophistication or technological capabilities over time, can bring a nation larger benefits from international trade. How does foreign direct investment (FDI) affect export sophistication and export upgrading in emerging economies? While the topic is important and timing, studies on the issue in the literature have been limited. This paper attempts to close the gap by using the Chinese manufacturing panel data in 2005-2013. Estimates suggest that FDI indeed has strong sophistication- and upgrading-enhancing effects on China's manufactured exports; and such gains from FDI depend largely on China's absorptive capacity measured by human capital.

Keywords: Foreign Direct Investment (FDI), Export Sophistications (XS), Export Upgrading (XU), Manufactured Exports (MX)
JEL Classifications: F21, F23, O14, O53

RIASSUNTO

FDI, sofisticazioni e promozione dell'export nelle economie emergenti: evidenze dal caso dei manufatti cinesi

La promozione dell'export, considerato il potenziamento nel tempo delle sofisticazioni o delle capacità tecnologiche, può portare benefici maggiori ad un paese tramite il commercio internazionale. In quale modo le sofisticazioni e la promozione delle esportazioni di un'economia emergente sono influenzate dagli investimenti diretti esteri? Nonostante l'importanza e l'attualità dell'argomento, vi sono pochi studi al riguardo. Questo lavoro è un tentativo di colmare questa mancanza utilizzando dati panel relativi ai manufatti cinesi nel periodo 2005-2013. Le stime evidenziano che gli investimenti diretti esteri hanno notevoli effetti sulle sofisticazioni e sulla promozione delle esportazioni di manufatti cinesi. Questo vantaggio ricevuto dagli IDE dipende largamente dalla capacità di assorbimento della Cina misurata attraverso la variabile capitale umano.

1. Introduction

While exports have been widely viewed as an engine of economic growth for a long time, the recent studies focus on the export composition by emphasizing "*what you export matters*" (Hausmann *et al.*, 2007; Lederman and Maloney, 2012), since higher level of export sophistication (XS), defined as more technology-intensive exports, imply greater development benefits to exporting countries (Lall *et al.*, 2006; Jerreau and Poncet, 2012). Export upgrading (XU), defined as increases in XS, is the process in which an economy moves from exporting low-tech to high-tech products in the world markets. XU is a must for emerging economies like China as wages rise, since the main source of their initial export advantages is cheap labor (Li *et al.*, 2012). Upgrading exports is a long, costly and risky process, as it calls for large investment in human capital, research and development, and high quality infrastructure. While indigenous efforts in technology appear to be important, foreign direct investment (FDI) has become central to XS and XU as global production systems have grown in importance, especially in high-tech and fast-moving industries (Harding and Javorcik, 2012). How does FDI affect XS and XU? This paper attempts to work on the issues with China's manufacturing panel dataset.

Besides the intrinsic importance of the topic, the case of China is of special significance. As reported in Table 1, China's manufactured exports grew more than 10 times in merely 15 years (2000-2014), from $220 billion to $2335 billion, much faster than the rest of the world. As a result, China became the globally largest exporting nation in 2009, and its share in world manufactured exports rose dramatically from 4.7% to 17.9% in the same period. Along with the export boom, China experienced rapid export structural transformation as well. As Tables 1 and 2 show, China's export basket shifted from low-tech goods (e.g., food, mineral fuels, and textiles) to medium- and high-tech products (e.g., machinery, transport and electrical equipment's). In 2014, manufactured exports (MX) made up 94% of total exports, and medium- and high-tech MX accounted for 61% of the total MX[1]. It is widely believed that massive FDI inflows play a crucial role in China's export miracle (Zhang, 2015). China has been the most attractive location for FDI for the past decades and FDI inflows tripled in 2000-2014, resulting FDI stock of $1085 billion in 2014. The contribution of FDI to China's MX is even larger; about half of China's MX was

[1] Large processing trade and intra-industry trade in global value chains inflate China's exports due to imports of intermediate goods/components required to assemble/process for final products (Rodrik, 2006; UNIDO, 2016). Nevertheless, even after taking account of this, China still outperforms the rest of world in manufactured exports and export structural transformation (Schott, 2008; Xu and Lu, 2009).

generated by foreign-invested enterprises (FIEs) in most years of the period, as indicated by Table 1.

TABLE 1 - *Export Performance and Inward FDI of China: 2000-2014*

	2000	2005	2010	2014	Changes in 1995-2013
Export Capacity					
MX (billion US$)	220	700	1476	2335	+2115
MX per capita (US$)	180	550	1124	1705	+1525
MX share in the world (%)	4.71	9.32	14.06	17.88	+13.17
Export Composition					
MX share in merch. exports (%)	88.22	91.88	93.55	94.35	+6.13
LT-MX share in total MX (%)	53.82	42.32	41.56	39.15	-14.67
MT-MX share in total MX (%)	28.20	26.84	32.17	33.66	+5.46
HT-MX share in total MX (%)	18.98	20.84	26.27	27.39	+8.41
Inward FDI					
FDI flows (billion US$)	41	72	115	129	+88
FDI stock (billion US$)	193	272	588	1085	+892
MX by FIEs (billions of US$)	119	444	862	1075	+956
FIEs share in total MX (%)	48.93	58.29	54.65	45.90	-3.03

Notes: MX = manufactured exports; LT, MT, HT = low-, medium-, high-tech; and merch.= merchandise, and FIEs = foreign-invested enterprises.
Source: United Nations Industrial Statistics Database (UNIDO, 2016), China Industry Economy Statistical Yearbook 2006-2012 (NBSC, 2000-2016) and China Statistical Yearbook 2000-2016 (NBSC, 2000-2016).

TABLE 2 - *Export Compositions by SITC: 1984-2013 (in percentage, %)*

SITC	Description	1984	1995	2001	2007	2013	Changes in period
0+1	Food, animals + beverages, tobacco	13.7	7.5	4.7	2.6	2.6	-11.1
2+3+4	Crude materials + mineral fuels, lubricants + animal & vegetable oils	36.2	10.2	7.2	2.4	2.2	-34.0
5	Chemicals	1.1	2.3	3.1	5.0	5.4	+5.3
6	Goods classified chiefly by materials	18.8	22.0	17.5	18.1	16.4	-2.4
7	Machinery and transport equipment	5.8	20.0	33.0	47.4	47.1	+41.3
8	Miscellaneous manufactured articles	17.1	37.6	34.4	24.3	26.2	+9.1
9	Not classified elsewhere in the SITC	7.3	0.4	0.11	0.2	0.1	-7.2
Total		100.0	100.0	100.0	100.0	100.0	

Sources: Author's computations based on COMTRADE Data (UN, 2016).

Much attention in the literature has been paid to the role of FDI in exports by emerging economies, and these studies have provided useful insights (e.g., Girma *et al.*, 2008; Zhang, 2015). Research on the FDI-XS-XU nexus, however, has been limited, and no studies have been done on the issue for China with the latest data. Aiming at closing the gap, this study has several distinct features. First, it employs a fairly straightforward XS-XU model in which FDI and its interaction with human capital are introduced as additional determinants. Second, it uses data at the industry level to distinguish effects of FDI across industries with different technology intensity. Third, it measures XS and XU in both capacity (e.g., MX *per capita*) and composition (e.g., medium- and high-tech MX share in total MX). Last, it takes a close look at dynamic effects of FDI on export upgrading by estimating empirical models with changes in both dependent and independent variables.

2. The model and data

There is a large literature on the role of FDI in host-country exports, theoretical predictions in the context of the FDI-XS-XU link, however, may be summarized as two hypotheses: FDI may *potentially* promote XS and XU through direct effects and spillovers; and host countries with strong absorptive capacity in terms of human capital are more likely to capture the technological spillovers from FDI.

FDI may directly enhance XS and XU by (a) augmenting domestic capital for exports of medium- and high-tech products; (b) transferring of technology and new products for exports; and (c) facilitating access to new and large foreign markets (Zhang and Markusen, 1999; Zhang, 2009)[2]. The spillovers, or indirect effects, from FDI may help XS and XU through following mechanisms: (a) foreign-invested firms provide training for the local workforce and upgrade technical and management skills; (b) domestic firms may increase their XS and XU by observing export activities of foreign affiliates ("learning by watching"); (c) foreign-invested firms increase competition in host markets that forces local firms to adopt more advanced technologies in exporting activities; and (d) forward and backward linkages between foreign and local firms

[2] On the other hand, however, it is sometimes suggested that FDI may (a) lower or replace domestic savings and investment for indigenous exporting firms; (b) transfer technologies that are low level or inappropriate for the host country's factor endownments; (c) target primarily the host country's domestic market and thus not increase exports; and (d) inhibit the expansion of indigenous firms or through intensified competition even kill indigenous firms that might become exporters (Ram and Zhang, 2002; Zhang, 2015).

create opportunities for domestic exporting firms to move up in global value chains (Aitken *et al.*, 1997; Kneller and Pisu, 2007; Girma *et al.*, 2008).

While potential benefits of FDI to host-country XS and XU exist, they do not automatically accrue, and tapping the potentials depends on the host country's absorptive capacity in terms of human capital (Griffith *et al.*, 2003). Human capital not only increases productivity of domestic firms through helping technological progress, but also enables domestic firms to learn from foreign-invested enterprises by enhancing their ability to acquire FDI spillovers (Harding and Javorcik, 2012).

The preceding discussions suggest an important role of FDI and absorptive capacity as a condition for a host country to capture gains from FDI. Thus *FDI* and the interactive item (*FDI×HK*) may be treated as additional factors in the conventional framework of XS determination, resulting in the following equation for China's region *i* in year *t*[3]:

$$XS_{it} = \alpha_0 + \beta \boldsymbol{Z} + \gamma FDI_{it} + \delta(FDI \times HK)_{it} + \theta_i + \mu_t + \varepsilon_{it'} \quad (1)$$

where α_0 is the constant term and ε_{it} as stochastic component. θ_i and μ_t are unobserved region-specific and time-specific effects, respectively. $\boldsymbol{Z}$ is a vector of conventional XS determinants, including physical capital (*K*), human capital (*HK*), research and development (*RD*), infrastructure (*INFR*), and government policy (*POLICY*), as suggested in the literature (Limão and Venables, 2001; UNCTAD, 2002; Fugazza, 2004; Zhu & Fu, 2013)[4]. Therefore, equation (1) may read as:

$$\begin{aligned} XS_{it} &= \alpha_0 + \alpha_1 K_{it} + \alpha_2 HK_{it} + \alpha_3 RD_{it} + \alpha_4 INFR_{it} + \alpha_5 POLICY_{it} \\ &\quad + \alpha_6 FDI_{it} \alpha_7 (FDI_{it} \times HK_{it}) + \theta_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (2)$$

Changes in XS over time indicate XS dynamics, or XU:

$$\begin{aligned} XU_{it} &= \alpha_0 + \alpha_1 \Delta K_{it} + \alpha_2 \Delta HK_{it} + \alpha_3 \Delta RD_{it} + \alpha_4 \Delta INFR_{it} + \alpha_5 \Delta POLICY_{it} \\ &\quad + \alpha_6 \Delta FDI_{it} + \alpha_7 \Delta(FDI_{it} \times HK_{it}) + \theta_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (3)$$

[3] Several empirical specifications can be considered in a study of ES determinants. The focus of this paper on the role of FDI, however, necessitates the use of a model that could capture and isolate the basics of the *FDI-XS-XU* linkages.

[4] It should be noted that other determinants may exist but are excluded from the specification. This model, therefore, should not be treated as an exhaustive *XS* study of China but, rather, as a narrowly focused investigation of the FDI-XS-XU link. Other considerations for the specification include data availability and characteristics of cross-province (within China, rather than cross-country) estimations.

Equations (2)-(3) constitute the basis for our panel analyses of the impact of FDI on *XS* and *XU* for Chinese manufactured exports in 2005-2013. The period selected here is totally based on data availability and consistence of all variables used in the work. Sources for all data on 21 manufacturing sectors for 31 regions in 9 years (2005-2013) are China Industry Economy Statistical Yearbook 2006-2012 (NBSC, 2000-2016) and China Statistical Yearbook 2000-2016 (NBSC, 2006-2016).

The dependent variable (*XS*) in equation (2) is measured by two indices: medium- and high-tech manufactured exports (MHTMX) *per capita* (*MHTMXPC*); and MHTMX shares in total manufactured exports (*MHTMX/MX*)[5]. *MHTMXPC* reflects export capacity of more technologically complex industrial products; while *MHTMX/MX* indicates importance of such exports in total manufactured exports. It is noted that *MHTMX/MX* alone for ES may result in misleading: a region with very small amount of *MHTMX* but no other exports may have a large value of *MHTMX/MX*. Following the similar logic, the dependent variable (*XU*) in equation (3) is defined as changes in the two XS indices (i.e., *XU* = *△XS*): *△(MHTMXPC)* and *△(MHTMX/MX)*[6]. Thus increases of XS represent the transformation of export structure from low-tech to high-tech products, or export upgrading.

The *FDI* variable is constructed in two forms: share of manufactured output by foreign-invested enterprises (FIEs) in total (*FIEYS*) in a region and ratio of FDI stock to GDP (*FDIS*) in a region. The use of alternative measures of FDI serves for robustness checks in the following section. The corresponding interactive term with human capital are (*FIEYS×HK*) and (*FDIS×HK*). All other independent variables are measured in a way similar to that used in the literature. Physical capital (*K*) is proxied by the ratio of physical capital stock to GDP[7], the share of tertiary

[5] The technologic classification of the manufacturing sectors is based on OECD standard and global technological intensity (OECD, 2001). The three categories of 21 manufacturing sectors in China are as follows: (a) High-tech industries include pharmaceuticals, transport equipment, and electronic communications and computers; (b) Medium-tech industries include chemicals, chemical fibers, general machinery, special machinery, electrical equipment and machinery, scientific instruments and office machinery, petroleum refining, non-metallic mineral products, ferrous metals, non-ferrous metals, and metal products, and (c) Low-tech: food processing, food manufacturing, beverage, tobacco, textiles, clothing, and paper.

[6] To avoid potential problems of annual fluctuations, we use changes of all varaibles over three 3-year sbuperiods (2005-2007, 2008-2010, and 2011-2013) rather than annual changes, as done in many studies.

[7] The capital stock in year *t* (K_t) and initial capital stock (K_0) are constructed in the way same as many studies in the literature (Zhang and Zhang, 2003): $K_t = K_{t-1} + \frac{I_t - D_t}{P_t}$, and $K_0 = \frac{I_0}{\delta + g}$, where I_t is investment in year t, D_t is depreciation, P_t is price level, I_0 is initial real investment, δ is the rate of depreciation and g is the growth rate in real investment.

enrollments in technical subjects in total population is taken as a proxy for human capital (*HK*). Research and Development (*R&D*) is captured by the number of patents application granted due to unavailability of data on R&D expenditures. Infrastructure (*INFR*) is proxied by an index that is computed as a weighted average of the three standardized indicators: length of railways in operation per one hundred square kilometers, length of highways per one hundred square kilometers, and capacity of mobile telephone exchanges per one thousand people. Government policy (*POLICY*) is a dummy variable, taking value one for coastal regions and zero for inland regions, which reflects the fact that China's central government FDI policies and development strategies resulted in obvious advantages of coastal regions over inland regions[8].

3. THE MAIN RESULTS AND ROBUSTNESS CHECKS

Tables 3 and 4 report panel estimates of China's XS and XU, with focus on the role of FDI. All regressions are conducted with fixed effects because assumptions for OLS pooling and random effects are rejected[9]. In general, the regression estimates are reasonable and plausible, and the explanatory power is fairly good. Adjusted R^2 of regressions is high in all cases (0.71-0.89), indicating that most of the variance in all measures of XS and XU in Tables 3 and 4 can be accounted for with the independent variables.

[8] China has 31 administrative units of regions, including 22 provinces, 5 autonomous regions, and 4 municipalities. The coastal area comprises 11 regions: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. The inland area is composed of the remaining 20 regions: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

[9] The likelihood ratio and Lagrange multiplier statistics and Hausman test are significant at the 1% level, indicating that the OLS pooling and random effect models are not valid (Baltagi, 1995).

TABLE 3 - *Impact of FDI on Export Sophistication: 2005-2013*

Independent Variable	Dependent Variables			
	MHTMXPC		*MHTMX/MX*	
K	0.117*	0.135*	0.220	0.241
	(1.706)	(1.852)	(1.266)	(1.375)
HK	0.445	0.247	0.081	0.052
	(1.540)	(1.093)	(0.747)	(0.127)
R&D	0.082	-0.091	0.108*	0.080*
	(0.987)	(-0.821)	(1.719)	(1.801)
INFR	0.520***	0.719**	0.131***	0.233***
	(4.082)	(5.525)	(3.911)	(4.601)
POLICY	1.633***	2.041***	1.018***	0.894***
	(3.775)	(4.192)	(3.013)	(5.112)
FIEYS	0.756***		0.341*	
	(6.508)		(1.824)	
FIEYS×HK	0.217**		0.102**	
	(2.187)		(2.471)	
FDIS		0.964***		0.175**
		(5.551)		(2.266)
FDIS ×HK		0.353***		0.081**
		(3.401)		(2.356)
Regional Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
Adjusted R^2	0.854	0.893	0.760	0.781
Observations	279	279	279	279

Notes: *MHTMXPC* = medium- and high-tech manufactured exports per capita, *MHTMX/MX* = shares of medium- and high-tech manufactured exports in total manufactured exports. Constant terms are omitted (but available upon request) to save space. Figures in parentheses are *t*-statistics. The asterisks *, ** and ***, indicate significant levels at 10%, 5%, and 1%, respectively.

TABLE 4 - *Impact of FDI on Export Upgrading: 2005-2013*

Independent Variable	Dependent Variables			
	∆(MHTMXPC)		*∆(MHTMX/MX)*	
∆K	0.031*	0.051	0.008	0.012
	(1.811)	(1.015)	(0.623)	(0.752)
∆HK	0.022	0.031*	0.009	0.033*
	(1.020)	(1.798)	(0.273)	(1.818)
∆(R&D)	0.036	0.105	0.027	0.021
	(0.385)	(0.261)	(1.572)	(1.500)
∆INFR	0.321**	0.507***	0.083**	0.078**
	(2.282)	(3.812)	(2.476)	(2.447)
POLICY	1.012***	1.625***	0.669**	0.557**
	(3.336)	(3.711)	(2.213)	(2.601)
∆FIEYS	0.272*		0.118*	
	(1.850)		(1.784)	
∆(FIEYS×HK)	0.077*		0.051**	
	(1.779)		(2.287)	
∆FDIS		0.255**		0.084*
		(2.260)		(1.887)
∆(FDIS ×HK)		0.129*		0.036*
		(1.771)		(1.803)
Regional Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
Adjusted R^2	0.774	0.753	0.706	0.728
Observations	93	93	93	93

Notes: all is same as those in Table 3 except that ∆ denotes changes, and the changes are computed for three 3-year subperiods (2005-2007, 2008-2010, and 2011-2013). Figures in parentheses are *t*-statistics. The asterisks *, ** and ***, indicate significant levels at 10%, 5%, and 1%, respectively.

Some points are discerned easily from Tables 3 and 4. FDI seems to enhance both XS and XU in China substantially. The coefficients of two versions of the FDI variable (*FIEYS* and *FDIS)* and the FDI×HK item (*FIEYS×HK* and *FDIS×HK*) are significantly positive in every case of the XS models in Table 3, and so are the coefficients of changes in these variables (△*FIEYS*, △*FDIS*, △(*FIEYS×HK*), and △(*FDIS×HK*)) of the XU models in Table 4. The estimates suggest that sophistication- and upgrading-enhancement effects of FDI derive not only from additional capital and access to new export markets, but also from technology and managerial know-how that foreign-invested firms bring with them. The finding is consistent with both theoretical predictions and evidence in the literature. China's relatively high level of export sophistication and rapid export upgrading indeed benefit largely from FDI (UNCTAD, 2002; Rodrik, 2006; Zhang, 2015). And such big gains from FDI seem to depend substantially on China's absorptive capacity in terms of human capital. Without investment in human capital, China's relatively high export sophistication and rapid export upgrading would not be possible even with large FDI inflows (Schott, 2008; UNIDO, 2013).
Estimates for other independent variables are similar between the XS and XU models in almost all cases and in large part consistent with the theoretical predictions. The parameters for physical capital (*K*), human capital (*HK*), and technological efforts (*R&D*) show expected positive signs in all cases, although insignificance in some cases. The significantly positive parameters for infrastructure (*INFR*) and government policy (*POLICY*) in all cases reflect the fact that high quality infrastructure and effective government policies are important to China's export sophistication and technological deepening.

A close look at the estimates reported in Tables 3 and 4 reveals some interesting comparisons. FDI seems to have much larger and significant contributions to XS and XU than domestic capital (*K*) and R&D expenditures. Effects of domestic human capital (*HK*) are insignificant in most of cases, but its interaction with FDI (*FIEYS×HK*, *FDIS×HK* △(*FIEYS×HK*), and △(*FDIS×HK*)) is positive and significant in every case of the XS and XU models. The finding may not be taken as evidence that K, R&D, and HK have no contributions to XS and XU, rather their effects would be limited without FDI. In fact FDI served as catalyst in China' export performance as well as economic growth (Markusen and Venables, 1999).

Several tests and sensitivity checks must be conducted for robustness and endogeneity. Sensitivity checks with alternative measures of dependent variable (*XS* or *XU*) and independent variables (*FDI* and *FDI×HK*) are reported in Tables 3 and 4 as well. Two indicators of XS (*MHTMXPC* and *MHTMX/MX*) and two different measures of FDI (*FDIS* and *FIES*) and (*FDI×HK*) are employed in regressions. The estimate results reported in Tables 3 and 4 are similar in large and none of the estimation results is significantly affected by these alternative measures of XS, XU, FDI and (FDI×HK), implying that the observed results seem not to depend on specific measures used to quantify dependent and independent variables.

Another sensitivity checks are conducted with the instrumental available (IV) technique to deal with the possible endogeneity bias. The two-year lagged values of *FDIS* and *FIES* are used as instrumental variables due to their high correlation with current values of the variables in Tables 3 and 4 (Lileeva and Trefler, 2010). IV estimations with alternative measures of FDI and (FDI×HK) are presented in Table 5.

The coefficients of FDI and (FDI×HK) variables remain significantly positive and are similar qualitatively and quantitatively with those in Tables 3 and 4, suggesting robust results and little endogeneity bias in our regressions in Tables 3 and 4. The Wu-Hausman test statistics cannot reject the hypothesis that independent variables to be exogenously determined and the main estimates of Tables 3 and 4 seem to be unlikely to suffer from endogeneity bias.

TABLE 5 - *Instrumental Variable Estimations of Impact of FDI on Export Sophistication and Upgrading: 2005-2013*

Independent Variable	Dependent Variables			
	MHTMXPC		*MHTMX/MX*	
FIEYS	0.539***		0.302*	
	(4.509)		(1.748)	
FIEYS×HK	0.118**		0.088**	
	(2.225)		(2.365)	
FDIS		0.775***		0.108**
		(3.601)		(2.514)
FDIS ×HK		0.207***		0.105**
		(4.128)		(2.361)
	△(MHTMXPC)		*△(MHTMX/MX)*	
△FIEYS	0.501*		0.099*	
	(1.894)		(1.876)	
△(FIEYS×HK)	0.115*		0.097**	
	(1.808)		(2.553)	
△FDIS		0.337**		0.101*
		(2.118)		(1.796)
△(FDIS ×HK)		0.096*		0.061**
		(1.809)		(2.567)

Notes: (1) The meaning of all variables in the table is same as those in Tables 3 and 4. (2) Estimates for other variables are omitted (but available upon request) to save the space. (3) Data on FDI variables and FDI×HK variables in 2003 and 2004 are available and thus used; the size of sample in the estimations with two year lagged variables does not decrease. (4) Figures in parentheses are *t*-statistics. The asterisks *, ** and ***, indicate significant levels at 10%, 5%, and 1%, respectively.

4. CONCLUDING OBSERVATIONS

The objective of this study is to investigate the role of FDI in China's export sophistication and upgrading. The paper is motivated by the following considerations: export upgrading is important to economic growth of emerging economies; FDI is expected to enhance export sophistication and upgrading; benefits from FDI do not automatically appear but depend on a host-country's absorptive capacity in terms of human capital; and the studies on the FDI-XS-XU linkage has been limited. To close the gap in the literature, we take China as a case study by working with a panel dataset that contains 21 manufacturing sectors for 31 regions covering 8 years from 2005 to 2013. Export sophistication and upgrading are measured with both export capacity (export volume *per capita*) and export quality (medium- and high-tech manufactured exports share in total), and the absorptive capacity is measured by human capital.

Subject to the caveats appropriate for such panel studies, the basic finding is summarized as follows. First, FDI has strong sophistication- and upgrading-enhancing effects on China's manufactured exports. Second, absorptive capacity in terms of human capital is a necessary condition for China to benefit from FDI in technology deepening, especially in capturing spillovers of FDI. Third, high quality infrastructure and government policy are important to export performance, while contributions of domestic factors (physical capital, human capital, and R&D) alone seem to be limited, which may implies FDI as a catalyst of and irreplaceable to China's export success. In sum, working together with absorptive capacity, FDI made a crucial contribution to China's export sophistication and upgrading.

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