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Foreign Direct Investment, Human Capital and Economic Growth of People's Republic of China Using Panel Data Approach

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บทคัดย่อ

ผลกระทบของการลงทุนโดยตรงจากต่างประเทศต่อการเจริญเติบโตทางเศรษฐกิจได้ความสนใจอย่างมากด้านการศึกษาเชิงประจักษ์ งานวิจัยนี้มีเป้าหมายที่จะทดสอบความสัมพันธ์ระหว่างการลงทุนโดยตรงจากต่างประเทศและการเจริญเติบโตทางเศรษฐกิจเช่นเดียวกับความสัมพันธ์ระหว่างการเจริญเติบโตทางเศรษฐกิจและปฏิสัมพันธ์ระหว่างการลงทุนโดยตรงจากต่างประเทศและทุนมนุษย์ การศึกษานี้ครอบคลุมข้อมูลรายปีของ 30 จังหวัดของสาธารณรัฐประชาชนจีนระหว่าง ค.ศ. 1995 และ 2009 การทดสอบพาเนลยูนิทรูท พาเนลโคอินทิเกรชั่น พาเนลออร์ดินนาลีลีสแสควร์เช่นเดียวกับการทดสอบพาเนลแกรงเกอร์คอร์ซอลิที่กับวิธีเวคเตอร์เอเรอร์คอเร็คชั่นซึ่งแทบจะไม่ปรากฏในวรรณกรรมสำหรับความสัมพันธ์ระหว่างการลงทุนโดยตรงจากต่างประเทศ ทุนมนุษย์และการเจริญเติบโตทางเศรษฐกิจเช่นเดียวกับความสัมพันธ์ที่ถูกใช้ในการศึกษานี้ ผลการศึกษาพบว่า การลงทุนโดยตรงจากต่างประเทศโดยตัวเองไม่สามารถส่งผลทางบวกต่อการเจริญเติบโตทางเศรษฐกิจแต่จะส่งผลกระทบอย่างมากถ้าการลงทุนโดยตรงจากต่างประเทศมีปฏิสัมพันธ์กับทุนมนุษย์ ถ้าพิจารณาถึงปฏิสัมพันธ์ของการลงทุนโดยตรงจากต่างประเทศและทุนมนุษย์ผลการศึกษาพบว่ามีผลกระทบทางลบต่อการเจริญเติบโตทางเศรษฐกิจ ผลการศึกษาสามารถสรุปได้ว่าการลงทุนโดยตรงจากต่างประเทศส่งผลต่อการเจริญเติบโตทางเศรษฐกิจต่อเมื่อมีความสามารถในการรองรับเทคโนยีขั้นสูงที่มีอยู่ในระบบเศรษฐกิจจีน

ABSTRACT

The impact of foreign direct investment (FDI) on economic growth has received great attention in empirical studies. This paper aims to test the relationship between FDI and economic growth as well as the relationship between economic growth and the interaction of FDI and human capital. It covers the annual data of 30 provinces of China during the period 1995 to 2009. Panel unit root tests, panel cointegration tests, panel dynamic ordinary least squares (DOLS) estimation as well as panel Granger causality tests associated with vector error

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correction model (VECM) methodology, which have been rarely studied in the literature for relationship among FDI, human capital and economic growth are employed in this paper. The result shows that FDI by itself does not generate a positive effect to enhance economic growth, but generates a relatively large positive effect on economic growth when it is interacting with knowledgeable human capital. Considering the interaction of FDI and technical human capital, evidence shows that there is a negative effect on economic growth. The result concludes that FDI contributes to economic growth only when an adequate absorptive capability of advanced technologies is available in China's economy.

Key words: FDI, Human Capital, Economic Growth, Panel Data

1. INTRODUCTION

The role of foreign direct investment (FDI) in economic growth has been a hot issue in the literature. Different authors have studied the links between FDI and economic growth from different perspectives. However, most of the studies provide different results about their relationship. FDI is considered as a channel for transferring new ideas, technology and skills. Technological progress enhances the total factor productivity (TFP). In this sense, FDI is supposed to play an important role in boosting economic growth.

Human capital is the stock of knowledgeable and skilled labor which produces economic value efficiently. In industrialized countries, workers with skills and talents, which are defined as human capital, play a more important role than raw labor. The stock of skills and talents are increased by investment in human capital through schooling, on-the-job training, and by other means (Dornbusch et al., 2011). An influential article by Mankiw, Romer, and Weil (1992), suggests that the production function is consistent with three factors, which share one-third each; physical capital, raw labor and human capital. Adding human capital into the production function is necessary for industrialized countries since empirical evidences of human capital models reveal that investment in education has a positive correlation with economic growth and development (Olaniyan and Okemakinde, 2008).

This study tests the relationship between FDI and economic growth as well as the relationship between economic growth and the interactions of FDI and two different kinds of human capitals (namely knowledgeable human capital and technical human capital) following the model proposed by Borensztein et al. (1998) by using a panel data approach. It employs panel unit root tests, panel cointegration tests, panel dynamic ordinary least squares (DOLS) estimation as well as panel Granger causality tests associated with vector error correction model (VECM) methodology, which have been rarely studied in the literature for relationship among FDI, human capital and economic growth, and which are even rarer to be used in China.

2. THEORY AND LITERATURE REVIEW

Neoclassical growth theory concludes that long-run rate of growth does not depend on the saving rate but resulted from improvements in technology. Endogenous growth theory assumes that long-run growth rate of output is determined by variables within the model, not by an exogenous rate of technological progress as in a neoclassical model (Dornbusch et al., 2011). According to endogenous growth model, technological progress depends on saving, particularly investment directed towards human capital (Dornbusch et al., 2011).

Yao and Wei (2007) used ordinary least squares (OLS) and generalized method of moments (GMM) estimations to find that FDI helps to generate technological progress and shifts China's production frontier, the results indicated that both FDI and human capital positively affected the total output in China during 1979 to 2003. Buckly et al. (2002) employed OLS regression and Granger causality tests to find the positive effect of FDI on economic growth. However, the positive effect depends on the conditions of the host economy. Hsiao and Hsiao (2006) investigated the relationship between FDI, exports and GDP in East and Southeast Asia by using both time-series and panel data (deleted) . The authors concluded that both FDI and exports caused the economic growth in the long term, and FDI caused GDP both directly and indirectly through exports. Furthermore, this study proved that panel data analysis is superior compared with traditional time-series or cross-section analysis. Tuan et al. (2009) employed OLS and two-stage least squares (2SLS) estimations to verify that FDI promoted economic growth by increasing technological productivity growth in China over the period 1987 to 2004.

Some studies have shown that although there is a positive relationship between FDI and economic growth, the extent of the positive effect depends on the human capital threshold. For instance, by employing the seemingly unrelated regressions (SUR) technique, Borensztein et al. (1998) pointed out that FDI is much more efficient than domestic investment in boosting the economic growth if the host country has a minimum threshold stock of human capital over the period 1970 to 1989. In a study for 36 developing countries from Africa, Asia and Latin America during the period 1980 to 1994, Noorbakhsh et al. (2001) found that the level of human capital in host countries can affect the geographical distribution of FDI. Developing countries enhance their attractiveness for FDI by raising the level of local skills and building up human resource capabilities. Fu (2010) used panel data to verify the existence of the FDI spillover effect in China over the period 1998 to 2008. The author concluded that FDI generates a spillover only when it interacts with human capital, regional development, financial marketing and openness of the economy, respectively. All these literatures proved that human capital is quite an important element when testing the relationship between FDI and economic growth.

On the contrary, there are some empirical works showing the positive effect of FDI on economic growth is insignificant or FDI even generated a negative effect on economic growth by crowding out the domestic industries. Carkovic and Levine (2002) examined the effect of FDI in 72 countries by using OLS and GMM estimations, the authors found that there is no positive influence in economic growth. Furthermore, evidence shows that there is no causal link between FDI and economic growth. The effect of FDI on economic growth depends on the recipient country's level of educational attainment, economic development, financial development and trade openness. Katerina et al. (2004) also found the same results as Carkovic and Levine (2002) based on a Bayesian analysis. It states that FDI does not have any significant effect on economic growth for transition countries.

3. MODEL AND DATA

To investigate the long-run relationship among FDI, human capital and economic growth, the model proposed by Borensztein et al. (1998) is employed to do the empirical work. The long-run relationship among these variables can be written as:

$$LN\,(GDP)_{it} = \alpha_{it} + \alpha_{1i}\,LN(FDI)_{it} + \alpha_{2i}\,LN(FDI{*}H_1)_{it} + \alpha_{3i}\,LN(FDI{*}H_2)_{it} + \mu_{it} \quad (1)$$

where GDP is the real Gross Domestic Product of province i in time period t at constant price of 2000 (USD); FDI is the actual utilized Foreign Direct Investment of province i in time period t (USD); H_1 represents the knowledgeable human capital which measured by the share of the enrollment of university and college students over the total employed people (Borensztein et al. (1998)), H_2 represents the technical human capital which measured by the share of enrollment of specialized secondary school (including vocational school and technical school) students over the total employed people (Borensztein et al. (1998); $LN(FDI{*}H)$ represents the logarithmic form of the interaction of FDI and human capital; μ_{it} is the white noise error term. α_{1i}, α_{2i} and α_{3i} are parameters, which represent the long-run FDI elasticity, interaction of FDI and knowledgeable human capital elasticity and interaction of FDI and technical human capital elasticity, respectively.

The study examines Chinese secondary data during the period 1995 to 2009. According to the availability of data, data is based on a panel of 30 provinces and municipalities. China has 31 provinces and municipalities, but Tibet is excluded because it does not attract significant FDI throughout the period. Since the unavailability of some data, the study will employ an unbalanced panel. All of the data and information needed have been collected from *China Statistical Yearbooks* and various *Provincial Statistical Yearbooks* which were published by the National Bureau of Statistics of China from 1996 to 2010 and the World Development Indicators and Global Development Finance (WDIGDF). Table 1 shows the descriptive statistics of the data.

Table 1 Descriptive statistics of variables.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
1. The logarithmic form of real gross domestic products					
LNGDP	448	19.74	1.01	16.89	22.14
2. The logarithmic form of actual utilized foreign direct investment					
LNFDI	448	20.50	1.75	15.41	23.95
3. The logarithmic form of the interaction of FDI and knowledgeable human capital					
LN(FDI*H_1)	448	16.08	2.29	10.00	20.68
4. The logarithmic form of the interaction of FDI and knowledgeable human capital					
LN(FDI*H_2)	448	16.28	2.05	10.92	20.27

Source: Calculated from China Statistical Yearbooks and various Provincial Statistical Yearbooks (2006-2010).

4. ECONOMETRIC METHODOLOGY AND RESULTS

In this study, the existence of long-run relationship among the variables in Eq. (1) is examined. The utilization of the vector error correction model (VECM) captures the short-run dynamics of the variables. The analysis is conducted in four steps. The first step is to verify the order of integration for the variables because the various cointegration tests are valid only if the variables have the same order of integration. In the second step, the Pedroni (1999, 2004) tests and the Kao (1999) test are employed to examine the panel cointegration relationship, which are based on the estimated residuals of Eq. (1) when all the series are integrated into the same order. Step three is the estimation of the long-run structural coefficients by using the panel dynamic ordinary least squares (DOLS) approach. Finally, panel Granger causality tests associated with vector error correction model (VECM) are conducted between the variables to examine the existence of both short-run and long-run causations.

4.1 PANEL UNIT ROOT TESTS

Consider a following AR (1) process for panel data:

$$y_{it} = \rho_i y_{it-1} + X_{it} \delta_i + \in_{it} \tag{2}$$

where $i = 1, 2, \ldots, N$ cross-section units or series, that are observed over periods $t = 1, 2, \ldots T$. The X_{it} represents the exogenous variable in the model, including any fixed effects or individual trends, δ_i is the autoregressive coefficient, and $\in_{it}$ is the error term which assumed to be mutually independent idiosyncratic disturbance. If $|\rho_i| < 1$, y_{it} is said to be weakly (trend-) stationary. On the other hand, if $|\rho_i| = 1$ then y_{it} contains a unit root.

Fisher-type unit root tests (Maddala and Wu, 1999, and Choi, 2001) are employed in the study since they have ability to handle unbalanced panel data. Fisher-type tests have been proposed by Maddala, Wu and Choi by using Fisher's (1932) results to derive tests that combine the p-values from individual unit root tests.

Define π_i as the p-value from any individual unit root test for cross-section i, under the null of unit root for all N cross-sections, we have the asymptotic result that:

$$-2 \sum_{i=1}^{N} \log(\pi_i) \rightarrow \chi^2_{2N} \tag{3}$$

Note that $-2 \log(\pi_i)$ has a χ^2 distribution with 2 degrees of freedom (Baltagi, 2008).

In addition, Choi demonstrates that:

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(\pi_i) \rightarrow N(0, 1) \tag{4}$$

where Φ^{-1} is the inverse of the standard normal cumulative distribution function. Since $0 \le \pi_i \le 1$, $\Phi^{-1}(\pi_i)$ is an $N(0,1)$ random variable and $Z \rightarrow N(0, 1)$ (Baltagi, 2008).

In this study Fisher-type unit root tests, both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) are employed. Table 2 displays the results of panel unit root tests in levels as well as in the first differences for all the variables. The tests for each variable are performed in three types: test including individual intercept, test including intercept and trend, and test including neither intercept nor trend.

According to Table 2, both tests of the ADF and PP cannot reject the null hypothesis in their levels, which indicate that all the variables are non-stationary in their levels. However, after taking first difference of each variable, all statistics of these four variables rejected the null hypothesis at the 0.01 level. This indicates that all the variables become stationary in their first differences. These results imply that all these variables are integrated of order one, i.e.; I(1).

Table 2 Fisher-type panel unit root tests results.

Variable		Method	Fisher type test-ADF			Fisher type test-PP		
			Individual Intercept	Intercept and Trend	None	Individual Intercept	Intercept and Trend	None
LNGDP	Level	Fisher Chi-square	0.35	26.75	8.29	0.31	5.64	0.00
		Choi Z-stat	19.64	7.76	12.93	20.36	11.01	23.38
	First Difference	Fisher Chi-square	74.04	99.32***	34.25	77.19*	100.47***	44.92
		Choi Z-stat	-0.77	-3.65***	2.30	-1.67**	-3.12***	0.67
LNFDI	Level	Fisher Chi-square	16.33	55.89	5.19	13.31	36.16	4.48
		Choi Z-stat	7.23	1.28	9.77	7.83	3.14	11.27
	First Difference	Fisher Chi-square	187.57***	163.54***	230.23***	199.63***	203.66***	252.69***
		Choi Z-stat	-8.41***	-7.50***	-10.11***	-8.87***	-8.51***	-11.55***
LN(FDI*H_1)	Level	Fisher Chi-square	17.24	77.02*	1.94	9.74	81.58**	0.89
		Choi Z-stat	7.95	-1.42*	15.03	10.07	-1.35*	16.70
	First Difference	Fisher Chi-square	186.96***	150.20***	152.18***	231.86***	201.56***	185.68***
		Choi Z-stat	-8.04***	-5.53***	-6.44***	-9.62***	-7.33***	-8.46***
LN(FDI*H_2)	Level	Fisher Chi-square	21.03	57.44	4.09	19.35	47.59	3.30
		Choi Z-stat	7.22	0.93	10.28	7.84	2.56	11.75
	First Difference	Fisher Chi-square	187.51***	172.50***	241.91***	222.81***	227.53***	260.28***
		Choi Z-stat	-8.68***	-7.79***	-10.83***	-9.52***	-8.95***	-11.80***

Note: ***, ** and * indicate the rejection of the null hypothesis at 0.01, 0.05 and 0.10 level of significance, respectively. The lag lengths are selected by using SIC. The maximum number of lags is set to be two.

4.2 PANEL COINTEGRATION TESTS

Having established that each of the four variables is I (1), the panel cointegration among economic growth and FDI as well as the interactions of FDI with two kinds of human capitals can be checked by the panel cointegration tests. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary data may be stationary. If such a stationary linear combination exists, these non-stationary data are said to be cointegrated. The stationary linear combination is called the cointegration equation and may be interpreted as a long-run equilibrium relationship among the variables. To test for cointegration among these variables, both the Pedroni (1999, 2004) tests and the Kao (1999) test are employed to confirm the variables are cointegrated.

Pedroni's panel cointegration allowing for individual-specific fixed effects and deterministic trends can be expressed as:

$$LNGDP_{it} = \alpha_{it} + \delta_i t + \alpha_{1i} LNFDI_{it} + \alpha_{2i} LN(FDI^*H_1)_{it} + \alpha_{3i} LN(FDI^*H_2)_{it} + \mu_{it} \quad (5)$$

where $\mu_{it} = \rho_i \mu_{it-1} + \varepsilon_{it}$ are the estimated residuals from the panel long-run relationship. The parameters α_{it} and δ_i allow for the possibility of individual-specific fixed effects and deterministic trends, respectively. The null hypothesis of no cointegration is $\rho_i = 1$. If the null hypothesis is rejected, panel cointegration among dependent variable and independent variables will be confirmed. The Kao (1999) test follows the same basic approach as the Pedroni tests but specifies cross section specific intercepts and homogeneous coefficients during the first stage.

Table 3 presents the panel cointegration tests results. The Pedroni tests are conducted in three types: test with no deterministic trend, test with deterministic intercept and trend, and test with neither deterministic intercept nor trend.

According to the Pedroni tests in Table 3, two of the four panel-based statistics show evidence of panel cointegration among the variables at a 0.05 level of significance. Additionally, two of the three group test statistics also reveal evidence of panel cointegration. In sum, four of the seven tests indicate that the null hypothesis of no cointegration is rejected at the 0.05 significance level among all the three types' tests.

The Kao test also confirms panel cointegration at a 0.01 level of significance. Overall, there is strong statistical evidence in favor of panel cointegration among economic growth, FDI, and the interactions of FDI and knowledgeable human capital as well as technical human capital.

Table 3 Panel cointegration tests results.

Pedroni Tests			
Test Statistics	No Deterministic Trend	Deterministic Intercept and Trend	No Deterministic Intercept or Trend
Panel v-Statistics	3.097***	30.256***	-3.925
Panel rho-Statistics	2.345	4.417	1.200
Panel pp-Statistics	-0.102	-1.040	-1.919**
Panel adf-Statistics	-3.683***	-2.749***	-5.064***
Group rho-Statistics	4.485	5.623	3.776
Group pp-Statistics	-1.745**	-4.155***	-3.093***
Group adf-Statistics	-4.429***	-6.664***	-7.083***
Kao Test			
ADF		-4.739***	

Note: ***, ** and * indicate the rejection of the null hypothesis at 0.01, 0.05 and 0.10 level of significance, respectively. The test statistic is distributed N (0, 1) under null no cointegration.

4.3 PANEL LONG-RUN ELASTICITIES

To deal with the endogeneity bias in regressors, this paper employs the dynamic ordinary least squares (DOLS) approach to estimate the long-run relationship among FDI, human capital and economic growth in a panel context. Hausman test is employed to choose between fixed effect model and random effect model estimations. The null hypothesis in the Hausman test is that the correlated random effect model is appropriate (Hsiao and Hsiao, 2006). If the null hypothesis is rejected, fixed effect model will be confirmed to be the better estimation. The Chi-square statistic of the Hausman test for this model is 15.61 with the p-value of 0.016, which indicates that it is better to use the fixed effect model to estimate the long-run relationship between the four integrated variables.

Evidence of cointegration among these variables confirms the impossibility of spurious estimation. The panel DOLS estimation based on fixed effect model can be written as:

$$\begin{aligned} LNGDP_{it} = {} & 15.3036 + 0.0125LNFDI_{it} + 0.4497LN(FDI^{*}H_1)_{it} - 0.1832LN(FDI^{*}H_2)_{it} \\ & -0.0795\Delta LNFDI_{it-1} - 0.2860\Delta LN(FDI^{*}H_1)_{it-1} + 0.2532\Delta LN(FDI^{*}H_2)_{it-1} \end{aligned} \quad (6)$$

Table 4 Fixed effect model estimation results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	0.0125	0.0399	0.3136	0.7540
LN(FDI*H1)	0.4497***	0.0237	18.9739	0.0000
LN(FDI*H2)	-0.1832***	0.0326	-5.6141	0.0000
D(LNFDI(-1))	-0.0795*	0.0432	-1.8390	0.0668
D(LN(FDI*H1(-1))	-0.2860***	0.0543	-5.2707	0.0000
D(LN(FDI*H2(-1))	0.2532***	0.0496	5.1009	0.0000
Constant term	15.3036***	0.4873	31.4056	0.0000
Dependent var.: LNGDP	Mean Standard deviation		19.8469 0.9880	
Model size	Observation Parameters Degree of freedom		388 7 381	
Residuals	Sum of squares Standard error of regression		11.0739 0.1773	
Fit	R-squared Adjusted R-squared		0.9707 0.9678	
Model test	F-statistic F (prob.)		332.9912 0.0000	
Diagnostic	Log likelihood		139.3961	
Information criterion	Schwarz Criterion Akaike Info. Criterion		-0.1655 -0.5330	

Note: *** and * indicate the rejection of the null hypothesis at 0.01 and 0.10 level of significance, respectively

The estimation of the fixed effect model shows that most of the variables have the expected signs; FDI positively affects the economic growth of China during the period 1995-2009; FDI together with knowledgeable human capital exerts a more positive effect on economic growth comparing with only FDI; knowledgeable human capital performs better than technical human capital when it is interacting with FDI. However, the coefficient of the positive effect of FDI on economic growth is not statistically significant at 0.10 significance level. The panel result indicates that FDI by itself does not generate positive effect on China's economic growth, whereas the interaction of FDI and knowledgeable human capital reveals a relatively high positive effect on economic growth. Result shows that a 1% increase in FDI together with knowledgeable human capital increases the GDP by 0.4497%. It confirms that knowledgeable human capital plays an important role in economic growth when it is interacting with FDI, the more knowledgeable human capital in the host economy, the stronger technological spillover effect generated by FDI. The panel elasticity of GDP with respect to the interaction of FDI and technical human capital reveals a significant negative sign with the coefficient of -0.1832. This indicates that technical human capital interacting with FDI cannot enhance economic growth in China. Evidence also implies that knowledgeable human capital is much more efficient than technical human capital together with FDI. This result may explain the reason why people pay more and more attention on academic high education instead of secondary technical education.

4.4 PANEL GRANGER CAUSALITY TESTS

To examine the causal relationships of both short-run and long-run, a panel Granger causality test associated with vector error correction model (VECM) is estimated. The Engle and Granger two-step procedure is undertaken by first estimating the cointegration equation to obtain the estimated residuals. Next, defining the lagged residuals from the cointegration equation as the error correction term, the following dynamic error correction model is estimated:

$$\begin{aligned}\Delta LNGDP_{it} = {} & \alpha_{1i} + \lambda_{1i} ECT_{i,t-1} + \sum_{k=1}^{q} \theta_{11i,k} \Delta LNGDP_{i,t-k} + \sum_{k=1}^{q} \theta_{12i,k} \Delta LNFDI_{it-k} \\ & + \sum_{k=1}^{q} \theta_{13i,k} \Delta LN(FDI^{*}H_1)_{i,t-k} + \sum_{k=1}^{q} \theta_{14i,k} \Delta LN(FDI^{*}H_2)_{i,t-k} + \mu_{1i,t}\end{aligned} \tag{7}$$

$$\begin{aligned}\Delta LNFDI_{it} = {} & \alpha_{2i} + \lambda_{2i} ECT_{i,t-1} + \sum_{k=1}^{q} \theta_{21i,k} \Delta LNGDP_{i,t-k} + \sum_{k=1}^{q} \theta_{22i,k} \Delta LNFDI_{it-k} \\ & + \sum_{k=1}^{q} \theta_{23i,k} \Delta LN(FDI^{*}H_1)_{i,t-k} + \sum_{k=1}^{q} \theta_{24i,k} \Delta LN(FDI^{*}H_2)_{i,t-k} + \mu_{2i,t}\end{aligned} \tag{8}$$

where Δ is the first-difference operator; $\alpha_{ji}(j=1,2)$ represents the fixed-province effect; $k\,(k=1,...,q)$ is the optimal lag length determined by the Schwarz Criterion; $ECT_{i,t-1}$ is the estimated lagged error correction term derived from the long-run cointegration relationship; λ_{ji} $(j=1,2)$ is the speed of adjustment; $\mu_{i,t}$ is the serially uncorrelated error term with mean zero. The interaction terms of FDI and two kinds of human capitals are omitted because the aim of this study is to examine causality between FDI and economic growth. The short-run causality is determined by the statistical significance of the partial F-statistic associated with the

corresponding right hand side variables. Long-run causality is revealed by the statistical significance of the respective error correction terms using a t-test.

For short-run causality, the null hypothesis is $H_0: \theta_{12i,k} = 0$; $H_0: \theta_{13i,k} = 0$; and $H_0: \theta_{14i,k} = 0$ for all i and k in Eq. (7) or $H_0: \theta_{21i,k} = 0$; $H_0: \theta_{23i,k} = 0$; and $H_0: \theta_{24i,k} = 0$ for all i and k in Eq. (8). For long-run causality, the null hypothesis is $H_0: \lambda_{1i} = 0$ for all i in Eq. (7) or $H_0: \lambda_{2i} = 0$ for all i in Eq. (8).

Table 5 Panel causality tests results.

Dependent Variable	Sources of causation (Independent variables)				
	Short-run				Long-run
	$\Delta LNGDP$	$\Delta LNFDI$	$\Delta LN(FDI*H_1)$	$\Delta LN(FDI*H_2)$	ECT
$\Delta LNGDP$		6.5792 [0.00]***	5.1718 [0.01]**	4.2031 [0.02]**	-5.3368 [0.00]***
$\Delta LNFDI$	24.434 [0.00]***		49.689 [0.00]***	0.663 [0.42]	-1.9448 [0.05]*

Note: Partial F-statistics reported with respect to short-run changes in the independent variables while t-statistics reported with respect to long-run. Probability values are in brackets. Significance at the 0.01 and 0.10 levels denoted by *** and *, respectively.

Table 5 presents the results of panel Granger causality tests in both short-run and long-run. For short-run causality, the coefficients of $\Delta LNFDI$, $\Delta LN(FDI*H_1)$, and $\Delta LN(FDI*H_2)$ are significant at 0.10 level, 0.05 level, and 0.05 level in Eq. (7), respectively, which rejected the null hypothesis of no short-run causation. It indicates that there is a short-run causality from FDI, the interaction of FDI and knowledgeable human capital as well as the interaction of FDI and technical human capital to China's economic growth. In Eq. (8), the coefficients of $\Delta LNGDP$ and $\Delta LN(FDI*H_1)$ are both significant at 0.01 level, while the coefficient of $\Delta LN(FDI*H_2)$ is not statistically significant. It implies that there is a short-run causality from economic growth and the interaction term of FDI and knowledgeable human capital to FDI but no short-run causality from the interaction term of FDI and technical human capital to FDI.

For long-run causality, the coefficient of the lagged error correction term in Eq. (7) is -0.07 which statistically significant at 0.01 level. It indicates that there is a long-run causality from FDI, the interaction of FDI and knowledgeable human capital as well as the interaction of FDI and technical human capital to GDP. In other words, the economic growth responds to a deviation from the long-run equilibrium in the previous period. It also confirms the cointegration relationship among these four variables. In Eq. (8), the coefficient of the lagged error correction term is -0.13 which statistically significant at 0.10 level. It reveals that there is a long-run causality from GDP, the interaction of FDI and knowledgeable human capital as well as the interaction of FDI and technical human capital to FDI.

In sum, the results imply that there is a bi-directional Granger causality between FDI and China's economic growth both in the short term and the long term.

5. CONCLUSIONS AND SUGGESTIONS FOR FUTURE STUDY

The result of this study is in conflict with the conventional belief of presuming that it is always beneficial for China to have more FDI. Evidence shows an insignificant positive relationship between FDI and economic growth, which means that FDI by itself does not generate a significant positive effect to enhance economic growth. The same results have been found by Carkovic and Levine (2002) as well as Katerina et al. (2004).

On the contrary, the result shows strong complementary effect between FDI and knowledgeable human capital towards economic growth. FDI generates a relatively large positive effect on economic growth when it is interacting with knowledgeable human capital. This result is consistent with the idea that the flow of advanced technology brought along by FDI can increase the growth rate of host economy only by interacting with that country's absorptive capability, which was proposed by Borensztein et al (1998). For the interaction of FDI and technical human capital, evidence shows that there is a significant negative effect on economic growth. Technical human capital supposed to have a significant positive effect on economic growth in the presence of FDI. The reason for this contrary result might be the data which has been employed to represent the technical human capital. Since the unavailability of collecting the exactly number of technicians and skilled labor, technical human capital in this study is measured by the enrollment of specialized secondary school students, which might lead to the inaccuracy of the effect of technical human capital on economic growth. Empirical result also indicates that in the case of China, it is likely that higher efficiency of FDI results from a combination of advanced management skills and more advanced technology. Knowledgeable human capital plays a more important role in the presence of FDI to enhance China's economic growth. FDI contributes to economic growth only when an adequate absorptive capability of advanced technologies is available in the host economy. It also confirms that a higher academic education is more needed in China compared with the secondary technical education.

The results show that the positive effect of FDI on economic growth depends on the recipient region's capability of human capital resource. Future study may focus on testing the relationship between economic growth and the interaction terms of FDI and other factors of the recipient region's capability such as regional development, financial development and trade openness. The study does not examine in detail of FDI in different specific industries which could lead to positive or negative effects on economic growth. These issues deserve further investigation.

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