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CAUSAL RELATIONSHIP BETWEEN ECONOMIC GROWTH, FINANCIAL DEEPENING, FOREIGN DIRECT INVESTMENT AND INNOVATION: EVIDENCE FROM CHINA

Mollah Aminul Islam[1+]
Haiyun Liu[2]
Muhammad Asif Khan[3]
Sultanuzzaman MD Reza[4]
Yassin Elshain Yahia[5]
Layla Nasrin[6]

[1,3,4,5]*PhD Scholar, School of Economics, Huazhong University of Science and Technology, Wuhan, P.R.China*
[1]*Email: mollahaminul@hust.edu.cn*
[3]*Email: khanasif82@hotmail.com*
[5]*Email: yas.hero2020@gmail.com*
[2]*Professor, School of Economics, Huazhong University of Science and Technology, Wuhan, P.R.China.*
[2]*Email: lhaiyun@mail.hust.edu.cn*
[6]*Master Degree Candidate, School of Health Science, Wuhan University, Wuhan, P.R.China.*
[6]*Email: laylanasrindhaka@gmail.com*

(+ Corresponding author)

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ABSTRACT

This research examines the cointegration and causal relationship between economic growth, financial deepening, foreign direct investment and innovation in the context of China. The empirical results of the ARDL Bounds test to cointegration and VECM Granger causality validate the cointegration and causal association among variables. The study offers policy implication to bring more depth to the financial system to elevate potential innovative environment through FDI. Moreover, to boost real growth through the creation of spillover effects and to enrich the absorptive capacity, the policymakers need to pay attention to financial institutions access, depth and efficiency.

Contribution/Originality: This study contributes in the existing literature by integrating FDI and innovation in finance-growth relationship and by analyzing the depth, access and efficiency of financial institutions and markets using the "New Broad-based Index of Financial Development". More importantly, the paper has identified the weaker subsector and suggested more concentration.

1. INTRODUCTION

The current empirical endeavor proceeds to answer three primary questions. Firstly, does the deepening financial system has a significant influence on Chinese economic growth in the short and long-term? Secondly, what role FDI and innovation play to enhance the finance-growth nexus in the short and long-term? Thirdly, which segment of the financial sector (e.g., financial institutions or markets) contributes more to the Chinese economy? To answer these questions, we review the prior literature and find that financial deepening, in addition to its direct impact on growth, creates an indirect channel for real sector growth, through which foreign direct investment (Lee and Chang, 2009) and innovation (Pradhan *et al.*, 2018) can play a promising role, in terms of building absorptive capacity and spillover effects in the host economy. Different cross-country studies suggest that the more developed a country's financial system is, the more likelihood it expects to retrieve benefit from FDI towards economic development (Ang, 2009).

The deepening of the financial sector determines the FDI of the host country, at least in three distinct ways. Firstly, firms having more working capital from credits to purchase better machinery updated technologies and hire skilled human resources due to the higher developed financial system. Secondly, the existing financial mechanism creates backward linkages for FDI which make the local suppliers (Smarzynska, 2004) further efficient, thus allows the host economy to absorb the FDI spillover effect. While, thirdly, the better the financial system the more the inflow of FDI enrich the competitive environment that in turn, encourages local players to concentrate on research and innovation. In other words, the money supply through FDI can maximise the speed of real growth when the financial system of the recipient country is developed enough to offer more advantage to the enterprises, to absorb the backward linkage spillover effects and to concentrate on investing more in research and development to beat the competition.

Although, a handsome amount of literature is present on the finance-growth nexus, the joint effect of innovation and foreign direct investment in the finance-growth relationship, to the best of our knowledge, is still unexplored. To mitigate this knowledge gap, the current study brings the above constituents together to investigate the status of relationships and ultimate casual flows simultaneously. We examine the relationships taking China as the sample due to the global importance of her economy. Despite significant progress in economic growth since the starting of economic liberalisation and opening up in 1979 (Liu *et al*., 2002; Wu and Chen, 2017) recently China has experienced a slowdown in economic growth. The average growth before 2010 was above 10% which falls to 8.5% per annum in recent years (IMF, 2017). Along with, the Chinese financial system found more indigent. In 2013, according to the IMF country ranking on financial development, the China mainland secured the 33rd position in financial development (Svirydzenka, 2016). As financial depth influences many other factors of economic growth, the low depth of the financial system can be suspected as a cause of the recent slowdown in the Chinese economy. In the existing context, the emergence of financial deepening in conjunction with FDI and innovation for the real sector growth motivates to study the long-run and causal impact FDI and innovation on the finance-growth relationship of China.

The ARDL Bounds test to cointegration shows that long-run equilibrium relationship exists among the variables studied and VECM Granger causality approach confirms that FDI and innovation have a significant impact on the economic growth of China channeled through financial development. We also find unidirectional causality flows from financial deepening, foreign direct investment and innovation to the economic growth of China.

This study contributes to the body of literature in several ways. Firstly, unlike previous empirical studies, the study uses the "New Broad-based Index of Financial Development' established by IMF (2016) built on relatively reliable methodology with the broader coverage of counties and contemplates both financial institutions and financial markets categorically regarding depth, access and efficiency. Secondly, the paper integrates the domestic innovation and FDI into the analysis of finance-growth literature, which has not been tested so far in the context of China. Thirdly, the comparison of financial institutions and markets sheds light on the relatively weaker component of the financial sector to be concentrated by policymakers. The next section covers the brief literature review in this area. The third section accounts for methodology, while the conclusion is drawn in the final section.

2. RELEVANT LITERATURE

Financial deepening and financial development used interchangeably in the financial economics literature (Anwar and Sun, 2011; Hamdi *et al*., 2014; Trabelsi and Cherif, 2017) is thought to be one of the influential forces for economic growth (Krah *et al*., 2014; Mhadhbi, 2014; Ghildiyal *et al*., 2015; Durusu-Ciftci *et al*., 2017; Pradhan *et al*., 2017; Silva *et al*., 2017; Capolupo, 2018) for both developed and developing economies (Adeniyi *et al*., 2015). In the presence of conflicting arguments regarding the direction and extent of causality, researchers conclude that finance directs real growth through accumulation of capital and enabling long-run investment (Soedarmono *et al*., 2017) accumulation and allocation of finance across the supply and demand sides of the economy (Silva *et al*., 2017)

mitigation of transactions costs (Hoffman *et al.*, 2015) information acquisition and processing, corporate governance efficiency (Abedifar *et al.*, 2016) mobilization of saving, technology transfer and reducing risk (Ahmed and Mmolainyane, 2014) cheap financing for borrowers through banking channel efficiency (Rahman *et al.*, 2017).

The Chinese economy was studied by some researchers considering provincial level data (Jun *et al.*, 2007; Hasan *et al.*, 2009) who find that financial sector liberalisation and local firm privatisation enhance productivity and hence accelerate economic growth. Abedifar *et al.* (2016) considered Islamic sense of finance in 22 Islamic countries and revealed that nations are practising banking sector development, which is an indicator of financial deepening, can boost economic growth especially in the countries with high uncertainty avoidance index, lower GDP per capita and medium-sized Islamic. Most recently, Pradhan *et al.* (2017) while analysing the finance-growth relationships of Eurozone, found that financial deepening and real sector growth along with trade openness and FDI inflows are cointegrated amongst each other.

Despite the belief that finance and growth has a positive relationship, some studies in the literature found to have no connection between these. For example, Akinboade (2000) in Tunisian case, Gries *et al.* (2009) and Ahmed (2013) in Sub-Saharan African case, Gries *et al.* (2011) in Latin American and Carrabin case, Chortareas *et al.* (2015) on a advance and developing economies study found that finance and growth are causally independent of each other, especially in the long run. Although their analysis evidence for a robust bi-directional relationship in the short run, it disappears in the long run. On the other hand, some researchers found nonlinear links between finance and growth. Such researchers found an inverted U shaped the relational impact of finance on real sector growth. It means that financial deepening grows the economic development, but after a certain point of development it turns to inverse and takes a U shape form (Samargandi *et al.*, 2015); (Soedarmono *et al.*, 2017). Silva *et al.* (2017) also agree with too much finance effects resulting in a nonlinear relationship.

Several measures of financial deepening are accounted for throughout the literature to represent the financial deepening for example financial depth proxy (e.g. M2 to GDP ratio (Giedeman and Compton, 2009; Pradhan, 2010; Anwar and Cooray, 2012; Mhadhbi, 2014; Ghildiyal *et al.*, 2015; Jalloh and Guevera, 2017)) M3 to GDP ratio (Dawson, 2008; Huang and Lin, 2009; Hassan *et al.*, 2011) M3 to M1 ratio (Rousseau and Wachtel, 2002; Yilmazkuday, 2011)) bank based financial deepening proxies (e.g. bank ratio (King and Levine, 1993)) activity based proxies (e.g. private domestic credit provided by deposit money banks to GDP ratio (Beck and Levine, 2004; Cole *et al.*, 2008)) the proportion of private domestic credit provided by deposit money banks and other financial institutions to GDP (De Gregorio and Guidotti, 1995; Andersen and Tarp, 2003) credit allocated to private enterprises to total domestic credit ratio (King and Levine, 1993; Rousseau and Wachtel, 2011) stock market proxies (e.g. market capitalizaiton raito (Shen and Lee, 2006; Chakraborty, 2010; Yu *et al.*, 2012)) stock market turnover ratio (Beck and Levine, 2004; Liu and Hsu, 2006; Yay and Oktayer, 2009) stock market acitvity (Manning, 2003; Tang, 2006; Shen *et al.*, 2011) etc. However, the use of a single measure draws some significant limitations over another and the avoidance of many of the critical aspects of the economy. Some recent studies used combination several measures of financial deepening through principal component analysis which still possesses limitation of avoiding some essential indicators and not account for the financial market and financial constraints equivalently. The restrictions are to a great extent removed by the 'New Brod Based Index of Financial Development' (Svirydzenka, 2016) as it combined a larger ever macroeconomic, financial indicators from both of market and institution contexts.

The foreign direct investment comes with opportunities to expand the productivity of the economy, human capital development technological advancement. Prior literature documents the significant connection of foreign direct investment and economic growth (Iamsiraroj, 2016); (Makun, 2017); (Su and Liu, 2016); (Sunde, 2017) hence, it is expected that inflows of foreign direct investment can have a positive impact on the economic progress. Therefore, foreign direct investment is included as a control to economic growth for realistic estimation. Similarly, the innovation is considered a one of the critical change maker of the economy creating growth and competitive

advantage (Koh, 2006; Fu, 2008; Hsu *et al.*, 2014; Hu, 2015; Lee, 2015). China has become successful in the economic growth and attaining sustainable growth starting from the economic reform in 1978. Currently, Chinese leaders are driving the country towards knowledge and technology-based economy. Moreover, following that strategy in recent Chinese enterprises are playing an increasing role in innovation (Wu, 2011). The innovation activities of Chinese enterprises are visible from the incremental number of patent and trademark applications. The number of the patent application was 30038 in 2001 and 801135 in 2014 (WDI, 2018) whereas the number of trademark application was 259417 in 2001 and 2104409 in 2014 (WIPO, 2018). The impact of Chinese innovation on the economy was investigated by some researchers over the last couple of decades. For example, Wu (2011) found a positive image of innovation on the Chinese economy using a regional growth accounting approach. Chinese enterprises enjoy a multiplier effect of research and development (another proxy of innovation) while controlling expenses and raising sales (Hu and Jefferson, 2004) that may make the firms profit sustainable and also expand new horizons. Keeping in view the dynamic role of innovative nature of Chinese economy, we incorporate it as a key determinant of economic growth.

3. ECONOMETRIC MODEL AND DATA SOURCE

The theoretical relationships among the underlying variable are mathematically expressed in equation (1).

$$LGDP_t = \beta_0 + \beta_1 FDx_t + \beta_2 LIFDI_t + \beta_3 LInno_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Whereas, $LGDP$, FDx, $LIFDI$ and $LInno$ represents the gross domestic product (GDP), financial development index, the inflow of foreign direct investment and innovativeness respectively, while, β_1 to β_3 are corresponding coefficients and β_0 represents intercept, t time and ε denotes the error term.

The study period ranges from 1980 to 2014 with the objective to utilise maximum available data on financial deepening. Following previous studies, we employ gross domestic product (GDP), one of the most standard measures used in the literature to represent the economic welfare of a country (Silva *et al.*, 2017) in current prices, as the dependent variable. Financial deepening was proxied by IMF's financial deepening index (Svirydzenka, 2016) foreign direct investment was measured as the inflows of direct investment from alien investors into the reporting country estimated in the US dollar (Reza *et al.*, 2018) and the innovativeness of the country is measured by the number of annual patent applications (Castellacci and Natera, 2016). All the data series except the financial deepening index are transmitted into log form to avoid heteroscedasticity problem. Table 1 exhibits the variables and respective data source.

Table-1. Description of Variables and Data Source

Variables	Description	Data Source
$LGDP_t$	Log of Annual GDP in current dollar value.	World Bank
$LIFDI_t$	Log of annual inflow of foreign investment in current dollar value.	UNCTAD
$LInno_t$	Innovation proxy-Log of annual patent application number	World Bank
FDx_t	Financial deepening index.	IMF
FMx_t	Financial market index	IMF
FIx_t	Financial institution index	IMF
$FMAx_t$	Financial market access index	IMF
$FMDx_t$	Financial market depth index.	IMF
$FMEx_t$	Financial market efficiency index	IMF
$FIAx_t$	Financial institution access index	IMF
$FIDx_t$	Financial institution depth the index.	IMF
$FIEx_t$	Financial institution efficiency index	IMF

Source: Authors' compilation

To estimate cointegration among variables of the interest, we use Autoregressive Distributive Lag (ARDL) bounds testing approach in Pesaran *et al.* (2001). This robust methodology overcomes the limitations of traditional approaches such as Engle and Granger (1987) and Johansen and Juselius (1990) mainly in the scenario of mixed integration order (level or first difference). Also, the ARDL approach produces the best estimation in case of small sample size. Finally, the model is capable of providing unbiased results even though some of the regressors are endogenous. The ARDL model is expressed as;

$$\Delta LGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LGDP_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta FDx_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta LIFDI_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta LInno_{t-i} + \alpha_1 LGDP_{t-1} + \alpha_2 FDx_{t-1} + \alpha_3 LIFDI_{t-1} + \alpha_4 LInno_{t-1} + \mu_t \dots\dots\dots (2)$$

Where Δ represents the operator of the first difference, β_0 is the constant component, μ is the usual unobserved white noise term, t is the time dimension and p is the number of lags to be considered. The terms which include the summation operator represent the short-run error correction dynamics, while the terms with α correspond to the relationship in the long-run.

The optimal lag is selected using the renowned Akaike information criterion (AIC) because AIC has exclusive power to estimate the lag-length for small samples (Shahbaz *et al.*, 2018) compared to other criteria. If the calculated F-statistics is higher than the upper bound at 1%, 5% and10% level of significance the existence of cointegration is proved (Barkhordari and Fattahi, 2017) and the null hypothesis is rejected to accept the alternative hypothesis of the existence of cointegration. The existence of a long-run relationship can be revealed by joint F-Statistics or Wald statistic. For the purpose we construct our null hypothesis as H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ with the corresponding alternative hypothesis HA: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$. The null of no cointergretion is to be accepted is cointegretion is absent, while the alternative hypothesis is to be accepted if existence of cointegretion is proven (Shahbaz *et al.*, 2018).

As for testing cointegration with ARDL bounds testing approach, each of the variables should be treated as dependent in the equation, the number of equations should be equal to the number of variables (Wang and Wang, 2018). Following Ahmad and Du (2017) we consider the following equations for each of the variables:

$$\Delta FDx_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta FDx_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta LGDP_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta LIFDI_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta LInno_{t-i} + \alpha_1 FDx_{t-1} + \alpha_2 LGDP_{t-1} + \alpha_3 LIFDI_{t-1} + \alpha_4 LInno_{t-1} + \mu_t \dots\dots\dots (3)$$

$$\Delta LIFDI_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LIFDI_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta FDx_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta LGDP_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta LInno_{t-i} + \alpha_1 LIFDI_{t-1} + \alpha_2 FDx_{t-1} + \alpha_3 LGDP_{t-1} + \alpha_4 LInno_{t-1} + \mu_t \dots\dots\dots (4)$$

$$\Delta LInno_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LInno_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta LIFDI_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta FDx_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta LGDP_{t-i} + \alpha_1 LInno_{t-1} + \alpha_2 LIFDI_{t-1} + \alpha_3 FDx_{t-1} + \alpha_4 LGDP_{t-1} + \mu_t \dots\dots\dots (5)$$

If the variables are cointegrated in the long run, short-run estimation is tested. We estimate the following error correction model for judging the short run relationship:

$$\Delta LGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta LGDP_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta FDx_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta LIFDI_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta LInno_{t-i} + \gamma ECT_{t-1} + \mu_t \dots\dots\dots (6)$$

Where the speed of adjustment toward long-run equilibrium is measured by, and the cointegration residuals of the model (1) are obtained by ECT_{t-1}.

As discussed above, the ARDL approach estimates the cointegration is lying within the variables if they are stationary at the level I(0) or first difference I(1). However, it gives spurious estimates if any variable does not fit the criteria. To satisfy this condition we use Augmented (Dickey and Fuller, 1979) and PP Fisher methods to test the stationarity status of the variables, the results are reported in table 2.

Table-2. Stationarity Results

Variables	ADF		Phillip Perron		Status
	LD	FD	LD	FD	
	T-Stat	T-Stat	T-Stat	T-Stat	
FDx	0.6079	-10.4086***	-3.3163**	-6.1263***	I(1)
FMx	-0.1696	-3.0655*	-2.7942*	-4.0026**	
FIx	-6.3000***	-11.517***	-4.0542***	-5.9402***	I(0)
LGDP	2.4909	-3.5885**	2.0505	-3.5885**	I(1)
LIFDI	-3.1317**	-2.8146**	-4.7366***	-5.3745***	I(0)
LInno	2.2093	-4.3843***	2.0603	-4.3848***	I(1)
FMAx	-0.3818	-5.8051***	-0.3011	-5.8051***	I(0)
FMDx	0.8520	-3.8234***	-0.5239	-6.9082***	I(1)
FMEx	-5.0628***	-10.012***	-6.6341***	-5.8942***	I(0)
FIAx	1.096553	-3.307966*	1.795001	-3.215178*	I(1)
FIDx	-3.7543***	-6.6350***	-2.8006*	-6.6350***	I(0)
FIEx	-17.489***	-23.805***	-6.6701***	-5.6723***	I(0)

- **Source:** Authors' Calculation.
- The figures indicate t values of unit root test. LD means at the level, and FD implies at first difference ***, **, and * indicates the rejection of the null hypothesis of a unit root at 1%, 5% and 10% level of significance.

Although the short and long-run relationship is evident from the above estimation, yet this is utmost important to identify the explicit directions of the causality as a base for the decision makers to formulate appropriate policies. The ARDL approach to cointegration investigates the relationships amongst the variables without signaling the direction of the relationships (Boutabba, 2014). Therefore, we employ Granger causality approach (Engle and Granger, 1987) to detect the causal relationship among the underlying variables, which is a traditional way to find relationship directions for time series (Walker and Calcagno, 2013). We apply vector error correction model (VECM) to identify the short and long run relationship (Ben Jebli and Ben Youssef, 2017) amongst the variables.

4. EMPIRICAL RESULTS

The empirical results of the study are discussed in this section.

4.1. Unit Root Test

As shown in table 1, the LIFDI is found stationary at the level I(0), while the FDx, LInno, and LGDP become stationary at first difference I(1). Therefore the application of ARDL bounds test is best suitable in a situation when there is mixed integration order [I(0) and I(1)], and none of the parameters is stationary ar 2nd difference (Boutabba, 2014).

4.2. ARDL Bounds Test and Long-Run Dynamics

ARDL bounds testing approach is sensitive to the lag-length, hence, after determining the optimal lags, we perform ARDL bounds test to cointegration and table 3 reveals the outcome based on F-statistics. The variables are considered cointegrated in long-run when computed F-statistics crosses upper bound. The F-Statistics (17.38) in table 4 is much higher than the upper bounds at 1%, 5% and 10% level of significance, implies that the variable under consideration is cointegrated in long-run for the primary model. We reshape this model to see the cointegration amongst variables in each separate case transposing the status of independent variables and found the long-run association in each case at various significance level.

Table-3. ARDL Bound Testing to Co-integration

Estimation Model	Lag length	F-Stat.	Remarks	Co-integration
$LGDP_t = f(FDx_t, LIFDI_t, LInno_t)$	1, 2, 2, 1	15.83692	Conclusive at 1% Significance	Yes
$FDx_t = f(LGDP_t, LIFDI_t, LInno_t)$	1, 0, 0, 0	3.639841	Conclusive at 10% Significance	Yes
$LIFDI_t = f(FDx_t, LGDP_t, LInno_t)$	1, 1, 0, 0	8.720813	Conclusive at 1% Significance	Yes
$LInno_t = f(FDx_t, LIFDI_t, LGDP_t)$	1, 1, 1, 2	7.423012	Conclusive at 1% Significance	Yes
Critical Values				
Level of Significance	Lower bound I(0)		Upper bound I(1)	
10% Level	2.72		3.77	
5% Level	3.23		4.35	
2.5% level	3.69		4.89	
1% Level	4.29		5.61	

Source: Authors' Calculation.

Our analysis, based on 1980 to 2014 time series data from Chinese economy, found a long run association among Financial Deepening, Foreign Direct Investment, Innovation and real sector economy in case of China using ARDL model. The long-run coefficients are reported in table 4. The table shows that coefficients are significant and in the right direction as expected. When the log of annual GDP in current prices (LGDP) is the dependent variable, then the Financial Deepening Index is positive and significant at 1% level of significance. It bears the positive impact of financial deepening on the GDP of the country and means that if the financial development index

is raised by 1 unit, the GDP of China can be expected to grow by 1.36% per year in the long run. The result creates a positive sense to deepen the financial sector of China. This cointegration result is consistent to the arguments of Levine (2003); Anwar and Sun (2011) and the findings of Fang and Jiang (2014); Hamdi *et al.* (2014); Jahfer and Inoue (2014); Tan *et al.* (2017). China should also look into the inward foreign direct investment-friendly policies because as per our investigation results annual foreign direct investment inflows (LIFDI) can also raise the GDP by 0.22% through a 1% increase in FDI inflow in the long run, as the coefficient of LIFDI is positive and significant at 1% level of significance (Sun and Parikh, 2001; Makun, 2017). The current study also identified that Chinese innovation could contribute to the GDP of the country to a greater extent than the inflow of FDI which is an inconsistency to the findings of Wu (2011) and the arguments of Zhang (2017). As per our results, the coefficient of LInno variable is positive and significant which means that a 1% rise in innovativeness can contribute to the GDP of the country by 0.40% annually in the long run.

Table-4. Long run relationship

Dependent Variable: LGDP			
Regressor	**Coefficient**	**Std. Error**	**T Value**
FDx	1.362255***	0.342765	3.974314
LIFDI	0.225916***	0.025849	8.739922
LInno	0.403302***	0.044537	9.055493
C	7.453563***	0.203311	36.660821

Source: Authors' Calculation.
*** denotes the rejection of the null hypothesis at 1% level of significance.

4.3. Short-Run Dynamics

Table 5 reports the results of short-run dynamics. The results show that the short-run dynamics of financial deepening, inflow of FDI and innovation all are positive but statistically insignificant. That is the independent variables of our model have a positive but insignificant impact on the dependent variable, GDP in the case of China. The lagged error correction term is -0.609145 which is significant at 1% level of significance. This further evidence us the stable and long-run association amongst the variables. It also represents the speed of adjustment from short run to the long run equilibrium. According to the lagged error correction term, a deviation from the long run equilibrium level of GDP in one year will be corrected by almost 61% in the following year. In other words, the system will recover any disturbance in the short run towards long-run equilibrium in less than two following consecutive years.

Table-5. Short-Run Dynamics

Regressors	**Coefficient**	**Std. Error**	**T-value**
ΔFDx	0.102839	0.171523	0.599565
ΔFDx(-1)	-0.39883*	0.196234	-2.03241
ΔLIFDI	0.007701	0.054824	0.140467
ΔLIFDI(-1)	-0.21345***	0.064107	-3.32954
Δ LInno	0.027689	0.08433	0.328344
CointEq(-1)	-0.60915***	0.102875	-5.9212

Source: Authors' Calculation.
***,* denotes the rejection of the null hypothesis at 1% and 10% level of significance.

4.4. Diagnostic and Stability Analysis

We conduct diagnostic and stability test to assure the reliability and perfection of our model. The diagnostic test results are reported in table 6. The normality of residual term is confirmed by the Jarque-Bera test. We also found our model to free from serial correlation confirmed by Breusch-Godfrey LM test. The correlogram of squared residuals (figure 3) also proves the freeness of the model from serial correlation. The Breusch-Pagan-Godfrey and Harvey tests are evidence of the absence of white noise heteroscedasticity in the model. The cumulative sum

(CUSUM) and the cumulative sum of squares (CUSUMsq) graphs are plotted in figure 1 and figure 2. The graphs of CUSUM and CUSUMsq indicates that the relevant statistics are within the bounds in 5% level of significance. It reveals that the error correction coefficients are stable that means our model is stable and can be used for drawing thoughtful comments on the variables. The Ramsey RESET test also confirms the stability of the model.

Table-6. Diagnostics Test

	F Statistics	Obs. R-squared	Scaled Explained SS	Other coefficients
Heteroscedasticity Test				
Breusch-Pagan-Godfrey	0.847833 (0.5837)	8.309436 (0.5033)	4.308416 (0.8900)	
Harvey	1.295994 (0.3016)	11.03102 (0.2736)	19.17759 (0.0237)	
Serial Correlation test				
Breusch-Godfrey LM Test	0.002638 (0.9596)	0.004249 (0.9480)		
Normality Test				
Jarque-Bera Test				0.210126 (0.900268)
Adjusted R^2				0.751300
Ramsey RESET				
t-statistic				0.221207 (0.8274)
F-statistic	0.048933 (0.8274)			
CUSUM				Stable
CUSUM Sq.				Stable

Note: The figures in the parenthesis represents p-value of the statistics.
Source: Authors' calculation using eviews 9

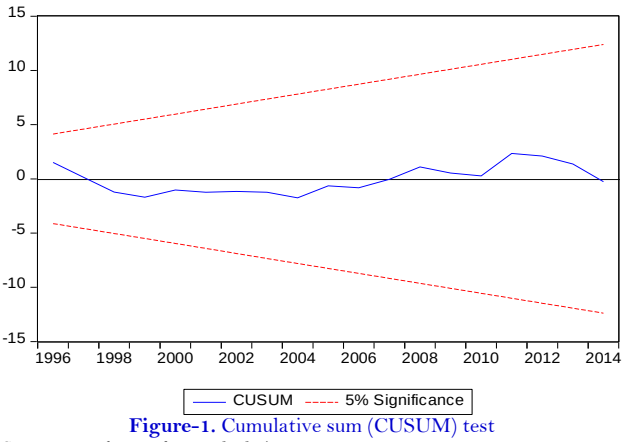

Figure-1. Cumulative sum (CUSUM) test
Source: Based on authors' calculation.

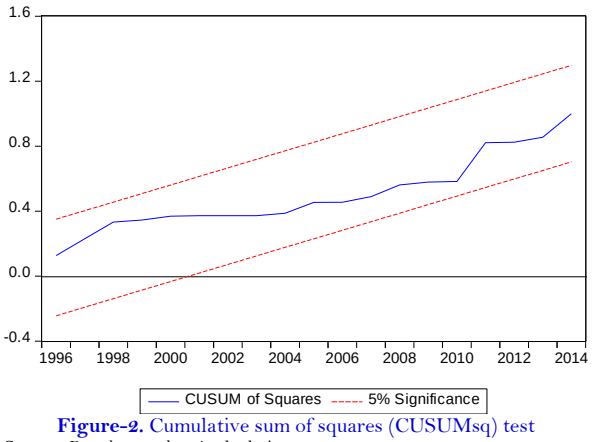

Figure-2. Cumulative sum of squares (CUSUMsq) test
Source: Based on authors' calculation.

4.5. Granger Causality Results

Despite the fact that cointegration analyses as importantly help investigators by being a decision tool the find that existing association or the prospective cointegration of variables, it lacks in decision assistance regarding the direction of the causality of the variables under study. The VECM Granger causality test as suggested by Engle and Granger (1987) cover the gap and uncover the relational direction. Using the standard procedure, the variable in the current study is analysed to find the direction and findings are presented in table 8. As can be noted from the table, that the lagged error term or ECT-1 is found to be in a negative sign and statistically significant at 1% level when the gross domestic product variable is used as dependent variable. It means that finance depth of the economy, level of direct foreign investment inflow and innovation Granger-Cause the real growth in the long run. This implies that any change in Chinese real growth responds rapidly to any change in the long run equilibrium (or

short run disequilibrium). However, when financial deepening, foreign direct investment inflow and innovation is used as dependent variables the significance and the negative sign in case of foreign direct investment disappeared is a clear indication of no long term causality relationship from the independent variables to the dependent variables. In the short run, the unidirectional causality from financial deepening and foreign direct investment inflows to GDP is found at 5% and 1% level of significance. No other causal relation is found in the short run.

Table-7. Granger Causality Results

	Short run causality (F-stat)				**Long run causality**	**Joint Short and long-run causality (F-stat)**			
Variable	*ΔLGDP*	*ΔFDx*	*ΔLIFDI*	*ΔLInno*	ECT_{-1} (coeff)	*ΔLGDP* &ECT	*ΔFDx* &ECT	*ΔLIFDI* &ECT	*ΔLInno* &ECT
ΔLGDP	------- (-----)	6.1302** (0.0215)	19.3654*** (0.0002)	1.9887 (0.1725)	-0.6008*** (0.0000)	------- (-----)	23.9317*** (0.0000)	20.9777*** (0.0000)	21.2249*** (0.0000)
ΔFDx	0.4247 (0.5213)	------- (-----)	0.3229 (0.5756)	0.7319 (0.4015)	-0.2237 (0.3375)	0.5630 (0.5775)	------- (-----)	0.5346 (0.5933)	0.8699 (0.4329)
ΔLIFDI	1.6107 (0.2177)	0.4924 (0.4902)	------- (-----)	0.4298 (0.5189)	0.0007 (0.9947)	0.8641 (0.4352)	0.4720 (0.6299)	------- (-----)	0.2150 (0.8082)
ΔLInno	0.0093 (0.9238)	0.2112 (0.6503)	0.1471 (0.7050)	------- (-----)	-0.1577 (0.1307)	1.3747 (0.2738)	1.5945 (0.2256)	4.6641** (0.0205)	------- (-----)

Note: Figures in parenthesis represent P value of the statistics.
***, ** denotes the rejection of the null hypothesis at 1% and 5% level of significance.
Source: Authors' calculation using eviews 9

5. ROBUSTNESS ANALYSIS

To make the study more reliable, we perform robustness analyses using each sub-index of financial development to verify the relationship. We have a more profound view when we consider the sub-indices of the financial market and financial institution for the analysis, namely financial access, depth and efficiency of both. The results are presented in table 8 from column 2 to 9. In most of the cases (except models using financial intuition sub-indices as a measure of financial deepening), the results show financial deepening, foreign direct investment and innovation have a positive impact on Chinese GDP. The models and methods are found to be statistically fit, stable and consistent with our prime ARDL model results regarding signs and significance. So the robustness of the empirical analyses is confirmed, and the initial ARDL model can be declared as statistically robust.

It has been observed form the results that financial depth impact on the economy is relatively low because the sub-indices of financial institution index namely financial institution access index, financial institution depth index and financial institution efficiency index is insignificant. To describe, financial institution depth and financial institution access indices have a negative impact while that of financial institution efficiency is positive, though all are insignificant. Most interestingly, although the sub-indices have an insignificant impact the aggregate index of financial institutions on Chinese economy is positive and significant. It means that the overall effect of financial intuition development is adding positive value to the real growth. It can be intuited from this result, as overall financial institution development upsurge financial development or financial depth and financial depth has a significant positive impact on real growth, more development of financial institutions regarding access, depth and efficiency can add positive value to be economy.

Table-8. Long run relationship with different financial deepening proxies while GDP is the dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FDx	1.3623***								
FMAx		0.8244*							
FMDx			0.4214***						
FMEx				0.3050**					
FIDx					-0.0572				
FIAx						-0.3748			
FIEx							0.6408		
FMx								0.6801***	
Fix									-5.9899**
LIFDI	0.2259***	0.2468***	0.1861***	0.2206***	0.3160***	0.2137***	0.2893***	0.2038***	0.1192**
LINNO	0.4033***	0.4525***	0.4619***	0.5491***	0.5020***	0.5323***	0.5339***	0.4627***	1.2375***
Constant	7.4536***	7.5006***	8.0794***	7.1638***	6.8234***	7.6320***	6.3407***	7.6901***	8.1658***
F-Stat Bound	15.8369	12.9317	10.3921	12.8304	13.6002	10.9549	11.9252	15.4238	6.3941
Lag length	1,2,2,1	1,2,2,1	1,2,2,2	1,1,2,1	1,2,2,1	1,1,2,1	1,1,2,1	1,2,2,1	3,0,2,3
Adj. R^2	0.6989	0.6272	0.6049	0.6174	0.7328	0.5828	0.5937	0.6958	0.4889
D-W	1.8815	1.7585	1.6189	1.8257	1.7893	1.9190	1.6978	1.9542	2.0047
HK F	0.8478	1.0287	1.4481	0.7265	0.6646	0.4434	0.7260	0.7815	1.3777
Serial Corr	0.0042	0.2860	0.2556	0.0549	0.2764	0.0416	0.4875	0.0137	3.0163
Serial Corr F	0.0026	0.1793	0.1474	0.0361	0.1732	0.0273	0.3249	0.0085	0.5031
J.B.	0.2101	3.0297	0.3565	1.2566	1.2249	1.2545	0.5182	1.2658	1.7955

Source: Authors' Calculation.

6. CONCLUDING REMARKS AND POLICY IMPLICATIONS

Financial depth is required in an economy to channelise the capital flows among households and other sectors of the economy. If the financial system is stable and developed the foreign and domestic capital holders are attracted to invest in the economy that brings cyclical financing and development. This also brings efficiency competition in production and service sector. To meet up the changing competitive demand of the economy due to financial development, domestic and foreign investment the market is expected to face an expansion challenge. Innovation and imitation of material, methods and organisation can make the media to meet up the demand and challenges. A technology and innovation spillover comes with foreign direct investment. When the MNEs invests into the host country, they transfer their technology into the economy. This also brings competition for the local firms, and they feel the emergence of innovation to cope up with the competition. Some firms may also imitate the competitors' technology to exist in the business.

This paper investigates the said relational existence between financial deepening, foreign direct investment, innovation and economic growth in a long and short run in case of China for the period of 1980 to 2014. The study also looks into the direction of the relations with VECM Granger causality analysis. China, the initiator of 'One Belt One Road' program, is chosen for this study as the country is considered as an upcoming economic superpower of the world. The country achieved upper than 10% growth in the economy for an extended period of more than three decades since the initiation of the economic reform program in 1979. However, recently after 2014, Chines GDP growth (the most common economic indicator) has been shrunk to around 8.5% per annum. This leads the researchers a context to study the relationship of the said instruments and to find policy implications. For analysing the said relationship, we followed a two-step process: at the beginning, we examine the existence of cointegration among the variables using ARDL bounds testing approach. Moreover, then we employ VECM Granger causality to trace the relational direction in case of the OBOR leader. After checking the relationship and the direction of it, we check the fitness and stability of our estimated model through CUSUM and CUSUMsq tests. Beyond this, we also checked the robustness of our empirical model using different strategies. The first robustness strategy is to use two different proxies namely financial market depth index (FMDx) and Financial institution depth index (FIDx). The

other strategy is to re-estimate our model using different models namely OLS, Fully Modified OLS, Dynamic OLS and Canonical Cointegration Regression (CCR).

The empirical results suggest that Chinese economy is positively and significantly associated with Financial deepening, foreign direct investment and innovation performance in the long run. Although found insignificant, the variables affect real growth positively in the short run as well. The results give us the insight that China can be benefited more from the further deepening of the financial system. There are several reasons in behind the suggestion. Firstly, along with other unobserved forces, a more rooted financial system will attract more domestic and foreign capital deployment into the economy which can lead to generating more finance for the fund seekers to invest in their projects. Secondly, the deepening policies will make the Chinese financial intermediaries smooth moving, capable of supplying adequate capital to the economy and work as a trust point to the potential foreign investors and thus finance deepening policy will also function as an additional force to attract foreign capital. Thirdly, the foreign direct investment is expected carry improved mechanisms and technologies from home countries. As the mechanisms and technologies will be used in China, slowly the Chinese firms and people will adapt those. In many cases, the improved tools and techniques will be adapted and imitated to improve the home technologies. Fourthly, as the finance- FDI loop enhances the competitive environment of the host economy, the intensity of competition will lead them to become more innovative, concentrate on research and development and facilitate innovations regarding technologies, techniques and productivity. Fifthly, the more developed financial sector, more deployed foreign and domestic capital, innovative characteristics of the firms due to competition will jointly derive the economy to have a further jump, i.e. GDP achievement can be expected in the long-run.

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