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THE INFLUENCE OF INNOVATION TOWARDS ECONOMIC GROWTH IN CHINA: EVIDENCE FROM THE ARDL MODEL

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Abstract: This study investigates the causal association between innovation and economic growth in China from 1993 to 2019. Using the Autoregressive Distributed Lag Model (ARDL) and Error Correction Model (ECM) both found long run, positive and significant association with economic growth. This study also found a positive short run relationship between Trademarks applications, R&D expenditure, Scientific & technical journal articles, and Patent applications with economic growth. Using the Average Impact Index Model, the Trademark application was found to be the most impactful indicator of innovation to the economic growth in China during the given period, if we increase one percent of a trademark's application, it can have enhanced 52% economic growth in China. The Error correction term ECT (-1) satisfied both conditions: the coefficient was found negative (-1.8311) and significant (0.0003) at the 5% level. While the speed of adjustment has recorded 183% to the long-run equilibrium. Like China's economic reform, Government should launch a vision to reform transitioning from "Made in China" to Innovated in China. To improve and enhance economic growth more through innovation. it is strongly recommended for one's economic growth policy because the distribution and inconsistency in innovation capability can affect regional economic growth in China.

Keywords: Innovation, Economic Growth, Ardl Model

1. Introduction

Innovation activities have a protracted cycle, an unexpected and unknown duration, and a high failure rate (Egorova & Dubkov 2016). (Cockburn, Henderson, & Stern 2018) innovation is not only the creation of new ideas and new devices or methods, but it also represents the new and undercover ways of a process to do things easily and be reliable. The creative process is not a piece of cake it is not always simple, but when a company or country adopts innovative culture then it has easily grown. Over several years, the most hotly debated topic of innovation reviewed by a circle of many different researchers. It brings attention and interest worldwide for the betterment and improving their core economic indicators as well as a level of competitiveness. Innovation is becoming a key driver and core element of economic development and economic growth. The traditional global economies are moving out of agricultural and labor-based economies and enter to a new era of innovative societies. Innovation has emerged critical factor and ensuring the sustainability of both developing and developed countries (Tew, Lee, Lau, Hoh, & Woon 2017). Innovations not only promote the development of these countries but are also a critical indicator for emerging economies like China, India, and Malaysia. China's reform and initiative from 1978 to the present enjoyed the last 4 decades of high economic growth due to its great leader-

ship visions, strategies, theories, policies, and most important their innovation strategies, inward FDI, and R & D. According to a report made by President Hu Jintao at the 18th National Congress Party on November 8, 2012, China proclaimed its intention to move to an innovation-driven economy. China's economic reforms of 35 years lifted poverty, dramatically decrease unemployment, and raised the economy to the second position in the world. Innovation is one of the important elements for economic growth, should not treat only as an economic element but also as a key issue for policymakers, and should consider a positive effect (Yu, Hong, Wu, & Zhao 2013).

Currently, economic growth theories reveal that innovation is another primary catalyst for the economic growth of a country such as a new range of innovative products and a new business model. We found most of the researchers conducted studied and devoted enormous energy to finding out how the innovation of the countries are affecting economic growth. Their results are mainly based on the collection of data source and their main target on pairwise relationships. In this scenario, it leaves a question that which indicator of innovation in a given data set is the most impactful one which influences economic growth in China. This paper examines the effect of innovation on economic growth in China using a time series analysis from 1993 to 2019. In this paper, we are going to find out the real economic growth of China through specific samples such as R&D expenditure, trademark applications, FDI, patent applications, scientific and technological journal articles, and exports. In addition, to find out the most impactful indicator influencing economic growth in China. The importance of this paper is to see how economic growth can improve and be enhanced by innovation to promote economic policy for the economy. This research could be a major contributor to economic policy, changing and upgrading the innovation system, and further, generate knowledge for the researcher. Paper results have proven significant and more upgrading can do to enhance further economic growth in the country. The paper is organized as follows. Section 2 provided recent and relevant literature reviews. Section 3 provided the research methodology, model specification, types, and source of data. Section 4 presented results and interpretations. Section, 5 provided discussions while the final Section presented the conclusion of the research and also provide policy recommendations.

2 Literature Review

Relationship Between Innovation and Economic Growth

Many researchers outside China and within the country have been intrigued by the growing Chinese economy and the importance of innovation. China became a success tale that lasted from 1978 to 2021 over the last four decades. Due to this reason innovation in China, become important to promote economic growth. (Gerguri & Ramadani 2010) found that innovation is the best way for the organization of a company or firm to achieve a competitive advantage over two existing rivals and it is also a fundamental indicator of the sustainable development of a country's economic growth. There is a different aspect of innovation such as the management system of innovation and market protection that can enhance the role of innovation further in economic growth. (Jie Wu, Zhuo, & Wu 2017) argues that the national innovation system of China has significantly promoted and enhanced economic growth and social entrepreneurial action in rural sectors. (Hasan & Tucci 2010) conducted a study on a sample of 58 countries from 1980 to 2003 and found that the quantity of R&D expenditure and quality of innovation ratio of patents influences economic growth. Many studies conducted on the causality effect of innovation and economic growth such as (Abazi-Alili, Ramadani, & Gerguri-Rashiti 2014) according to their studies innovation cannot neglect as a key driver to helping firms for their productivity and production efficiency. This result is also supported by (Sachwald 2015) that innovation enhances and promotes productivity efficiency in the business field. He also suggests that in the innovation process research and development act is in crucial variable to generate knowledge and economic growth.

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Although, (John Wu 2015) argued that due to scientific research scientists and researchers invent new technology and create and explore new ideas and techniques which bring positive productivity growth and bring continuously positive relationship toward economic growth. Moreover, (Wang 2013) investigate the relationship between innovation and economic growth in Australia, Japan, and France. He found that there is a long run effect, and innovation can bring economic growth positively to these countries.

Many scholars, on the other hand, found uncertainty and unfavorable links between the innovation system and economic growth, for example (Terziovski & Guerrero 2014). The results show that the link between innovation and economic growth depends on factors. This relationship can be a large degree affected by some factors like innovation culture circumstances and types of innovation. To find out whether innovation can promote the economic growth of a country or not it is required deeply identified. (Vuckovic 2016) found out that there is no significant relationship between economic growth and innovation for the emerging markets within the period from the year 1991 to 2013. (Goyal, McCord, & Kapoor 2017) conducted a study on BRIC countries (Brazil, Russia, India, and China) and found out that making a better-informed decision and directly adopting new emerging technology can promote competition and economic development. This implies a country's need to grasp and support innovation activities to go along with this new mindset that could sustain competitive advantage and economic growth. Chinese policymakers are keen to observe to boost the role of innovation in economic development that the economy transformed into a knowledge-intensive economy where the dependency on the external market will be less. That is why China spends an enormous amount on research and development. A share of GDP in 2008 was spent from 0.71% to 1.5%. It is projected that by 2020 this figure will reach 2,5% (Schaaper, 2009).

Research and Development Relationship with Economic Growth

According to (Wei & Liu 2006) R&D activities have a favorable influence on productivity. (Grossman & Helpman 1991) describe the function of innovation as a growth engine and government plays an essential role in achieving the optimal level of innovation and R&D. (Ulku 2004) conducted a study on innovation for 20 OECD countries and 10 counties that were not OECD countries. Innovation has had a favorable influence on economic growth, which has driven both developed and emerging economies to a continuous rise in per capita GDP. This study used panel data analysis from the year 1981 to 1997 and sued GMM methodology. This study also revealed that only developed OECD countries can achieve high economic growth while using R&D expenditure. Furthermore, there is interdependency between these countries to ensure by using other country innovations for knowledge of each other innovations. (Pessoa 2007) conducted another study. He emphasized on the function of R&D spending and the relationship between innovation and economic growth in Sweden and Ireland. His findings indicate that there is no strong relationship between innovation and economic growth in both countries. Another study was conducted by (Petrariu, Bumbac, & Ciobanu 2013) in Central and the Eastern Europe States to find out the relationship between economic growth and innovation by using panel data set. He found out that economic development is based on R&D expenditure and it is the main key and supporting unit for innovation. His findings also support the fast-economic growth of Central and Eastern European countries of that timeframe but he said that economic growth is not because of the innovation process; innovation is a catchup process compared with the economic growth rate. Another study conducted by (Guloglu & Tekin 2012) and found a causal relationship between innovation, R&D, and economic growth in the case of high-income OECD countries using a panel vector autoregressive model under the GMM and fixed effect framework. This study support that there is a Granger causality relationship from R&D to innovation and from technological innovation to the economic growth

of OECD countries. No evidence discovered that economic expansion had a reverse effect on innovation. In the period from 1991 to 2005, Xu and Zhou worked on the connection between economic growth and state investment in R&D in China. This analysis identified a long-term balance between various types of public R&D spending and Chinese economic growth. (Zhi & Jizhong 2007).

Foreign Direct Investment and Economic Growth Relationship

Malaysian scholars (Law, Sarmidi, & Goh, 2020) used time series data from 1985 to 2016 to perform an empirical study on the impact of innovation on Malaysian economic growth. They found out that empirical result shows a significant positive impact of innovation on economic growth for Malaysia. The empirical study implies that there is a positive role of innovation in economic growth in terms of the interaction between institutional quality and the total patent grants and it reveals the indirect impact of foreign direct investment on research and development. They suggested with good skilled human capital, broader networking and institutional quality framework could ensure and promote economic growth. (Tan & Azman-Saini, 2017) used panel data set over the sample period from the year 2000 to 2011 on 61 countries that used the GMM framework that reflect a positive impact of foreign direct investment on domestic innovation. They found out that there is little direct impact of foreign direct investment on domestic research and development. This finding was incompatible with traditional knowledge. Evidence shows that competition is the only power and ability to effect foreign direct investment on domestic innovation activities of the countries. In addition, the innovation level is a critical economic determinant for growth and recently innovation has been strengthened by both globalization and advanced technology in information and communication, which create new forms of competition for innovative products and services. (Yang, 2006) conduct a study on Taiwan's economy that reflected there is a positive relationship between both domestic patenting and foreign discoveries and ideas with economic growth. This study confirmed that both innovations are important and promote the economic growth of Taiwan. On the other hand (Schneider, 2005) conducted a study on 47 developed and developing countries using panel data set. He found that foreign innovation and technology have a more optimal and significant impact on gross domestic product per capita and growth than domestic innovation and technology. This study also argued the role of foreign innovation and domestic innovation in a specific country, where time series analysis is more important and gives significant addressing than panel data analysis. (Ross, Zheng, & Prime 2016) conduct a study and provides some statistics for economic growth of all countries in the world from the year 2007 to 2014, The economy of China increased by 78%, while the economy of the United States only grew by 8% at the same time. Several studies suggest that foreign direct investment is the reason for Chinese economic growth and success. (Kheng, Sun, & Anwar 2017).

We identified in the literature most of the researchers conducted their studies on economic growth. However, their results are mainly depending upon the source of series and combination of the dataset while their main target is pairwise relationships. However, our study focused on particular indicators of innovation such as trademark applications, patent applications, and scientific and technical journal articles to show separately the relationship to economic growth. No researcher found the most impactful indicator of innovation to economic growth. As a result, we are eager to demonstrate and determine which indicator, other than GDP, is the most relevant and impactful on economic growth. Therefore, it gave us a close look and motivation to conduct and contribute by identifying results in China from the year 1993 to 2019. This research could give us insight and a clearer comparison through this. The outcomes of continuous research and innovation can improve economic growth, policy maker always moves towards and give priority to innovation which promotes economic growth.

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3 Research Methodology

In this section econometrics framework and techniques has introduced. Time series datasets have been taken from the world development indicator (WDI). The following variables are employed in our econometric model to develop a rational behavior between economic growth and innovation. According to (Shahbaz 2012) order to organize data in the logarithms form enhanced data measurement and standardize the result accuracy. The following is our proposed model:

$$ln\,GDP = ln\,FDI + ln\,RD + ln\,EXP + ln\,PAT + ln\,STJ + ln\,TRM \quad (1)$$

Equation (1) represents, GDP (GDP growth annual), foreign direct investment net inflow (FDI), Research & development expenditure (RD), Export of goods & services (EX), Patent application, resident (PAT), Scientific & technical journal articles (STJ), and trademarks applications, total (TRM). Using ARDL (Auto-regressive distributed lag model) approach for our study equation (1) can be written in ARDL form as,

$$\Delta LGDP_t = \alpha_0 + \sum_{j=1}^{p} \beta_j \Delta LGDP_{t-j} + \sum_{j=1}^{k} \varphi_j \Delta LEX_{t-j} + \sum_{j=1}^{k} \delta_j \Delta LFDI_{t-j} + \sum_{j=1}^{k} \rho_j \Delta LPAT_{t-j} + \sum_{j=1}^{k} \theta_j \Delta LRD_{t-j} + \sum_{j=1}^{k} \mu_j \Delta LSTJ_{t-j} + \sum_{j=1}^{k} \lambda_j \Delta LTRM_{t-j} + \gamma_1 LGDP_{t-1} + \gamma_2 LEX_{t-1} + \gamma_3 LFDI_{t-1} + \gamma_4 LPAT_{t-1} + \gamma_5 LRD_{t-1} + \gamma_6 LSTJ_{t-1} + \gamma_7 LTRM_{t-1} + u_t \quad (2)$$

Where, ΔLGDP, ΔLEX, ΔLFDI, ΔLPAT, ΔLRD, ΔLSTJ, and ΔLTRM represent changes in the natural lag of Gross domestic product, export of goods and services, foreign direct investment, patent application, research and development expenditure, scientific and technical articles, and trademarks applications respectively. α_0 is intercepted, k is the lag operator, and u_t is the error term or white noise. Moreover, β_j, φ_j, δ_j, ρ_j, θ_j, μ_j, λ_j determines the short run dynamism. While the γ_1, γ_2, γ_3, γ_4, γ_5, γ_6, and γ_7, show long run parameters or coefficients.

Time Series Unit Root and Co-integration Test

We used the unit root test to observe stationary data, to check stationarity in the dataset we employed the Augmented Dickey-Fuller (ADF) test to avoid spurious regression. It is essential to find out stationary data for the research model before applying any other statistical test (Diks & Panchenko 2006). According to (Quattara 2004) we used ARDL when variables are stationary on a level and some on the first difference and non-on the second difference. Auto-Regressive Lag Model (ARDL) contains the lagged values of the dependent variable and the current lagged value of the explanatory variables.

ARDL Bound/Co-integration Test

To establish and find out long run association we used cointegration. It is the more desirable test where it is statistical properties as described in Gauss Markov theorem that the (OLS) estimator is unbiased and has minimum variance (Greene 2002). In the cointegration test, we used the bound test where the calculated F statistic value compared to the critical value of (Pesaran, Shin, & Smith 2001) tabulated. If the F statistic calculated value is greater than an upper bound critical value of the tabulated then we rejected the null hypothesis, which means there is cointegration exists amongst the variables and vice versa. Moreover, if F statistics calculated value occurs between the upper and lowers bound critical value then the result is inconclusive (Dube & Zhou 2013). If there is a presence of cointegration amongst variables then it suggests an error correction model.

Error Correction Model

In the error correction model, we have the combination of short run form and error term. The error term should be negative and significant. A negative value can determine how much time take short run shocks to adjust in the long run. The study proposed model could write in ECM form as,

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$$\Delta LGDP_t = \alpha_0 + \sum_{j=1}^{p} \beta_j \Delta LGDP_{t-j} + \sum_{j=1}^{k} \varphi_j \Delta LEP_{t-j} + \sum_{j=1}^{k} \delta_j \Delta LFDI_{t-j} + \sum_{j=1}^{k} \rho_j \Delta LPAT_{t-j} + \sum_{j=1}^{k} \theta_j \ \Delta LRD_{t-j} + \sum_{j=1}^{k} \mu_j \Delta LSTJ_{t-j} + \sum_{j=1}^{k} \lambda_j \Delta LTRM_{t-j} + \lambda ECT_{t-1} + u_t \quad (3)$$

Equation (3) describes a short run as well as error correction term (ECT) in the model and it is used for short run shocks adjustment, that in which rate the economy will adjust these short run shocks in the long run. While λ represents the coefficient of error term that needed to be negative and significant. Moreover, β_j, φ_j, δ_j, ρ_j, ρ_j, θ_j, μ_j, λ_j determines the short run dynamism of the model.

Average Impact Index Model

This model develops for the identification of the most impactful indicator for innovation in the economic growth of China; to fulfill one of our main objectives of the study we conducted an average-impact-index model. In this model, we just took the coefficient of each variable and multiply by their mean value, and then divided it by the total number of observations for each variable (Tew et al. 2017). The Average impact index model can write the form as,

$$\gamma_\rho = \frac{\sum|\beta_v \mu_v|}{n_v} \quad (4)$$

Equation (4) states, that γ_ρ is the average impact index for each variable, β_v is the coefficient of each variable, μ_v is the mean value of each variable, and n_v number of observations in those particular variables.

4. Results And Interpretations

Descriptive Analysis

We employed descriptive analysis on raw data of our dataset, in the given Table 1 shows high means of variables that give larger magnitudes. Skewness shows all variables are symmetrical normal distribution except PAT the value expected to be zero. The kurtosis value for all variables is below 3, meaning that all variables are platykurtic. Moreover, the Jarque Bera test shows differences between Skewness and Kurtosis of each variable. The probability value of Jarque Bera is greater than 5% for all variables except PAT. It means that all variables are normally distributed except PAT.

Table 1. Descriptive Statistics

	EX	FDI	GDP	PAT	RD	STJ	TRM
Mean	23.598	3.5543	9.3696	369631.3	1.3458	215353.2	909401.1
Median	21.354	3.6091	9.2307	122318.0	1.3685	189949.5	667025.0
Max	36.035	6.1868	14.231	1393815.	2.1856	528263.3	2104411.
Min	16.702	1.0863	6.1085	10011.00	0.3826	28363.05	132222.0
Std. Dev.	5.8474	1.2997	2.2290	471095.5	0.6163	170052.8	757516.0
Skewness	0.8431	-0.0713	0.6650	1.115663	-0.1002	0.371930	0.515666
Kurtosis	2.5032	2.6152	2.6047	2.718336	1.6353	1.711614	1.630649
Jarque-Bera	3.4763	0.1894	2.1661	5.690415	2.1402	2.489925	3.306112
Probability	0.1758	0.9096	0.3385	0.0581	0.3429	0.2879	0.1914

Time Series Test

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To run our econometric models for the time series dataset we are using EViews packages which is the best package for time series. After conducting descriptive analysis, we convert all data into natural logarithms to make possible accurate outcomes.

Unit Root Test

It has been conducted two different tests to ensure the stationarity of data. In Table 2 only the R&D variable is stationary on a level at ADF and PP test and all other variables are stationary on the first difference in both tests. If the p-value is less than 5%, we reject the null hypothesis. When variables are stationary and cointegrated with different order such as I (0) and I (1) then we used the ARDL model.

Table 2. Unit Root Test Results

Variables	ADF Level	ADF 1st difference	PP Level	PP 1st difference
LNGDP	0.1232	0.0002	0.1264	0.0002
LNEXP	0.7073	0.0004	0.6927	0.0004
LNFDI	0.0813	0.0000	0.0669	0.0000
LNRD	0.0049	0.0439	0.0000	0.0202
LNSTJ	0.8549	0.0556	0.8833	0.0520
LNTRM	0.4507	0.0411	0.7983	0.0423
LNPAT	0.2995	0.0221	0.2503	0.0293

VAR Lag Order Selection Criteria

Before conducting the ARDL model, we need to identify optimal lag selection. Table 3 used VAR lag selection criteria where the endogenous variable LNGDP and exogenous are (LNEX, LNFDI, LNRD, LNSTJ, LNTRM, LNPAT). For the study, we followed AIC (Akaike info criterion) lag 2 is the optimal lag for the ARDL model.

The Table 4 ARDL model Bound test showed that there is long run cointegration amongst variables. Bound test F-statistics value is 3.32147 greater than upper bound and lower bound value at 5% significant level 3.28, 2.27 respectively. The bound test identified that amongst variables have an association in the long run. Trademarks application and Export have the strongest relationship with economic growth while Research and Development expenditure and Scientific & technical articles and Patent application have significant relation with economic growth.

ARDL Error Correction Model (ECM)

Table 5 showed patent applications, R&D, and trademark applications have a positive and significant relationship with economic growth. In table ARDL error correction model where ECT (-1) satisfied both conditions, has a negative coefficient (-1.8311) and its corresponding probability is strongly significant which represents that the exogenous shocks will be adjusted at the speed of 183% in the long run. This has also another meaning that previous year periods deviation from long run equilibrium corrected in the current periods at adjustment with 183% of speed. Eventually, the whole system can get back to long run equilibrium at the rate of 183%. R-squared is 0.9096 the whole model is stable and good to fit.

Correlation test, Heteroskedasticity, and Stability test to confirm about the strength of our proposed model. This study found there is no serial correlation and heteroskedasticity,

Table 3. Optimal Lag Length Criterion

Lag	Logl	LR	FPE	AIC	SC	HQ
0	65.41081	NA	2.21e-11	-4.672865	-4.331579	-4.578207
1	260.7981	265.7267*	2.13e-16	-16.38385	-13.65356*	-15.62658
2	330.9550	56.12552	1.23e-16*	-18.07640*	-12.95712	-16.65653*

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Table 4. ARDL F-Bound test & Long run form

F-Bound Test	Null Hypothesis: No levels relationship			
Test Statistics	Value	Signif	I(0)	I(1)
F-Statistics	3.32147	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99

Table 5 ARDL Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP (-1))	0.946351	0.249338	3.795451	0.0090
D(LNFDI)	-0.054851	0.081686	-0.671486	0.5269
D(LNEX)	-0.449830	0.250987	-1.792249	0.1233
D(LNPAT)	-0.440276	0.119647	-3.679795	0.0103
D(LNPAT (-1))	0.455362	0.158239	2.877676	0.0281
D(LNRD)	0.055383	0.305577	0.181240	0.8621
D(LNRD (-1))	0.974122	0.281660	3.458503	0.0135
D(LNSTJ)	-0.522383	0.180654	-2.891615	0.0276
D(LNSTJ (-1))	-1.141478	0.230343	-4.955564	0.0026
D(LNTRM)	0.526917	0.123324	4.272623	0.0052
D(LNTRM (-1))	-0.536031	0.137907	-3.886909	0.0081
ECT (-1) *	-1.831174	0.241336	-7.587640	0.0003
R-squared	0.909622	Mean dependent var		0.030370

both test probability value is more than 5% that representing acceptance of the null hypothesis. Moreover, in the stability test we employed the CUSUM test, which shows a model curve lying between border lines at a 5% significant level. It represents the model is accurate and should be applied for further policy recommendations.

Average Impact Index

For the average impact index, we have to take the mean of each variable and multiply it by their coefficient to calculate the average impact index which will be used to identify how and which one is the most impactful indicator of the economic growth in China. To estimate better, we should normalize the average impact index by using absolute value.

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Table 6. Average Impact index model result

Variables	Mean (μ_v)	Coefficient (β_v)	$\beta_v . \mu_v$	Average Impact Index (γ_ρ)
LNGDP	2.211415	0.946351	3.157766	0.1169
LNTRM	13.27807	0.526917	13.804987	0.5112
LNEX	3.133953	-0.449830	2.684123	0.0994
LNRD	0.167203	0.055383	0.222586	0.0082
LNFDI	1.187812	-0.054851	1.132961	0.0419
LNPAT	11.64694	-0.440276	11.206664	0.4150
LNSTJ	11.84143	-0.522383	11.319047	0.4192

Eventually, in table 6 the average impact index has formed and the result showed that Trademarks application (TRM) 0.5112 is the most impactful variable of innovation towards economic growth of China then followed by Scientific & research articles (STJ) 0.4192, and Patent Applications (PAT) 0.4150. It means that variables that have been taken for innovation have a positive and significant impact on the economic growth of China from 1993 to 2019.

5 Discussions

Our result revealed that innovation increases economic growth in China similar to results found by (Wang 2013) for Australia, Japan, and France. He found that these countries have a long run effect between innovation and economic growth, and innovation can bring economic growth positively to these countries. (Law, Sarmidi, & Goh 2020) also supported similar results for Malaysia using time series data from1985 from 2016 and found a significant positive impact of innovation on economic growth in Malaysia. Many studies supported our hypothesis that there is a positive and significant relationship between economic growth and innovation such as (John Wu 2015), (Ulku 2004), (Sachwald 2015). While On the other hand, many researchers contradict our results such as (Terziovski & Guerrero 2014) who found ambiguity and insignificant relation between innovation and economic growth. To find out whether innovation promotes economic growth or not. Another study conducted by (Vuckovic 2016) found insignificant relation between economic growth and innovation for the emerging markets within the period from the year 1991 to 2013. In addition, this paper also found R&D long run positive, and (Petrariu, Bumbac, & Ciobanu 2013) found a significant relationship with economic growth, with a similar result for the Central and Eastern European Countries. They found that economic development is based on R&D expenditure and it is the main key and supporting unit for innovation. In another study found the same result conducted by (Pessoa 2007) on Sweden and Ireland and found a strong linkage between expenditure on R&D and the relation between innovation and economic growth.

Our finding also revealed the impactful indicator for innovation in the given dataset for Chinese economic growth is the trademark we found their strong and significant relationship with economic growth. While, in the long run, trademarks applications and scientific & technical journal articles, R&D expenditure, and exports, have also positive and significant relationships with economic growth. The error correction term in Table 5 ECT (-1.831174) shows a negative coefficient and its corresponding probability value (0.0003) which also reflect convergence in the long

run after short run shocks and the speed of adjustment is 183% to the long run equilibrium.

6 Conclusion and Policy Implications

Our study explores the effect of innovation on the economic growth of China over the period 1993 to 2019. This paper finds out a significant and positive relationship between economic growth and innovation. It has been used unit root test to determine the integration order of variables; results revealed that there is mixed integration order in the dataset. In addition, the cointegration ARDL test applied to reflect long associations between variables, we found there is a long run relationship between economic growth, trademarks, R&D scientific and technical journal articles, and exports. Then we used the error correction model to establish the short run and long run relationships between economic growth and innovation. In the economic literature, there are many pieces of research on innovation and its impact on economic growth. However, their results are mainly depending upon the source of series and combination of datasets while their main target was pairwise relationships. While, our study focused on particular indicators of innovation such as trademark applications, patent applications, and scientific and technical journal articles to show separately relationships to economic growth, second there is no such research that found the most impactful indicator of innovation to economic growth. Therefore, we are keen to prove and identify which indicator is the most significant and impactful to economic growth. The results show that the most impactful indicator of economic growth is trademark applications. This paper also conducted the diagnostic test to show stability in the econometric model, stability test, LM serial correlation and Heteroscedasticity applied for our proposed model. Based on the results the following important policy implication recommended.

In the first place, the government should launch a vision to reform transitioning from “Made in China” to Innovated in China. Government should take seriously the distribution of innovation in China because inconsistency in innovation capability can affect regional economic growth. Secondly, the government should design the most favorable policy that provides incentives and subsidies to private enterprises, and firms and encourage them to compete in different high tech to achieve high economic growth. It suggested providing incentives and free access to innovation discoveries can attract more investors. Thirdly, the government should make a clear and strict policy for property and patent rights to encourage businesses and investors’ confidence to run businesses without any hesitation from any uncertain situation. Finally, it is recommended to the government continue investing in the R&D sector, particularly in scientific and technical development.

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