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DOES INNOVATION HAVE AN IMPACT ON ECONOMIC POLICY UNCERTAINTY? EVIDENCE FROM THE EMERGING MARKETS

Paul Usman[1]; Kulo Issah Ibn Ali[2], Zafar Iqbal[3], Shafqat Nadeem[4], Irtaza Ishtiaq[5]

[1]*School of Public Finance and Public administration, Jiangxi University of Finance and Economics, Email: (usmanpaul84@gmail.com)*
[2]*School of International Trade and Economics, Jiangxi University of Finance and Economics, Email: (kuloissah969@gmail.com)*
[3]*Ms Management sciences, University of Sargodha, Pakistan, Email: (Zzafarm@yahoo.com)*
[4]*Ms Management sciences, University of Sargodha, Pakistan, Email: (shafqatnadeem@uaf.edu.pk)*
[5]*International Islamic university Islamabad, Pakistan, Email: (irtazaishtiaq@gmail.com)*

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ABSTRACT

This research aims to look at the influence of innovation on economic policy uncertainty in the growing Chinese economy. For data analysis, this study recommends using the autoregressive distributed lag model (ARDL). This research employed an annual time series data collection that spanned the years 2000 to 2019. With these statements, the outcomes of this study indicate that there is a long-term link between economic policy uncertainty and creativity. The autoregressive distributed lags (ARDL) model describes the long-term impact of policy uncertainty in a country on innovation and innovation techniques. The accounting findings show that there are short-run effects, but the long-run effects are more significant. To expand its investment portfolio, the Chinese government should pay attention to releasing policies for investors and providing equitable access to technology for both domestic and foreign investors.

1. Introduction

This study aims to investigate the impact of innovation on China's economic policy uncertainty (EPU). The significance of innovation in accelerating sustainable economic growth and competitiveness has been well acknowledged (Solow, 1957). Various empirical analyses by Bernstein (2015); Dong & Gou (2010); Faleye et al., (2014); Lin et al. (2010); Lin et al. (2011) estimates of the correlation between firm innovation, market-based characteristics, and firm innovation. However, few empirical analyses have discussed the influence of uncertainty on innovation and investment. Various empirical studies have discussed the innovation and market-specific characteristics and examine how different institutional factors like political stability or instability determine technological innovation are sparse. The political situation of the economy is also crucial because economic policies are determined by politics that can frequently change the economic condition in which innovative firms work, which ultimately influences an economy's innovation growth. According to Global Innovation Index (2013) edition (Dutta and Lanvin, 2013), the two leading indicators of this index are government effectiveness and political instability under the category of political environment.

The empirical evidence based on economic policy uncertainty (EPU), Baker et al. (2012) formulated an economic policy uncertainty index that included various indicators like the frequency of newspaper references to economic policy uncertainty. The statistics of the index of EPU indicate that uncertainty adversely affects hiring and investment, especially for different firms heavily dependent on government contracts. Based on the macro-level analysis, they find that using vector autoregression (VAR) models, the EPU is the main indicator of declines in output, employment, and investment. Fernandez-Villaverde et al. (2013) examined in their empirical analysis about time-varying volatility, especially in government spending as a share of production and in the US tax processes. Taking fiscal volatility shocks as a proxy of uncertainty in their analysis, they influence inversely economic activity to reduce investment, consumption, production, and hours worked. Economic policy uncertainty is negatively related to the firms and industrial investment in the US examined by Gulen and Ion (2015). Their analysis described that a 32% drop in corporate investments examined during the 2007 to 2009 crisis could be attributed to the economic policy-associated uncertainty.

Hasu et al. (2014) hypnotized those adverse effects are seen on corporate R & D investment as the increase in policy uncertainty. Economic reforms of China after late 1978 have taken five different economic development phases. The history of the market economy of western economies is more than a hundred years old as compared to the Chinese market economy, and incomplete general legal, government regulating rules and market rules are the main characteristics of China market. Usually, government intervention is present mainly in the market, trying to make a transparent and fair market environment (Chen et al., 2011; Fan, Wong, & Zhang, 2007). The incomplete market economy and its disposable resources of China are under the control of the government. China is a transitional economy; different firms have political connections and relationships between executives of firms and local government officials (Fan et al., 2007). This study tries to add our existing empirical literature by adequately examining the political and economic situation's actual effects

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on innovation. Based on existing literature, we develop a hypothesis regarding the relative importance of policy uncertainty in determining innovation in this study. Economic stability is highly correlated with internal and external economic balances explained by Keynesian economic thought. Over the last few decades, the essential changes in economic policies and structures created economic uncertainty that decreases the investment and resource allocations, creating external and internal imbalances. These imbalances are highly associated with the distortion of investment plans and affect economic growth (Ocampo 2005). High political uncertainty leads to less investment. When firms are politically connected, the advantages of political connection may not be beneficial, so An et al. (2016) highlighted that politically related firms are badly affected by the turnover of political parties. Consequently, the unrest political environment is significantly adverse effects of policy uncertainty on R & D investment.

This paper incorporates main contributions to the existing literature on the correlation between economic policy uncertainty and innovation. This study provides statistical evidence that China's political system is a significant source of uncertainty and related to innovational decision-making by policies. The proxy of uncertainty is established by Baker et al. (2012) as the uncertainty index of economic policy. Numerous studies used economic policy uncertainty (EPU) by Baker et al. (2012); this is an appropriate proxy for real-world economic policy uncertainty (EPU) (Wang et al., 2014). Various recent empirical analyses used the national election as the main indicator of times when a high level of political and economic uncertainty was found in a cross-country analysis. This uncertainty proxy only captures the election years that may be important in some countries but not for all. When studying the country-level cause of economic policy uncertainty on investment and innovation decisions, the election years as a proxy of policy uncertainty strongly bias inferences. The study of Julio and Yook (2012) used an election year dummy found no relationship between economic policy uncertainty and corporate investment in the US, which shows that investment is not significantly lower in the election period versus nonelection years in the United States. So, we agree that the index of policy uncertainty of Baker et al. (2012) is a significant measure of the policy uncertainty in the economy that shows substantial variation over time (Gulen and Ion 2015).

As discussed above, since the real options theory of Bernanke (1983), numerous theoretical literature pays attention to the significant effect of uncertainty on investment. However, empirical literature also finds the relationship between uncertainty and investment (Julio and Yook 2012, Wang et al. 2014, and Gulen and Ion 2015). Based on China cities data, An et al. (2016) check the effect of economic policy uncertainty on corporate investment and conclude that corporate investment is inversely related to political turnover. The relationship between market uncertainty and corporate R & D investment is examined by Czarnitzki and Toole (2007, 2011). Still, according to my knowledge, there is no empirical study that discusses innovation and economic policy uncertainty relationship focus on China at the macro level and based on time series data. This study contributes to the existing literature by empirically evaluating the main effect of policy uncertainty on innovation and controlling economic growth. Does innovation influence economic policies uncertainty in China?

2. Literature Review

The real options theory explains that the current investment level of the economy can be affected by uncertainty because higher the value of the information achieved by waiting for leads to reduced investment (see also Bernanke, 1983, Bond & Reenen, 2007) Dixit, 1989). Most investment-related to R&D includes equipment purchases, employee remuneration, materials expenses, etc. these are mostly affected by the uncertain economic condition (Dixit &Pindyck, 1994). According to the real options theory of investment, market uncertainty is not considered in this study; we try to investigate the influence of economic policy uncertainty on innovation and take time-series data related to China. Similarly, a strong association can be seen between corporate behavior and governments in emerging market economies (Shleifer&Vishny, 1994). The hypothesis of policy uncertainty states that it is economic policy uncertainty that affects innovation. Various empirical analyses (prior study of Bernanke 1983 than models of Chen and Funke, (2003)., Bloom et al. (2007)., and Bloom., et al., (2016) demonstrate that if different projects of investment are not profitable and reversible, then investment by firms hold back and due to uncertain economic condition because uncertainty enhances the value of the option to wait. Investment in R&D is highly affected by uncertainty and highly based on the value of the option to wait; the innovation is the discovering the new ideas, unknown approaches, and novel methods (see Holmstrom, 1989; also, Aghion and Tirole, 1994) that needs significant investment especially in intangible assets. The political situation for innovation is particularly important because the value of the option to wait is also related to innovation. As discussed before, success in exploring innovation also depends on political leadership and their policies. The significance of the option to wait is associated with political uncertainty about which government will be in power. Hence the hypothesis of policy uncertainty we develop argues that it is economic policy uncertainty that affects innovation.

China faced the most economic intervention by its government among all transitional market economies (see Fan, Huang, & Zhu, 2013). State-owned sectors, assets, and economic activity in China are also affected by government policies (Chen et al., 2011). The success of the government's stimulus-driven, but China as an emerging economy facing high economic

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policy uncertainty and still going far from a successful planned economy to a market-based economy (Wang et al., 2014). The central, provincial, county, and city government prepares social and economic growth and development plans every five years to achieve the future industrial development targets. So innovation is also related to long-term investment, which can be significantly affected by the government's long-term policies (monetary policy, fiscal policy, and industry policy). So, economic policy uncertainty also plays an important role in promoting innovation (Wang et al., 2014).

The government of China launched a patent subsidy program at the end of the 1990s to increase the local industries' technological competitiveness after becoming a WTO member. To encourage domestic firms in terms of "endogenous innovation" and strengthen the awareness of intellectual property rights, the central government launched policy instructions named "Strengthen Technology Innovation, Develop High-Tech Industries, and Promote Industrialization (related to Inventions)." Although the government's policies and goals are the same, the policy design is not the same across regions, and many governments have made significant revisions to their policies (Dang and Motohashi 2015). The uncertain political conditions affect firms and investors because they are not sure about future economic policies by the government, and firms have no idea about which sectors will be subsidies developed by the government and which can be imperfectly affected by government policies. The association between uncertainty and impact on the economy is an important query of long-standing anxiety to economists. Bernanke (1983) and Dixit (1989) investigated the connection between real implications of uncertainty and its effects on the real economy (Bachmann et al. (2013) and Handley (2014)) also explored the impact on investment opportunities. The future of China is uncertain due to political instability, so when the economic uncertainty is higher, it lowers the value of future activities of the economy of China.

Various Prior studies have discussed uncertainty associated with political decisions, and these policies can significantly enhance the future uncertainty and related to the firm's future profitability. These theoretical analyses have recommended mechanisms through which higher uncertain profits can reduce the rate of investment. The first theory presented by Bernanke (1983) explained the cyclical investment movements in terms of the irreversible choice theory under uncertainty, and Rodrik (1991) also describes the relationship between uncertainty and investment projects that cannot be usually reversible because uncertainty will raise the value of the option to wait until further knowledge about the profitability of the investments projects is revealed. Followed by this theory, many others have applied Bloom et al. (2007), Bloom, Draca & Reenen, (2016); Shabbir and Yaqoob 2019; Chen &Funke, (2003) these models to investigate the inverse relationship between uncertainty and investment projects. Innovation is not a short-term process. It takes time to explore different techniques, methods of completion, and implementation. Dixit &Pindyck (1994) explained that economic policy uncertainty uplifting the value of the postponing opportunity so many investment projects would be postponed, portraying a negative correlation between investment and uncertainty. Bhattacharya et al. (2015); and studies of Gulen& Ion (2015); Julio &Yook (2012) investigating the significant inverse relationship between policy uncertainty and intangible investment. Economic activity, especially in developing countries, are affected by governments in terms of firms' performance, shares, values, and choices (Firth, Gong, & Shan, 2013). The government has played a significant role in economic activity especially making industrial policy in the republic of China. In case of an uncertain political environment, different firms and investors are not sure about future economic policies by the government. Uncertainty of future policies is related to the industrial sector. Firms have no idea which sectors will be subsidies developed by the government and which can be badly affected by government policies. In this situation, when the economy faces policy uncertainty, the value of the option to wait to invest in R & D will suffer. In the condition of innovation, irreversible investment mostly in intangible goods and assets and the value of R & D strongly depends on the government policies (Bhattacharya et al., 2015). So, growing economic policy uncertainty negatively responds with firms waiting to make R & D investments.

Adner&Levinthal (2004) and Dixit &Pindyck(1994) examined that the decision of investment under uncertainty is discussed by real options approach and used this as a tool of decision analysis. Many economists criticized real options theory because of its limited use as a tool in the setting of originations. Bowman &Moskowitz (2001) also discussed by (Kogut. B&Kulatilaka, 2004). The real options theory proposes a reasoning logic which is related to the description of uncertainty, flexibility, and irreversibility inherent in decisions of innovation investment, so as a strategic heuristic in decisions of organizational innovation, the logic of real option was usually applied (see Adner & Levinthal, 2004; Shabbir et al., 2020; Kogut, B. (2001).; also, McGrath & Nerkar, 2004). McGrath (1997); McGrath & Nerkar, (2004) explained that various studies used the real options logic as an analytical framework for firms as "innovation investment, R&D investments" decisions, where investment is related to technology innovation, this framework of research is measured as strategic actions and flexibility in terms of amount and timing of investment by firms.

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3. Data Sources

This study uses three variables for analysis: innovation, economic policy uncertainty, the annual growth rate of GDP as the control variable. This paper's main objective is to investigate the influence of economic policy uncertainty on innovation in mainland China applying time-series data from 2000 to 2015. The patent data is used as proxy innovation, so this study uses the number of patent applications (per million inhabitants) of China on the website of SIPO. Due to the limitation of data based on innovation, as explained by (Keller 2004). This study used patents as a proxy of technology. So this proxy has become more standard in the literature of innovation (like Audretsch and Feldman (2004); Shabbir and Muhammad 2019; Acharya and Subramanian, 2009, Bloom et al. (2011), also explained by Nanda and Rhodes Kropf (2013), similarly Hsu et al. (2014). Dang and Motohashi (2015) also found that patent statistics is a good and meaningful indicator in China.

Most studies are based on firm's related policy uncertainty, especially in China based on China-listed firms and their volatility of stock returns, input and output prices, related to their production, investment-related uncertainty, and dispersion in analyst forecasts. Prior studies mostly used economic policy uncertainty (EPU) by Baker et al. (2012). This is an appropriate proxy for real-world economic policy uncertainty (EPU) (Wang et al., 2014). The variable of uncertainty is treated as exogenous interaction variable Aastveit et al. (2013). The growth of Gross Domestic Product (GDP) is the control variable in the period, and in this study, we take the lag of GDP growth rate in percentage. The GDP growth shows the role of macroeconomic variables on innovation. The data of China's annual GDP growth rate is obtained from World Development Indicators (WDI). This is a key variable because this is likely to be associated with subsequent innovation.

The uncertainty index of economic policy was established by Baker et al. (2012). This uncertainty index includes some important economic aspects: the frequency of newspapers relates to economic policy uncertainty, the numeral federal tax code provisions set to expire, and the degree of economic forecaster disagreement over future inflation rate and government purchases. Different studies related to Bloom (2009)., Alexopoulos& Cohen (2009) also explained by Fernandez-Villaverde et al. (2013)., Baker and Bloom (2013)., see Mumtaz and Theodoridis (2014)., similarly by Caggiano et al. (2014b)., Caggiano et al. (2014a), Benati (2014) and Nodari (2014) along with various others explained that economic policies could put a negative effect on employment, investment, industrial production, and consumption. Born et al. (2014) explain that that overstated can be seen in uncertainty, and the index of economic policy uncertainty established by Baker et al. (2015) also has small effects, especially on various economic activities when comparatively compared with various macroeconomic measures of uncertainty by Juradoet al. (2015). So, in this study, the economic policy uncertainty index is used (taking averages of monthly data for making annual data) as the proxy of uncertainty as an independent variable measure from Baker, Bloom, and Davis (2012).

4. Methodology

The economic policy uncertainty is the proxy of uncertainty used in this research which was also applied by Kang and Ratti (2015). The measure of uncertainty for China was established based on Baker et al. (2012). The negative relationship between uncertainty and innovation is supported by the findings of Wang et al. (2014) and Hsu et al. (2014). This study examines the relationship between innovation and economic policy uncertainty related to within-country data of China using the following function:

1. This study contributes by taking an inclusive method to examine the relationship between innovation and economic policy uncertainty for China with the help of a theoretically justified model that has not been done so far. However, the literature of time series analysis proposes that one must test to determine whether a long-run correlation is found among the specific model variables. To find out the relationship between variables, several econometric techniques are accessible in the published literature. Still, this study based on time series data is used the autoregressive distributed lag model (ARDL) to examine the main argument that is especially recommended by Pesaranet al. (2001) because the ARDL test has some significant advantages (Pesaran and Shin, 1999, Shabbir 2016, Li et al., 2021; Yikun et al., 2021; Lauranceson and Chai, 2003). The first step of the ARDL bounds testing method shows the existence of one or more long-run correlations between innovation and the remaining regressors are examined by calculating the F-statistic for testing the significance of the lagged levels of the variables in the error correction form in the model of ARDL (Pesaran and Pesaran 1997, pp. 304–305).

2. This current study uses the ARDL bounds testing technique because of its several advantages. The ARDL method is more preferred than the method of Johansen (1992) maximum likelihood and Pesaran et al. (2001). The ARDL method is used to test a relationship between innovation and economic policy uncertainty adopted for the following reasons. The ARDL method does not impose the most restrictive assumption, for example, that all variables related to a specific model should have the same order of integration, and it can be used whether the order of integration of variables is I(0), I(1),

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(Pesaran and Pesaran 1997). Besides this, ARDL estimators with their small sample properties are more superior to the co-integration techniques of Johansen and Juselius. Long-run coefficients of estimators based on ARDL are great consistent in small sample sizes (as the advantage of small sample size properties of the ARDL method is far improved to that of the Johansen and Juselius's technique of co-integration) (Pesaran and Shin 1999). Moreover, the endogeneity problem is less in the framework of the ARDL method because it is free of residual correlation. The ARDL method overcomes the issues caused by nonstationary time series data (Laurenceson and Chai, 2003). Finally, the ARDL bonds technique help to generate a dynamic error correction model without losing information about the long-term period through a simple linear transformation method. So, the ARDL test is used because of its various well-documented advantages in the literature by many researchers already mentioned above. The time-series data used for empirical analysis calls for checking of stationarity of all given variables. Testing of stationarity of the data is an essential prerequisite to avoid the key problem of spurious regression. The ordinary least square (OLS) regression results will be biased if data is nonstationary used in the level form. If the variables are nonstationary at level, then different methods are available to search co-integration in nonstationary series; like Engle–Granger's (1987) test, two-step Johansen's (1992) maximum likelihood method, the models of Pesaran–Shin's (1999); Liu et al., 2020; Saleem et al., 2019, Yu et al., 2020 and Pesaran et al. (2001) that explain the autoregressive distributive lag (ARDL) models. Engle–Granger's method does not support if greater than one cointegrating vector is presently found in the analysis (Seddighi et al. 2006). The method of ARDL bounds testing analysis to co integration includes estimating the "unrestricted error correction method" (UECM) of the ARDL approach is given below:

$$\Delta \ln INN_t = \alpha_1 + \alpha_{INN} lnLNN_{t-1} + \alpha_{UNC} lnLUNC_{t-1} + \alpha_{GDP} lnLGDP_{t-1} + \sum_{i=1}^{P} \alpha_i \, \Delta lnLNN_{t-i} + \sum_{j=0}^{q} \alpha_j \, \Delta LUNC_{t-j} + \sum_{l=0}^{m} \alpha_k \, \Delta lnGDP_{t-l} + \mu_{1i} \quad (1)$$

$$\Delta \ln UNC_t = \beta_1 + \beta_{UNC} lnUNC_{t-1} + \beta_{GDP} lnLGDP_{t-1} + \beta_{INN} lnLNN_{t-1} + \sum_{i=1}^{P} \beta_i \, \Delta lnLUNC_{t-i} + \sum_{j=0}^{q} \beta_j \, \Delta lnGDP_{t-j} + \sum_{l=0}^{m} \beta_k \, \Delta lnINN_{t-l} + \mu_{2i} \quad (2)$$

$$\Delta \ln GDP_t = \delta_1 + \delta_{GDP} lnGDP_{t-1} + \delta_{UNC} lnUNC_{t-1} + \delta_{INN} lnLNN_{t-1} + \sum_{i=1}^{P} \delta_i \, \Delta lnGDP_{t-i} + \sum_{j=0}^{q} \delta_j \, \Delta lnLUNC_{t-j} + \sum_{l=0}^{m} \delta_k \, \Delta lnINN_{t-l} + \mu_{3i} \quad (3)$$

The null hypotheses $of\ no\ co\ integration\ H_0{:}\alpha_{INN}{=}\alpha_{UNC} = \alpha_{GDP} = 0$, $H_0{:}\beta_{INN} = \beta_{UNC}{=}\beta_{GDP} = 0$, $H_0{:}\ \delta_{UNC} = \delta_{INN}{=}\delta_{GDP} = 0$, while alternative hypotheses is, $H_2{:}\alpha_{INN} \neq \alpha_{UNC} \neq \alpha_{GDP} \neq 0$, $H_2{:}\beta_{INN} \neq \beta_{UNC} \neq \beta_{GDP} \neq 0$, $H_2{:}\ \delta_{UNC} \neq \delta_{INN} \neq \delta_{GDP} \neq 0$
$The\ \alpha_1, \beta_1\ and\ \delta_1$ Intercepts are drift components and μ_1 is an error term and assumed to be white noise. To check the absence of serial correlation, we used Akaike Information Criterion (AIC) to choose the optimal lag length for the model.

5. Results and Discussion

5.1 Descriptive Analysis

Table 1 indicates the descriptive statistics for all variables. Table 1 also shows the correlation matrix and Jarque–Bera test for normality checking, and results show that all the variables are normally distributed. Results of correlation matrices indicate that data have no problem of Multicollinearity.

Table: 1 Descriptive statistics and Correlation Matrices

	LNN	UNC	GDP
Mean	4.953230	2.016851	9.481980
Median	4.970742	2.027740	9.399813
Maximum	6.004496	2.388098	14.23139
Minimum	4.000477	1.745757	6.914330
Std. Dev.	0.664766	0.174092	1.824493
Skewness	0.046708	0.360019	0.873710
Kurtosis	1.680454	2.249712	3.514029
Jarque-Bera	1.531187	0.946212	2.902989
Probability	0.465058	0.623064	0.234220
	LNN	UNC	GDP
LNN	1.000000		
UNC	0.603756	1.000000	
GDP	0.132076	0.356531	1.000000

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5.2 Unit Root Test

It is necessary to check all the variables for stationary. Otherwise, the regression will be spurious. For this purpose Augmented, Dickey-Fuller (ADF) test is applied to detect the stationary problem that variables are stationary or nonstationary. ADF is also applied to establish the order of integration for all the variables.

Table: 2 The results of unit root tests

Variables	ADF	DF-GLS Test
LNN	-4.34(1)**	-2.89(0)**
UNC	-4.30(0)*	-2.60(0)*
GDP	-4.11(1)**	-4.14(0)**
ΔLNN	-4.10(1)*	-2.90(0)**
ΔUNC	-3.87(0)**	-3.92(0)*
ΔGDP	-4.01(1)**	-4.04(1)**

Notes: The ** and * indicate significance at 1 % and 5 % levels of significance, respectively. The Table in the parenthesis is the test of ADF and PDF-GLS (unit root test). Null hypotheses: Data is not nonstationary.

5.3 Estimation Results

Although the approach of ARDL related to co integration is valid irrespective of whether the dependent or independent variables are integrated of order (0) or (1) also, before using of ARDL approach the pretest for non-stationarity is important because the presence of the different variables with I (2) or higher order of integration can complicate the F statistics test, making the biased results (Ouattara 2004). As a result, the test of augmented Dickey-Fuller (ADF) is performed to check the order of integration of the variables. Results of Augmented Dickey-Fuller (ADF) test from the Table (2) that uncertainty have not unit root problem and innovation and GDP have unit root problem and stationery at first difference level.

After the identification of the order of integration of all variables, our next task to find out whether, there is a long-run association among all these variables. However, before arranged to test of co integration analysis, a main step is to choose the optimal lag length of the selected variables. For this purpose, main conventional methods are used. Three optimal lag length criteria are according to conventional method. Followed the Akaike Information Criterion (AIC), we selected the lag length, after this the ARDL bound testing technique to co integration is used to examine the long-run association among all variables. Table (3) shows the statistical results of the test.

Table (3) indicates that all the three ARDL equations are examined taking each variable as dependent variable respectively. Table (3) shows each equation and their respective lag length of dependent and all independent variables. The results propose that null hypothesis (H_0) of no longer association between the variables is rejected at 5 and 10 percent respectively when innovation, economic policy uncertainty and gross domestic product are treated as response variables. The estimated values of F statistics are 5.99, 7.71 and 5.80 while the upper bound value is 5.06, 4.01 and 3.52 at 5 percent and 10 percent level of significance (Designed by Pesaran et al. 2001, Arif et al, 2020; Ejaz et al, 2017; and Narayan 2005). These results indicate three co integration vectors among innovation, economic policy uncertainty and gross domestic product over the study period of 2000 to 2015 in case of Republic of China.

Table: 3 ARDL bounds testing to co integration analysis

Bounds testing to co integration			
Estimated model	$\mathrm{INN_t = f(UNC_t, GDP_t)}$	$\mathrm{UNC_t = f(INN_t, GDP_t)}$	$\mathrm{GDP_t = f(INN_t, UNC_t)}$
Optimal lag length	(2)	(3)	(2)
F statistics (Wald test)	5.99	7.71	5.80
	Critical values (T=… 20)		
	Lower bounds I(0)	Upper bounds I(1)	
1 percent level of significance	3.74	5.06	
5 percent level of significance	2.86	4.01	
10 percent level of significance	2.45	3.52	
Diagnostic tests			

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R^2	0.80	0.85	0.70
F statistics	1.77(0.06)	4.97(0.01)	2.01(0.02)
J-B normality test	1.01(0.63)	0.50(0.79)	1.65(0.43)
Breusch–Godfrey lm test	2.19(0.33)	0.20(1.10)	2.40(0.30)
ARCH test	0.20(0.68)	0.94(0.33)	1.22(0.26)
Ramsey reset test	t=0.66(0.52)	2.12(0.18)	2.50(0.10)

Notes: The optimal lag length structure is selected byAkaike Information Criterion (AIC).
The *** and ** indicate the significant at 1 and 5 %levels of significance respectively.

The optimal lag length structure is selected by Akaike Information Criterion (AIC). F-statistics values are taken from Wald test after using ARDL approach. Lower and upper bonds values are taken from Pesaran et al (2001). The null hypothesis (H_0) that there is no heterokedasticity (ARCH), and no serial correlation (Breusch–Godfrey lm test). Results indicate that we accepted null hypothesis (which means long run relationship exists). The H_0 of Ramsey reset test indicate that model is correctly specified, we also accept null hypothesis in case of Jarque Bera (J.B test) which shows that data is normally distributed. Null hypothesis indicates that the values are greater than 5% level of significance.

According to results of these variables, in case of innovation being dependent variable, long run co integration among innovation, economic policy uncertainty and GDP. After concluding the existence of cointegration (long run) among these variables, equation 2 has been calculated applying ARDL cointegration approach to find the long-run estimates. These results are shown in table (4).

Table: 4 Long run results (INN_tis dependent variable)

Variables	Coefficient	T –statistics
Constant	-4.09	-0.317902
UNC_t	-0.107	-1.85*
GDP_t	0.015	1.83*
Diagnostic tests		
R^2	0.99	
F statistics	1199.397	
(χ^2)J-B normality test	0.38(0.82)	
(χ^2)Breusch–Godfrey lm test	9.18(0.20)	
(χ^2)ARCH test	1.03(0.30)	
Durbin-Watson (DW)	2.12	
(χ^2)Ramsey reset test	0.31(0.76)	

Notes: χ^2NORMAL test relates to the Jarque–Bera statistic of the test for normality of data, χ^2 the Breusch– Godfrey LM test is related to serial correlation , χ^2 ARCH test is the Engle's test for "autoregressive conditional heteroskedasticity", and χ^2 Ramsey reset test is used to test for model specification test, * represents the 10% level of significance. Durbin-Watson (DW) test is used to find the problem of autocorrelation results indicate that value of DW is 2.12, indicted that no problem of auto correlation.

After the discussion of long run dynamics, the next step concern is to analyze the main direction of causality among all these variables. As we discussed before, the purpose of the ARDL bounds testing method to cointegration only investigates the existence of long correlation between the variables, but the direction of causality cannot be suggested by this approach. Morley (2006) discussed that existence of long-run connection between the dependent and independent variables is only the order of necessary condition but not the order of sufficient condition to reject the non-causality hypothesis. The empirical result found in table 4 confirm the co integration between innovation, economic policy uncertainty and GDP but it is not sufficient to recognize the direction of causality. However, this existence of long run association between all variables does propose that there should be causality at least in one main direction. These grounds require the employ of innovation accounting approach (IAA) including of variance decompositions and also" impulse response functions" (see Wolde-Rufael 2009). The results of variance decompositions approach are shown in table 5 and these results are based on the direction of causality. The table 5 indicates those three blocks which is showing the variance decomposition of each other three variables separately. Variance decomposition of innovation, uncertainty and GDP is representing in first, second and third blocks respectively.

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Table: 5 Variance decomposition approach

	Variance Decomposition of INN_t			Variance Decomposition of UNC_t			Variance Decomposition of GDP_t		
Time horizons	INN_t	UNC_t	GDP_t	INN_t	UNC_t	GDP_t	INN_t	UNC_t	GDP_t
1	100.0000	0.0000	0.0000	9.0865	90.9135	0.0000	7.0636	74.2241	18.7122
2	97.9563	0.11164	1.9321	8.4454	90.8577	0.6970	8.0471	76.0010	15.9518
3	88.8567	7.5179	3.6253	9.7793	89.5254	0.6953	7.9196	76.3479	15.7323
4	71.0677	22.2517	6.6805	9.6207	87.1743	3.2050	7.9141	76.3516	15.7342
5	55.5545	34.9848	9.4606	9.3135	85.3306	5.3558	7.9022	76.3669	15.7308
6	47.3813	42.0059	10.6127	9.0133	85.4487	5.5379	7.9516	76.3214	15.7269
7	43.0178	45.5669	11.4151	9.1316	85.3448	5.5235	7.9736	76.2942	15.7322
8	40.1405	47.8265	12.0326	9.4906	85.0055	5.5038	7.9668	76.2707	15.7623
9	37.8836	49.5705	12.5458	9.6615	84.7911	5.5474	7.9560	76.2747	15.7692
10	36.0746	51.0249	12.9005	9.6808	84.6575	5.6616	7.9576	76.2775	15.7647

The results of table 5 in first block indicates the shock or impulse to uncertainty in start or short run contributes 0.11 percent fluctuation in innovation, it illustrates that the contribution of economic policy uncertainty (0.11%) to variation in innovation. But in the long run in if we checked at 9th and 10th periods of time than we can check that that the shock to economic policy uncertainty contributes 49.57% and 51.02 % variation in innovation. Similarly, the shock to GDP in the long run contributes 12.5 percent fluctuation in innovation.

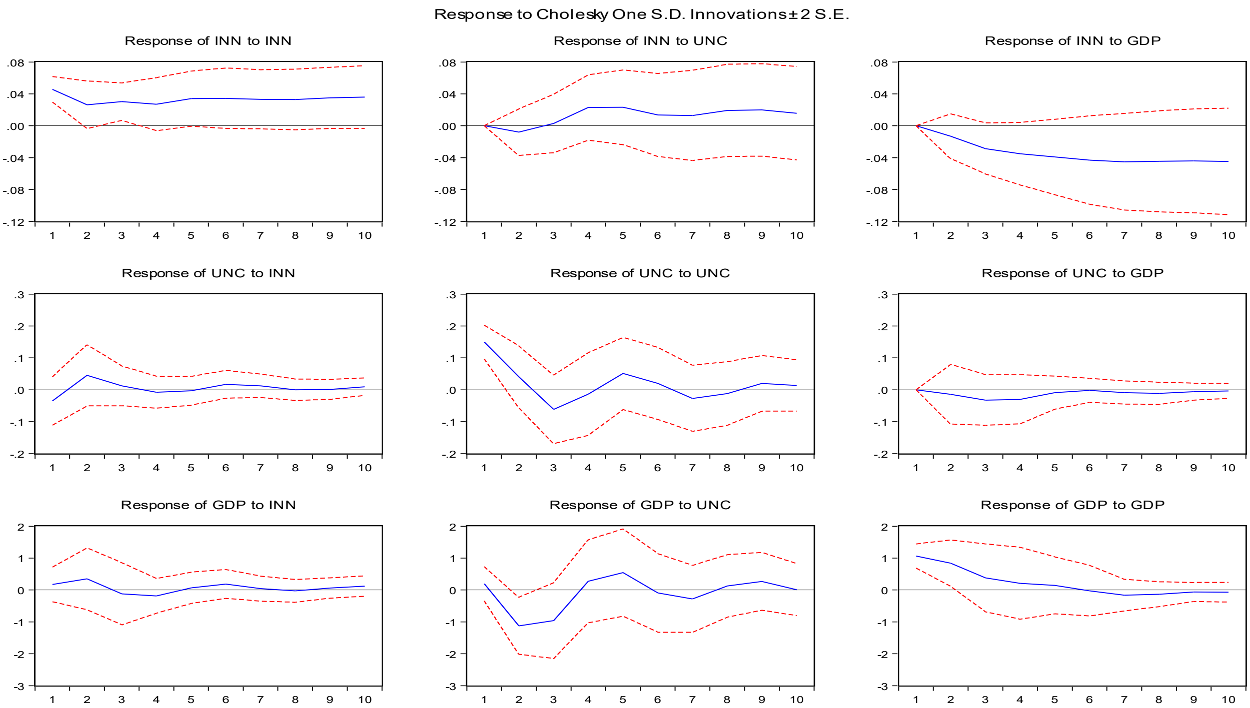

Figure 1: Impulse's responses

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Result shows that 51.02 percent variation in innovation is caused by the economic policy uncertainty. In this result if we analyze the results of GDP we found that GDP growth is also affected by uncertainty, and it is surprising that shock to uncertainty in start or short run contributes 74.2 percent fluctuation in GDP and in the long run in if we analyzed 10th periods of time than we can check that that the shock to economic policy uncertainty contributes 76.2 percent variation in GDP. Based on variance decomposition results, it is concluding that there is unidirectional causality running from uncertainty to innovation and uncertainty to GDP growth also.

6. Conclusion and Future Recommendations

The main purpose of the underlying study was to scrutinize the causality between economic policy uncertainty and innovation. By using the ARDL approach to co integration and the methods of innovation accounting for causality analysis, the study finds that innovation is highly affected by the uncertainty. This paper concludes that there is long run relationship between economic policy uncertainty and innovation. The ARDL model describes the long run effects of a country's policy uncertainty on innovation and the methods of innovation accounting results indicates that there is short run affects is exist but the degree of long run affect is larger. Uncertain economic policy has a clear impact on innovation as well as inversely related to the GDP growth rate of China. The results suggest that government should adopt such economic policies which reduce the uncertainty related to economic policies to encourage innovational investment in China. The risk increases by uncertainty which encourages the investors to postpone investment decisions. Government should also give more subsidies to the investors related to innovational investment and activities. The main challenge of this research is solving the problem of an appropriate measure of economic policy uncertainty.

The empirical findings show that economic policy uncertainty can negatively affect innovation. Economic policy uncertainty indicates a significantly negative impact on innovation as well as on GDP growth rate. The combined results based on ARDL, Innovation accounting approach (IAA) (variance decompositions and impulse response functions). The point is relating to the causality running from economic policy uncertainty to innovation. The future of China is uncertain, so when the economic uncertainty is higher it lowers the value of future activities of economy of China.

This study concludes that economic policy uncertainty is not only affected the current level of innovation but also affects the decision of future innovational projects. This paper suggests that steady and sustainable economic policies by government also minimize economic uncertainty and encourage the economic agents to increase economic activities in terms of investment. Our analysis also highlights that the strong relationship between innovation and political uncertainty depends on the nature of political situation in case of republic of China. Unlike diminishing in innovation is stimulated by increasing economic political uncertainty. It's clear that the long-run consequence of political uncertainty is not clear and a warning to policy makers especially in China about avoiding long debate about future policy is not entirely warranted.

References

Arif, A., Sadiq, M., Shabbir, M. S., Yahya, G., Zamir, A., & Bares Lopez, L. (2020). The role of globalization in financial development, trade openness and sustainable environmental-economic growth: evidence from selected South Asian economies. Journal of Sustainable Finance & Investment, 1-18.

Abel, A., (1983). Optimal investment under uncertainty. American Economic Review 73(1): 228233.

Acharya, V. V., & Subramanian, K. V. (2009). Bankruptcy codes and innovation. Review of Financial Studies, 22, 4949-4988.

Adner, R., &Levinthal, D. A. (2004). What is not a real option: considering boundaries of the application for real options to business strategy. Academy of Management Review.

Aghion, Philippe, and Jean Tirole, (1994).On the management of innovation, Quarterly Journal of Economics 109, 1185-1209.

Alesina, Alberto, SuleOzler, NourielRoubini and Philip Swagel, (1996). Political instability and economic growth, Journal of Economic Growth, forthcoming.

An, H., Chen, Y., Luo, D., & Zhang, T. (2016). Political uncertainty and corporate investment: Evidence from China. Journal of Corporate Finance, 36, 147–189.

Audretsch, D. B. &Fedman,M.P. (1996). R&D spillovers and the geography of innovation and production. American Economic Review, 86(3):630-640.

Baker SR, Bloom N and Davis SJ. (2012). Has Economic Policy Uncertainty Hampered the Recovery?.Chapter 3, in L.E. Ohanian, J.B. Taylor, and I.J. Wright (Eds.), "Government Policies and the Delayed Economic Recovery". Hoover Press, Hoover Institution, Stanford University.

Barro, Robert J., (1991). Economic growth in a cross-section of countries, Quarterly Journal of Economics 106, 407-444.

Basu, S.,Bundick, B.,(2014). Uncertainty Shocksina Model of Effective Demand.Federal Reserve Bank of KansasCity.WorkingPaperRWP14–15.

Bernstein, S. (2015). Does going public affect innovation? The Journal of Finance, 4, 1365–1403.

Bernanke, Ben S. (1983). Irreversibility, uncertainty, and cyclical investment. The Quarterly Journal of Economics, 98, 14–31.

Bhattacharya , U., HSU,P., Tian, Xu, Y.,(2015). What affects innovation more: Policy or Policy Uncertainty? Quarterly Journal of Economics 98:85-106.

Bloom, N., Bond, S., &Reenen, J. V. (2016). Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity. The Review of Economic Studies, 83, 87–117.

Bloom, N., Draca, M., & Van Reenen, J. (2011). Trade induced technical change? The impact of Chinese imports on innovation, IT and Productivity. National breaue of Economic Research:Working paper No.16717.

Bloom, Nicholas, (2009). The Impact of Uncertainty Shocks, Econometrica, 77, pp. 623-685.

Bloom, N., Bond, S., &Reenen, J. V. (2007).Uncertainty and investment dynamics. Review of Economic Studies, 74, 391–415.

Bloom, N., and Van Reenen, J., (2002). Patents, Real Options, and Firm Performance. Economic Journal 112(478): 97-116.

Bond, S. R., and J. G. Cummins,(2004). Uncertainty and investment: An empirical investigation using data on analysts' pro_ts forecasts, Working paper, FEDS.

Bowman, E. H., &Moskowitz, G. T. (2001). Real options analysis and strategic decision making. Organization Science, 12(6), 772-777.

https://dx.doi.org/10.30566/ijo-bs/2021.10.60

Chen, S., Sun, Z., Tang, S., & Wu, D. (2011). Government intervention and investment efficiency: Evidence from China. Journal of Corporate Finance, 17, 259–271.

Chen, Yu-Fu &Funke, Michael (2003).Option value, policy uncertainty, and the foreign direct investment decision. Hamburg Institute of International Economics

Discussion Paper.

Czarnitzki, D., & Toole, A. A. (2007). Business R & D and the interplay of R & D subsidies and product market uncertainty. Review of Industrial Organization, 31, 169–181.

Czarnitzki, D., & Toole, A. A. (2011).Patent protection, market uncertainty, and R & D investment. The Review of Economics and Statistics, 93, 147–159.

Dang.J and Motohashi.K (2015). Patent statistics: A good indicator for innovation in China? Patent subsidy program impacts on patent quality. China Economic Review 35 (2015) 137–155.

Dixit, A. K., &Pindyck, R. S. (1994). Investment under uncertainty Princeton, NJ: Princeton University Press.

Dixit, A. K. (1989). Entry and exit decisions under uncertainty. Journal of Political Economy, 97, 620–638.

Dong, J., & Gou, Y. N. (2010).Corporate governance structure, managerial discretion, and the R & D investment in China. International Review of Economics and Finance, 19(2), 180–188.

Duta, S. &Lanvin, B. (Eds) (2013). Global Innovation Index 2013.Cornell, NY: INSEAD, WIPO.

Ejaz, S., Amir, H., & Shabbir, M. S. (2017). Public Expenditure and its impact on Economic Growth: A case of Pakistan. Kashmir Economic Review, 26(1).

Engle, R.F., Granger, C.W. J (1987). Co integration and error correction representation: estimation and testing. Econometrica55(2), 251–276.

Faleye, O., Kovacs, T., &Venkateswaran, A. (2014). Do better-connected CEOs innovate more. Journal of financial and quantitative, 49, 1201–1225.

Fan, J., Huang, J., & Zhu, N. (2013).Institutions, ownership structures, and distress resolution in China. Journal of Corporate Finance, 23, 71–87.

Fan, J. P., Wong, T. J., & Zhang, Tianyu (2007). Politically connected CEOs, corporate governance,and Post-IPO performance of China's newly partially privatized firms. Journal of Financial Economics, 84, 330–357.

Fernandez-Villaverde, Jesus, Pablo Guerron-Quintana, Keith Kuester, and Juan Rubio-Ramirez (2013): "Fiscal Volatility Shocks and Economic Activity", Working Paper, University of Pennsylvania.

Firth, M., Gong Stephen, X., & Shan, L. (2013). Cost of government and firm value. Journal of Corporate Finance, 21, 136–152.

Gulen, H., & Ion, M. (2015).Policy uncertainty and corporate investment. The Review of Financial Studies, 29, 523–564.

Hartman, R., (1972). The effects of price and cost uncertainty on investment. Journal of Economic Theory 5(2): 258-266.

Holmstrom, Bengt, (1989). Agency costs and innovation.Journal of Economic Behavior and Organization 12, 305-327.

HSU, P.,Tian., and Xu,Y., (2014). Financial Development and Innovation: Cross- country evidence. Journal of Financial Economics, Forthcoming.

Julio, Brandon, and YoungsukYook, (2012). Policy uncertainty and corporate investment cycles, Journal of Finance 67, 45-83.

Kang, W., Ratti., (2015). Oil shocks and China's Policy Uncertainty and Stock Returns, Economics of Transition 23,657,676.

Keller , W (2004) International technology diffusion. J Econ Lit 42(3):752–782

Kogut, B., &Kulatilaka, N. (2004). Real options pricing and organizations: the contingent risks of extended theoretical domain. Academy of Management Review, 29(1).

Kogut, B. (2001). Capabilities as real options.Organization Science, 12(6), 744-758.

Laurenceson, J., and Chai, J. C. H. (2003). Financial reform and economic development in China. Advances in Chinese economic studies series. Cheltenham, UK: Edward Elgar.

Li, Q., Cherian, J., Shabbir, M. S., Sial, M. S., Li, J., Mester, I., & Badulescu, A. (2021). Exploring the Relationship between Renewable Energy Sources and Economic Growth. The Case of SAARC Countries. Energies, 14(3), 520.

Lin, C., Lin, P., Song, F., & Li, C. (2011).Managerial incentives, CEO characteristics and corporate innovation in China's private sector.Journal of Comparative Economics, 39, 176190.

Lin, C., Lin, P., & Song, F. (2010). Property rights protection and corporate R & D: Evidence from China. Journal of Development Economics, 93, 49–62.

Liu, Y., Saleem, S., Shabbir, R., Shabbir, M. S., Irshad, A., Khan, S., (2020). The relationship between corporate social responsibility and financial performance: a moderate role of fintech technology. Environmental Science and Pollution Research. DOI: 10.1007/s11356-020-11822-9

McDonald, R., Siegel, L.D., (1986). The value of waiting to invest. Quarterly Journal of Economics, 101:707-727.

McGrath, R. G., &Nerkar, A. (2004). Real options reasoning and a new look at the

R&D investment strategies of pharmaceutical firms.Strategic Management Journal, 25, 1-21.

McGrath, R. G. (1997). A real options logic for initiating technology positioning

investments. Academy of Management Review, 22(4), 974-996.

Morley, B. (2006). Causality between economic growth and immigration: an ARDL bounds testing approach. Econ.Lett.90(1), 72–76.

Nanda, Ramana, and Matthew Rhodes-Kropf,(2013). Investment cycles and startup innovation. Journal of Financial Economics 110, 403-419.

Narayan, P.N (2005). The saving and investment nexus for China: Evidence from cointegration tests. Appl. Econ. 37(17), 1979–1990.

Ocampo, J. A (2005).A broad view of macroeconomic stability. DESA Working Paper No. 1. ST/ESA/2005/DWP/1.6

Oi, W., 1961.The desirability of price instability under perfect competition.Econometrica 29(1): 58-64.

Ouattara, B. (2004). Foreign Aid and Fiscal Policy in Senegal.University of Manchester, Manchester, UK.

Pesaran, M.H., Shin, Y., Smith, R. (2001). Bounds testing approaches to the analysis of level relationships. J. Appl. Econom. 16(3), 289–326.

Pesaran, M.H., Shin, Y. (1999). Anautoregressive distributed lag modeling approach to co integration analysis. Chapter 11 In: Strom S. (ed.) Econometrics and economic theory in the 20th century: the ragnarfrisch centennial symposium. Cambridge University Press, Cambridge.

Pesaran, M. Hashem and BahramPesaran, (1997).Working with Microfit 4.0: Interactive Econometric

Analysis, UK: Oxford University Press.

Rodrik, Dani, (1991). Policy uncertainty and private investment in developing countries, Journal of Development Economics 36 (2), 229{242.

Seddighi, H.R., Lawler, A., Katos, A.V. (2006). Applied Econometrics: A Practical Approach.Routledge, London.

Shabbir, M. S., Bashir, M., Abbasi, H. M., Yahya, G., & Abbasi, B. A. (2020). Effect of domestic and foreign private investment on economic growth of Pakistan. Transnational Corporations Review, 1-13.

Shabbir, M. S., & Yaqoob, N. (2019). The impact of technological advancement on total factor productivity of cotton: a comparative analysis between Pakistan and India. Journal of Economic Structures, 8(1), 27.

Shabbir, M. S. (2016). Contributing factors of inland investment. Journal of Economic Research and Studies, 1(10), 1-27.

Shabbir, M. S., & Muhammad, I. (2019). The dynamic impact of foreign portfolio investment on stock prices in Pakistan. Transnational Corporations Review, 11(2), 166-178.

Shleifer, A., &Vishny, R. (1994). Politicians and firms.The Quarterly Journal of Economics, 109, 995–1025.

Solow, R. (1957). Technical change and the aggregate production function. Review of Economics and Statistics, 39, 312–320.

Turner, P. (2006). Response surfaces for an F-test for Co integration. Appl. Econ. Lett.13(8), 479–482.

https://dx.doi.org/10.30566/ijo-bs/2021.10.60

Venieris, Y.P., Gupta, D.K. (1986). Income distribution and socio political instability as determinants of savings: A cross-sectional model. J. Polit. Econ. 94(4), 873–883.

Wang, Y. Z., Chen, C. R., & Huang, Y. S. (2014). Economic policy uncertainty and corporate investment: Evidence from China. Pacific-Basin Finance Journal, 26, 227–243.

Wolde - Rufael, Y. (2009). The defence spending-external debt nexus in Ethiopia. Def. Peace Econ. 20(5), 423–436.

Yikun, Z., Gul, A., Saleem, S., Shabbir, M. S., Bilal, K., & Abbasi, H. M. (2021). The relationship between renewable energy sources and sustainable economic growth: evidence from SAARC countries. Environmental Science and Pollution Research, 1-10.

Yu, S., Sial, M. S., Shabbir, M. S., Moiz, M., Wan, P., & Cherian, J. (2020). Does higher population matter for labour market? Evidence from rapid migration in Canada. Economic Research-Ekonomska Istraživanja, 1-18.

https://dx.doi.org/10.30566/ijo-bs/2021.10.60