Linear and Nonlinear Growth Determinants: The Case of Mongolia and its Connection to China

Chu, Amanda M.Y. and Lv, Zhihui and Wagner, Niklas F. and Wong, Wing-Keung

20 March 2020

Linear and Nonlinear Growth Determinants:

The Case of Mongolia and its Connection to China

Amanda M.Y. Chu[a], Zhihui Lv[b], Niklas F. Wagner[c,d,*], Wing-Keung Wong[e,f,g]

[a] Department of Mathematics and Statistics, The Hang Seng University of Hong Kong, Hong Kong

[b] KLASMOE & School of Mathematics and Statistics, Northeast Normal University, China

[c]Department of Business, Economics and Information Systems, University of Passau, Germany

[d]Research Center for Financial Services, Steinbeis Hochschule Berlin, Germany

[e]Department of Finance, Fintech Center, and Big Data Research Center, Asia University, Taiwan

[f]Department of Medical Research, China Medical University Hospital, Taiwan

[g]Department of Economics and Finance, The Hang Seng University of Hong Kong, Hong Kong

* Corresponding author. Email addresses of the authors: amandachu@hsmc.edu.hk (A.M.Y. Chu), luzh694@nenu.edu.cn (Z.H. Lv), niklas.wagner@uni-passau.de (N.F. Wagner), wong@asia.edu.tw (W.K. Wong).

Acknowledgments: The fourth author would like to thank Robert B. Miller and Howard Thompson for their continuous guidance and encouragement. The research is partially supported by The Hang Seng University of Hong Kong, Northeast Normal University, University of Passau, Asia University, China Medical University Hospital, the Research Grants Council of the Hong Kong Special Administrative Region, China (Project Numbers UGC/IIDS14/P01/17 and 12500915), and Ministry of Science and Technology (MOST) (Project Numbers 106-2410-H-468-002 and 107-2410-H-468 -002-MY3). All errors remain with the authors.

Linear and Nonlinear Growth Determinants:

The Case of Mongolia and its Connection to China

Abstract

We investigate growth determinants for Mongolia as a small emerging economy considering China as its large neighbor. Our causality analysis during January 1992 to August 2017 reveals significant linear and nonlinear relationships in growth explanation. China's GDP and coal prices, together with some of their linear and nonlinear lagged components, predict Mongolia's GDP, where a one percent increase in China's GDP relates to an increase in Mongolia of 1.5 percent. Current exchange rates and the nonlinear components of lagged levels of consumer prices also explain growth. Our results underline the role of macroeconomic drivers of growth in emerging economies.

Keywords: gross domestic product (GDP); economic growth; energy prices; coal prices; consumer prices; foreign direct investment (FDI); exchange rates; cointegration; multivariate Granger causality; nonlinear Granger causality;

JEL Classification: C53, E52, F42

1. Introduction

During the past few decades, China has completed its transition from a planned economy to a market economy and implemented its reform to adopt an opening-up policy. By doing so, China has become the world's largest exporter and the world's second-largest economy. Academics are interested in examining whether the rise of China's economy has been a key driver of global economic growth. Taking Mongolia as an example, this is the question of the present study. Given that Mongolia is an important emerging neighbor economy of China, and China is Mongolia's largest trading, investment, and tourism partner,[1] one would expect that China is a major intraregional trade partner and could have substantial influence on Mongolia's economic growth.

A large body of empirical studies examines the determinants of economic growth (see, for example, Barro (1991), Doppelhofer and Miller (2004), Grier and Tullock (1989), and Kormendi and Meguire (1985), among many others). However, only very few empirical studies, if any, have investigated China's impact on Mongolia's economy. At the same time, Mongolia's economy is a well-fitting example of one emerging economy that is in turn driven by the emergence of a large neighbor. Mongolia is thereby impacted by the "Belt and Road" initiative to expand land and maritime transport links between China, Europe, and Africa (see Ferdinand, 2016). Also, the U.S. administration has imposed nearly US$100 billion in tariffs on Chinese goods in 2018, while China introduces retaliatory tariffs. Both issues will affect the economy of many

[1] China accounted for about 80% of total Mongolia's exports and for about about 30% of Mongolia's imports in 2016. For more details see for example World Bank statistics (https://wits.worldbank.org), the Ulaanbaatar Tourism Department (http://tourism.ub.gov.mn/?p=3099) and the Mongolia Immigration Agency (http://www.immigration.gov.mn).

countries including Mongolia significantly. The Chinese Yuan Renminbi (CNY) has recently been at risk of depreciation. With this background of economic uncertainty, the task of the present paper is to study the growth determinants of a small emerging economy. We thereby ask how Mongolia fosters economic growth in such environment.

The present paper helps to fill the gap in the literature that concerns macroeconomic determinants of growth in a small emerging economy. We study Mongolia, with an assessment of the impact of China, based on cointegration analysis, the vector error correction mechanism, and linear as well as nonlinear causality tests. It is our aim to examine long-term comovement, short-term impact, and linear or nonlinear Granger causality between the GDP of China, coal prices, consumer prices, the Shanghai stock market, foreign direct investment, and exchange rates with growth in Mongolia. Our cointegration analysis confirms that there is an equilibrium long-run co-movement among the variables. Mongolia' economy is clearly linked to China with systematic dependence: We find that a one percent increase in China's GDP will lead to an increase in Mongolia's GDP of around 1.5 percent and vice versa. A one percent increase in the exchange rate with a higher valuation of the CNY will lead to around 1.28 percent increase in Mongolia's GDP, and a one percent increase in coal prices will lead to around 0.19 percent increase in Mongolia's GDP. However, a one percent increase in the foreign direct investment index will make Mongolia's GDP drop by around 0.03 percent and a one percent exchange rate slowdown in Mongolia will increase nearly 1.3 percent in Mongolia's GDP. Our causality analysis shows that there exist significant linear causalities from the GDP of China, coal prices, and exchange rates in explaining the growth in Mongolia. There also exist significant *non*linear causalities from all variables considered except the exchange rates in explaining the GDP of Mongolia. Our findings demonstrate that all the variables considered in this paper play significant roles in influencing Mongolia's GDP. As such, we document that linear as well as nonlinear relationships play a role and help to predict Mongolia's GDP. Our empirical results help us to assess the drivers of growth in a small emerging economy. They are of importance for policymakers in making decisions regarding the developmental path of Mongolia's economy and in assessing the possible impact of the "Belt and Road" initiative.

The remainder of the paper is structured as follows. Section 2 presents a brief review of the related literature. Section 3 discusses the theory for the determinants that affect economic growth in Mongolia. Section 4 presents the data and the methods being used. Section 5 discusses the empirical results, Section 6 presents some implications, and Section 7 concludes.

2. Literature review

The causality test and cointegration test have been heavily used in studies of economic growth. The causality test is first proposed by Granger (1969), who points out that our real world is "*almost certainly nonlinear*". Baek and Brock (1992) extend the linear causality test to the nonlinear causality test, which has then been modified by Hiemstra and Jones (1994) by applying the asymptotic property of U-statistics. Generally, these methods are more persuasive when accompanied with the cointegration test. During the past two decades, Johansen's maximum likelihood test has most often been used by academics and practitioners to check the cointegration relationship. Gonzalo (1994) uses a Monte Carlo approach proposing that the Johansen test performs better with the full information maximum likelihood procedure. However, Toda (1995) proposes that the causality test using a Johansen-type error correction model (ECM) may suffer from severe biases because of the role of nuisance parameters in the finite sample. Toda and

Yamamoto (1995) propose a procedure to test for causality according to a vector autoregression (VAR) approach applied to any arbitrary level of integration. Yamada and Toda (1998) conclude that ECM procedures are more powerful than the Toda and Yamamoto procedure. Odhiambo (2009) notes that the Johansen test is very sensitive to small sample sizes. In a more recent study, addressing the VAR or vector ECM (VECM) models, Bai et al. (2010) extend the bivariate causality test to the multivariate Granger causality test, which is more useful in testing for the influence of a group of variables. Many applied empirical studies have appeared in finance and economics along this line of gradual improvement of the cointegration and causality tests (see e.g. Chiang et al., 2010; Chow et al., 2018a, 2018b; Owyong et al., 2015; Qiao et al., 2008a, 2008b, 2009, 2011). We use the Johansen test and the causality test proposed by Bai et al. (2010) to study the relationships between Mongolia's GDP and China's GDP, coal prices, the Shanghai stock market, consumer prices, the exchange rates between the Chinese and Mongolian currencies to the USD, and foreign direct investment (FDI). To our best of our knowledge, this study is first to exhaustively investigate China's impact on Mongolia's growth with the linear and nonlinear Granger causality methods. We thereby obtain more detailed insight into the growth determinants of Mongolia as an emerging economy.

3. Economic Background

3.1. Research Framework

This paper uses the cointegration test, the VECM, and linear and nonlinear causality to study any long-term co-movement, short-term impact, or linear and nonlinear causality tests from seven variables: (i) China's GDP, (ii) the coal price index, (iii) the Shanghai stock index, (iv) the consumer price index (CPI), (v) the exchange rate between the Chinese currency and the USD, v(i) the exchange rate between Mongolian currency and USD and finally (vii) FDI to Mongolia.

3.2. Variable Selection

Economic growth is a primary concern in every economy, and many studies have examined the relationships between GDP and various macroeconomic variables in various countries with various methods. There are basically five research strands in the literature on economic growth.

First, it is interesting to investigate the relationship between stock market development and economic performance, and some researchers and economists structure the model to investigate the relationship between these variables. For example, Atje and Jovanovic (1993) construct a cross-section model using lagged or initial values of investment and stock market activity variables and found that stock market development has a substantial impact on economic growth. There are two main theoretical explanations of this process: (i) a stock market provides greater opportunities for both risk spreading and risk pooling, and (ii) a stock market greatly increases the amount of information available to investors about firms and their proposed investment projects. Both factors result in a more efficient allocation of resources and thus raise the marginal product of capital. However, after an estimation of the same model using current investment rather than lagged investment, Harris (1997) finds no hard evidence that the level of stock market activity could help to explain economic growth. Meanwhile, other researchers and economists prefer to investigate the causality between stock market development and economic growth. Deb and Mukherjee (2008) use the Toda and Yamamoto procedure and conclude that a strong causality exists from stock market development to economic growth. A similar result has been obtained by Enisan and Olufisayo (2009) for Egypt and South Africa. Demirguc-Kunt and Levine (1996a, 1996b), King and Levin (1993a, 1993b), Levine and Zervos (1996), and Singh (1997) also investigate the relationship between the stock market and economic growth. A more recent review with more details on the topic is for example by Nyasha and Odhiambo (2015).

Second, the theoretical foundation for empirical evidence on FDI and economic growth derives from either neoclassical or endogenous growth models. In the neoclassical growth models, FDI plays a significant role in expanding the investment volume, improves efficiency, leads to medium- or long-term effects, and thus promotes economic growth. The endogenous growth models consider long-term economic growth as a function of technological progress and provide a framework in which FDI can permanently promote economic growth in the host country via knowledge spillover or technological upgrading. De Mello (1997, 1999) show that the extent to which FDI promotes economic growth depends upon the degree of complementarity and substitution between FDI and domestic investment. In addition, many studies have examined the causality between FDI and economic growth applied to various samples and estimation techniques and have obtained rather mixed results (see Apergis et al., 2008; Carkovic and Levine, 2005; Choe, 2003; Chowdhury and Mavrotas, 2006; Holtz-

Eakin et al., 1988; Zhang, 2001). The generally accepted reason is that the effects of FDI on economic growth at the firm level may depend upon many factors. Harrison (1994) finds that the productivity of domestic competitors decreased with the presence of multinational corporations in Venezuela. Atkins and Harrison (1999) show that firms with foreign equity participation were more productive and efficient than domestic firms in Venezuela, but this relationship was stable only for small enterprises. Moreover, Nair-Reichert and Weinhold (2001) propose that considerable heterogeneity exists among countries regarding the impact of FDI on economic growth. Balasubramanyam et al. (1996, 1999) conclude that the interactions between FDI and human capital have a significant impact on growth performance. Borensztein et al. (1995) show that FDI has a positive but non-significant effect on economic growth. Only when a country has a minimum threshold stock of human capital is FDI the main determinant of economic growth. Similar results have been obtained by Blomstrom et al. (1994), Borenztein et al. (1998), Haddad and Harrison (1993), and Alfaro et al. (2004). Zhang and Daly (2011) study the history and the determinants of China's outward FDI. They identify target countries and find that the mining and petroleum sectors play a major role.

Third, the management of exchange rates exerts an important influence on economic growth. According to Hausmann et al. (2005) and Easterly (2005), rapid economic growth shows a significant association with real exchange rate depreciation and vice versa. However, Haddad and Pancaro (2010) show that real undervaluation only works for low-income countries and only in the medium term. Dollar (1992) suggests that policymakers should avoid a significantly low real exchange rate based on the experience of economic growth around the world. Rodrik (2008) argues that real undervaluation increases the profitability and expansion of the trade sector and promotes economic growth, especially in developing countries, mainly because it accelerates structural change in a direction that promotes growth. Rapetti et al. (2012)

show that the relationship between exchange rate undervaluation and per capita GDP is non-monotonic, especially in the least developed countries and the richest countries. The final effect on economic performance depends on the level of financial sector development and complementary factors, such as political and macroeconomic stability, as shown by Eichengreen (2008) and Aghion et al. (2009). In addition, Bosworth et al. (1995) propose that the volatility of the real exchange rate hampers economic growth, especially in a large sample of industrial and developing countries.

Fourth, understanding the relationship between commodity prices and economic growth has become increasingly important in the most recent decade of booming global commodity demand. Deaton (1999) raises the issue of the effect of commodity prices on Africa's economic development and showed a close positive relationship between commodity price movements and economic growth. Deaton and Miller (1993) find that the economies of African countries grew faster when the prices of their exports increased than when the prices fell. Deaton also found that additional income from commodity price booms helped African economies, just as they were hurt by the loss of income during economic downturns when prices fell. An account by Deaton (1999) illustrates how a plant such as cotton could bring wealth to a few and poverty to the rest because of bad governance. Thus, commodities can be an important determinant of a country's growth and wealth. Collier and Goderis (2012) find that commodity booms have positive short-term effects on output, but adverse long-term effects. The long-term effects are confined to "high-rent" non-agricultural commodities.

Finally, natural resources have been extensively investigated as determinants of economic growth. Using cross-country regressions, Sachs and Warner (1997; 2001) find empirical evidence for a "resource curse" in which countries with an abundance of natural resources tend to exhibit slower economic growth. Gylfason et al. (1999) also consider natural resources as negative growth determinants. Further empirical evidence, such as that given by Alexeev and Conrad (2009), Brunnschweiler and Bulte (2008), Doppelhofer et al. (2004), Haber and Menaldo (2011), and Lederman and Maloney (2007), however, shows either insignificant or positive effects of natural resource abundance on economic growth. Although the empirical results are mixed, a key outcome of this literature is that the existence of the resource curse is conditional on country-specific factors such as the quality of institutions and governance and the type of commodity specialization.

In addition, since the pioneering study of Kraft and Kraft (1978), the literature on the study of the Granger causality between energy consumption and GDP has grown considerably (see e.g. Cheng and Lai, 1997; Erol et al., 1987; Glasure, and Lee, 1998; Hu and Lin, 2008; Paul and Bhattacharya, 2004; Sari and Soytas, 2004; Soytas and Sari, 2003; Thoma, 2004; Yang, 2000b) and the direction of causality has significant policy implications (Jumbe, 2004; Masih and Masih, 1997, 1998; Yu and Choi, 1985). As of today coal remains to be the principal energy source, and it is given a strategic role in the economic growth of many countries. Thus, the relationship between coal and economic growth has received considerable attention (see e.g. Apergis and Payne, 2010; Bloch et al., 2012; Govindaraju and Tang, 2013; Jinke et al., 2008; Li et al., 2012; Wolde-Rufael, 2010; Yang, 2000a; Yoo, 2006).

4. Data and Methodology

We consider seven variables in order to capture more information about the macroeconomic growth determinants of Mongolia's economy. These include China's GDP, coal prices, the CPI, the Shanghai stock market index, FDI, and the exchange rates of the Chinese and Mongolian currencies. We thereby also assess China's impact on Mongolia's GDP.

4.1. Data

The dependent variable in our analysis is Mongolia's GDP, GDP_t^M as reported in year t. The independent variables used include China's GDP (GDP_t^C), the coal price index (Coal_t), the Shanghai stock index (Stock_t^C), the consumer price index (CPI_t^W), foreign direct investment in Mongolia (FDI_t^M), and the exchange rates of China $\mathrm{CNY/USD}$ and Mongolia $\mathrm{MNT/USD}$ each with respect to the U.S. dollar USD, namely $\mathrm{Ex.rate}_t^C$ and $\mathrm{Ex.rate}_t^M$ in year t (where MNT is the Mongolian official currency and CNY is the Chinese Yuan Renminbi). We obtain annual data for GDP_t^C, GDP_t^M, and FDI_t^M and monthly data for all other variables. We convert the annual data into monthly data by interpolation. The GDPs of Mongolia and China are expressed in billions of U.S. dollars. All data used span the period from January 1992 to August 2017 as obtained from the World Bank, Yahoo Finance, and the Wikipedia website.

4.2. Cointegration test

During the past few decades, many researchers and economists have paid considerable attention to studies of the cointegration test and the VECM model (see Engle and Granger, 1987; Granger, 1981; Johansen, 1991; Johansen and Juselius, 1990). Engle and Granger (1987) and Granger (1981) introduce the main idea of cointegration with two restricted conditions as follows: (i) all components of the vector x_t are $I(d)$, and (ii) there exists a vector $\alpha\ (\neq 0)$ with $z_t = \alpha' x_t \sim I(d-b),\ b > 0$. Then, the vector x_t is said to be cointegrated of order (d, b), denoted $x_t \sim CI(d, b)$, where the vector α is called the cointegrating vector. Thus, once we find that the variables given are non-stationary at their level but are in the same order of integration, we can apply the cointegration test. According to this idea, two important test methods are relevant: the Johansen cointegration test and the Engle-Granger test. Because the Johansen cointegration test allows for the existence of more than one potential cointegration relationship, we apply the Johansen cointegration test to determine whether there is any cointegration relationship between the variables (i.e. between GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, Stock_t^C and GDP_t^M). There are two statistics of the Johansen test, a trace statistic and a maximum eigenvalue statistic. The null hypothesis of the trace statistic and the maximal eigenvalue statistic is that the number of cointegration vectors is $\mathrm{r} = \mathrm{r}^* < k$, but the alternative hypothesis of these two statistics is not the same: the alternative hypothesis of the trace statistic is $\mathrm{r} = \mathrm{k}$, and the alternative hypothesis for the maximum eigenvalue test is $\mathrm{r} = \mathrm{r} + 1$. Readers may refer to Johansen (1991) for more details.

We find that the variables (GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, Stock_t^C, and GDP_t^M) are non-stationary at their level and are in the same order of integration, namely $\mathrm{I}(1)$. After application of the Johansen cointegration test; we obtain the following cointegration equation of the variables (see also e.g. Enders (2008) and Feasel et al. (2001):

$$\mathrm{GDP}_t^M = \beta_0 + \beta_1 \mathrm{Ex.rate}_t^C + \beta_2 \mathrm{Ex.rate}_t^M + \beta_3 \mathrm{GDP}_t^C + \beta_4 \mathrm{FDI}_t^M + \beta_5 \, \mathrm{Stock}_t^C + \beta_6 \mathrm{CPI}_t^W + \beta_7 \mathrm{Coal}_t + \varepsilon_t \quad . \tag{4.1}$$

4.3 Linear causality test

After obtaining the cointegration relationship between GDP_t^M and GDP_t^C, Coal_t,

CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, and Stock_t^C, we apply the Granger causality test to examine whether past information for GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, and Stock_t^C may contribute to predicting future levels of GDP_t^M. To this aim, we study both linear and nonlinear Granger causality in bivariate and multivariate situations. We first discuss the methods of linear causality in the next subsection. Thereafter, we discuss the methods of nonlinear causality.

4.3.1. Granger linear causality test

Because the components of the vector $\mathrm{Z}_t = (\mathrm{GDP}_t^M, \mathrm{Ex.rate}_t^C, \mathrm{Coal}_t, \mathrm{CPI}_t^W, \mathrm{FDI}_t^M, \mathrm{GDP}_t^C, \mathrm{Ex.rate}_t^M, \mathrm{Stock}_t^C)'$ are all $\mathrm{I}(1)$, after obtaining the cointegration equation, we can use a VECM specification to adjust the short-term dynamics of the variables in the system with deviation from equilibrium. We subtract the deterministic components and obtain the following multivariate Wold representation

$$(1 - \mathrm{B})\mathrm{Z}_t = \mathrm{C}(\mathrm{B})\varepsilon_t, \tag{4.2}$$

where $\mathrm{C}(\mathrm{B})$ is given by the function $\det[\mathrm{C}(\mathrm{Z})]$, $\mathrm{Z} = e^{iw}$ has all zeros on or outside the unit circle, $\mathrm{C}(0) = \mathrm{I}_N$, and I_N denotes the $\mathrm{N} \times \mathrm{N}$ identity matrix. Based on the Granger representation theorem, we obtain the following error correction model

$$\mathrm{A}^*(\mathrm{B}) \begin{pmatrix} \Delta\mathrm{GDP}_t^M \\ \Delta\mathrm{Ex.rate}_t^C \\ \mathrm{Coal}_t \\ \Delta\mathrm{CPI}_t^W \\ \Delta\mathrm{FDI}_t^M \\ \Delta\mathrm{GDP}_t^C \\ \Delta\mathrm{Ex.rate}_t^M \\ \Delta\mathrm{Stock}_t^C \end{pmatrix} = -\gamma\alpha' \begin{pmatrix} \mathrm{GDP}_{t-1}^M \\ \mathrm{Ex.rate}_{t-1}^C \\ \mathrm{Coal}_{t-1} \\ \mathrm{CPI}_{t-1}^W \\ \mathrm{FDI}_{t-1}^M \\ \mathrm{GDP}_{t-1}^C \\ \mathrm{Ex.rate}_{t-1}^M \\ \mathrm{Stock}_{t-1}^C \end{pmatrix} + \mathrm{d}(\mathrm{B})\varepsilon_t, \tag{4.3}$$

where $A^{*}(0) = I_N$ with $A(0) = I$, $A(1)$ has all elements finite, $\gamma \neq 0$ and ε_t denotes a stationary multivariate disturbance term (Engle and Granger, 1987).

Given the above VECM model, we examine the causalities from GDP_t^C, $Coal_t$, CPI_t^W, $Ex.rate_t^M$, $Ex.rate_t^C$, FDI_t^M and $Stock_t^C$ to GDP_t^M. Without loss of generality, we can denote the vectors as $X_t = \left(Ex.rate_t^C, Coal_t, CPI_t^W, FDI_t^M, GDP_t^C, Ex.rate_t^M, Stock_t^C\right)' = (X_{1.t}, \dots, X_{7.t})'$ and $Y_t = GDP_t^M$. Hence,

$$\Delta X_t = \left(\Delta Ex.rate_t^C, \Delta Coal_t, \Delta CPI_t^W, \Delta FDI_t^M, \Delta GDP_t^C, \Delta Ex.rate_t^M, \Delta Stock_t^C\right)' = (\Delta X_{1.t}, \dots, \Delta X_{7.t})'$$

and $\Delta Y_t = \Delta GDP_t^M$, were the symbol Δ denotes the first-order difference of a time series. We next adopt the following VECM model

$$\begin{pmatrix} \Delta X_t \\ \Delta Y_t \end{pmatrix} = \begin{pmatrix} A_{x[7\times1]} \\ A_{y[1\times1]} \end{pmatrix} + \begin{pmatrix} A_{xx}(L)_{[7\times7]} & A_{xy}(L)_{[7\times1]} \\ A_{yx}(L)_{[1\times7]} & A_{yy}(L)_{[1\times1]} \end{pmatrix} \begin{pmatrix} \Delta X_{t-1} \\ \Delta Y_{t-1} \end{pmatrix} + \begin{pmatrix} \alpha_{x[7\times1]} \\ \alpha_{y[1\times1]} \end{pmatrix} \cdot ecm_{t-1} + \begin{pmatrix} e_{x,t} \\ e_{y,t} \end{pmatrix}, \qquad (4.4)$$

where $A_{x[7\times1]}$and $A_{y[1\times1]}$are vectors of intercept terms; $A_{xy}(L)_{[7\times1]}$, $A_{xx}(L)_{[7\times7]}$, $A_{yx}(L)_{[7\times1]}$, and $A_{yy}(L)_{[1\times1]}$ are matrices of lag polynomials; ecm_{t-1} denotes the lag one of the error correction terms and $\alpha_{x[7\times1]}$ and $\alpha_{y[1\times1]}$ are the coefficient vectors for the error correction term ecm_{t-1}. It is obvious that there are two sources of causality in (4.4), either from the lagged dynamic terms $\Delta X_{t-1}(\Delta Y_{t-1})$ or from the lagged error correction term ecm_{t-1}. Finally we can test the null hypotheses $H_{01}\colon A_{xy}(L) = 0\left(H_{02} : A_{yx}(L) = 0\right)$ and $H_{03}\colon \alpha_x = 0\left(H_{04} : \alpha_y = 0\right)$ to identify a

Granger causality by applying a likelihood ratio LR-test (see Bai et al., 2010, 2011, 2018).

4.3.2. Nonlinear causality test

From the VECM model (4.4), we can obtain corresponding residuals $\{\hat{e}_{x,t}\}$ and $\{\hat{e}_{y,t}\}$ to test for nonlinear causality. For simplicity, $X_t = (X_{1,t}, \dots, X_{7,t})'$ and Y_t denote the corresponding residuals of any two vectors examined. For $X_{i,t}, \mathrm{i} = 1, \dots, 7,$ we denote the m_{x_i}-length lead vector and the L_{x_i}-length lag vector of $X_{i,t}$ as

$$X_{i,t}^{m_{x_i}} \equiv \left(X_{i,t}, X_{i,t+1}, \dots, X_{i,t+m_{x_i}-1}\right), \; m_{x_i} = 1,2, \dots, \; t = 1, 2, \dots,$$

$$X_{i,t-L_{x_i}}^{L_{x_i}} \equiv \left(X_{i,t-L_{x_i}}, X_{i,t-L_{x_i}+1}, \dots, X_{i,t-1}\right), \; L_{x_i} = 1, 2, \dots, \; t = L_{x_i} + 1, L_{x_i} + 2, \dots,$$

and the definitions are analogous with $Y_{i,t}$. We further denote $M_x = \left(m_{x1}, \dots, m_{x_7}\right)$, $L_x = \left(L_{x1}, \dots, L_{x_7}\right)$, $m_x = \max(m_{x1}, \dots, m_7)$, and $l_x = \max\left(L_{x1}, \dots, L_{x_7}\right)$. Under the assumption that the time series vector variables $\mathrm{X_t} = (\mathrm{X_{1,t}}, \dots, \mathrm{X_{7,t}})'$ and $\mathrm{Y_t}$ are strictly stationary, weakly dependent, and satisfy the mixing conditions stated in Denker and Keller (1983), we can test the null hypothesis that $\mathrm{Y_t}$ does not strictly Granger cause $\mathrm{X_t} = \left(\mathrm{X_{1,t}}, \dots, \mathrm{X_{7,t}}\right)'$. Given that the null hypothesis is true, the test statistic has the following asymptotic Normal distribution:

$$\sqrt{\mathrm{n}}\left(\frac{\mathrm{C_1(M_x+L_x,L_y,e,n)}}{\mathrm{C_2(L_x,L_y,e,n)}} - \frac{\mathrm{C_3(M_x+L_x,e,n)}}{\mathrm{C_4(L_x,e,n)}}\right) \sim \mathrm{N}\left(0, \sigma^2\left(\mathrm{M_x}, \mathrm{L_x}, \mathrm{L_y}, \mathrm{e}\right)\right) \qquad (4.5)$$

Readers may refer to Bai et al. (2010, 2011, 2018) for more details regarding the test statistic (4.5) and the definitions of $\mathrm{C_1}$, $\mathrm{C_2}$, $\mathrm{C_3}$, and $\mathrm{C_4}$.

5. Findings

In this section, we apply the Johansen cointegration and linear and nonlinear causality tests described above. We employ the vector error correction mechanism (VECM) model to analyze whether there exists long-term co-movement and short-run impact from GDP_t^{C}, Coal_t, CPI_t^{W}, $\mathrm{Ex.rate}_t^{M}$, $\mathrm{Ex.rate}_t^{C}$, FDI_t^{M} and Stock_t^{C} to GDP_t^{M}. We also examine whether past levels of GDP_t^{C}, Coal_t, CPI_t^{W}, $\mathrm{Ex.rate}_t^{M}$, $\mathrm{Ex.rate}_t^{C}$, FDI_t^{M}, and Stock_t^{C} can be used to predict future levels of GDP_t^{M}. Before checking the above, we examine the variables' descriptive statistics.

5.1. Descriptive Statistics

Table 1 presents the basic descriptive statistics for GDP_t^{C}, Coal_t, GDP_t^{M}, CPI_t^{W}, $\mathrm{Ex.rate}_t^{M}$, $\mathrm{Ex.rate}_t^{C}$, FDI_t^{M}, and Stock_t^{C}. From the table, we find that the means of all the variables are significantly positive at the 1 percent level. We also find that the skewness of all the variables are significantly positive at the 1 percent level, implying that all variables are skewed to the right. The variables CPI_t^{W}, GDP_t^{C} and GDP_t^{M} have negative excess kurtosis ("thin tails"), while the others have positive excess kurtosis ("heavy tails") at the 1 percent level. Furthermore, from the Jarque–Bera (J-B) test statistics we conclude that the variables are obviously not normally distributed.

Table 1

Descriptive statistics for the variables.

Variable	Mean	Stdev	Skewness	Kurtosis	J-B

GDP_t^M	4.3844***	3.9997	0.9042***	-0.8047***	50.3989***
GDP_t^C	3883.782***	3708.233	0.9065***	-0.7101***	48.7995***
$Ex.rate_t^M$	0.0013***	0.0014	2.9939***	8.3840***	1382.739***
$Ex.rate_t^C$	0.0095***	0.0081	2.2400***	4.6320***	541.3838***
CPI_t^W	63.6061***	39.2838	0.6602***	-0.7948***	30.9004***
$Stock_t^C$	1933.52***	1021.255	0.9259***	0.9600***	56.915***
FDI_t^M	1139907***	1681914	1.8723***	2.5554***	267.9089***
$Coal_t$	56.9838***	30.9662	1.0871***	0.6654***	68.4339***

Note: The table reports the summary statistics including the mean, standard deviation (Stdev), skewness, and excess Kurtosis. The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively.

5.2. Unit-root test

Before examining cointegration and causality among the variables being studied, we employ the Augmented Dickey-Fuller test to check whether there are any unit roots and present the results in Table 2. From the table, we conclude that there exists a unit root in each of the variables and hence the first differences of all the series are stationary.

Table 2

The Augmented Dickey-Fuller test.

	GDP_t^M	GDP_t^C	$Ex.rate_t^M$	$Ex.rate_t^C$
Level	-0.7647	-2.1643	-3.1312	-2.1532
1st difference	-3.2270***	-3.6752***	-20.7148***	-6.7270***
	CPI_t^M	$Stock_t^C$	FDI_t^M	$coal_t$
Level	-1.4372	-1.2488	-2.8717	-1.1632
1st difference	-13.0014***	-4.5658***	-8.5227***	-12.3736***

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively.

5.3. Cointegration test

As all series are integrated of order one, we apply the Johansen cointegration test to examine whether there are cointegration relationships among the variables. From the results in Table 3, we can reject the null of no cointegration, but cannot reject the hypothesis of no more than one cointegration relationship. The evidence of one cointegration relationship implies that there is an equilibrium long-run co-movement among the variables. This rules out spurious correlation and implies that at least one direction of influence can be established among the time series.

Table 3

Cointegration test.

	Trace Statistic	Max-Eigen Statistic
None	233.5271***	87.34665***
At most 1	146.1804	37.51926
At most 2	108.6612	32.92509

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively.

As the interest in our paper is to examine the determinants of GDP_t^M, we investigate whether there is any cointegration equation from GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M and Stock_t^C to GDP_t^M. We exhibit the results in column 2 of Table 4 and obtain the following cointegration equation for GDP_t^M, which we call *Full Model*:

$$\mathrm{GDP}_t^M = -6.4811 + 1.2823\mathrm{Ex.rate}_t^C - 0.4906\mathrm{Ex.rate}_t^M + 1.4395\mathrm{GDP}_t^C - 0.0282\mathrm{FDI}_t^M - 0.0444\,\mathrm{Stock}_t^C - 0.0468\mathrm{CPI}_t^W + 0.0336\mathrm{Coal}_t + \varepsilon_t. \quad (5.1)$$

The cointegration equation displayed above describes the long run relationship among the variables. According to equation (5.1) and the second column of Table 4, we find that GDP and the Chinese exchange rate have significantly positive effects while the exchange rate in Mongolia has significantly negative effects on Mongolia's GDP. Table 4 furthermore shows that $\mathrm{Ex.rate}_t^C$, $\mathrm{Ex.rate}_t^M$, GDP_t^C have significant linear effects on Mongolia's GDP while Coal_t, CPI_t^W, FDI_t^M, and Stock_t^C are not significant to Mongolia's GDP. To check for each insignificant variable, we include all significant variables and one insignificant variable from the full model (5.1) to obtain four reduced models, R1 to R4:

R1 model:

$$\mathrm{GDP}_t^M = -6.8078 + 1.5616\mathrm{Ex.rate}_t^C - 0.6280\mathrm{Ex.rate}_t^M + 1.4921\mathrm{GDP}_t^C - 0.0315\mathrm{FDI}_t^M + \varepsilon_t;$$

R2 model:

$$\mathrm{GDP}_t^M = -7.2810 + 1.6377\mathrm{Ex.rate}_t^C - 0.8018\mathrm{Ex.rate}_t^M + 1.4625\mathrm{GDP}_t^C - 0.0705\ \mathrm{Stock}_t^C + \varepsilon_t;$$

R3 model:

$$\mathrm{GDP}_t^M = -7.4787 + 1.8035\mathrm{Ex.rate}_t^C - 0.8390\mathrm{Ex.rate}_t^M + 1.5006\mathrm{GDP}_t^C - 0.0162\mathrm{CPI}_t^W + \varepsilon_t;$$

R4 model:

$$\mathrm{GDP}_t^M = -7.5851 + 2.1570\mathrm{Ex.rate}_t^C - 0.9990\mathrm{Ex.rate}_t^M + 1.6822\mathrm{GDP}_t^C - 0.1890\mathrm{Coal}_t + \varepsilon_t.$$

The results from the four reduced models R1 to R4 above are given in columns 3 to 6 of Table 4. From the reduced models, we realize that Coal_t and FDI_t^M become significant while CPI_t^W and Stock_t^C remain insignificant to Mongolia's GDP. We therefore suggest that the variables Coal_t and FDI_t^M are not significant in the full model because of possible multicollinearity.

Table 4

The cointegration equations for GDP_t^M.

Cointegrating Eq:	Full Model	R1 Model	R2 Model	R3 Model	R4 Model
$\mathrm{Ex.rate}_t^C$	-1.2823***	-1.5616***	-1.6377***	-1.8035***	-2.1570***
	(-4.4265)	(-4.8311)	(-3.6290)	(-3.7103)	(-4.3275)
$\mathrm{Ex.rate}_t^M$	0.4906**	0.6280***	0.8018**	0.8390**	0.9990***

	(2.2723)	(2.5053)	(2.2920)	(2.1922)	(2.5976)
GDP_t^C	-1.4395***	-1.4921***	-1.4625***	-1.5006***	-1.6822***
	(-20.6473)	(-21.5057)	(-16.0745)	(-14.5881)	(-13.6877)
FDI_t^M	0.0282	-0.0315*			
	(1.3048)	(1.3413)			
$Stock_t^C$	0.0444		0.0705		
	(1.0908)		(1.1168)		
CPI_t^W	0.0468			0.0162	
	(1.1352)			(0.2377)	
$Coal_t$	-0.0336				0.1890**
	(-0.6570)				(2.2051)
C	6.4811***	6.8078***	7.2810***	7.4787***	7.5851***
	(18.6435)	(10.7448)	(9.7817)	(11.6248)	(11.3211)
F-statistic	985.0015***	1819.108***	1165.929***	1819.108***	1164.438***
Adj.R-squared	0.9676	0.9679	0.9508	0.9679	0.9507
ADF test for residual	-4.9621***	-4.8369***	-5.2784***	-5.2281***	-5.4778***

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively. The upper is the estimate of coefficient and the lower is T-statistics in brackets.

From the full model, we find that both GDP and exchange rate in China have significant positive effects while exchange rate in Mongolia has a significant negative effect on Mongolia's GDP. The estimates show that one percent increase of China's GDP will lead to around 1.5 percent increase in Mongolia's GDP and one percent increase of the Chinese exchange rate will lead to around 1.28 percent increase in Mongolia's GDP. A one percent exchange rate slowdown in Mongolia will increase Mongolia's GDP by nearly 1.3 percent. From the reduced model R1, we conclude that foreign direct investment FDI_t^M is significant and that a one percent increase in FDI will make Mongolia's GDP drop by around 0.03 percent. From the reduced model R4, we find that coal prices $Coal_t$ are significant and a one percent increase in coal prices will lead to around a 0.19 percent increase in Mongolia's GDP. In sum, we conclude that Mongolia's GDP can be explained by both exchange rates, the GPD of China, FDI and coal prices in the long run cointegration relationship.

5.4. Causality tests

According to the cointegration relationship in equation (5.1), we know that there exist short-run impacts and causality from the dependent variables to Mongolia's GDP. Before checking whether there is any causality relationship, we first apply the VECM model as stated in Equation (4.4) for $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$, $\Delta\mathrm{Stock}_t^C$, and $\Delta\mathrm{GDP}_t^M$ to incorporate the short run effect and causality. We exhibit the results in Table 5.

From Table 5, one can obtain the VECM model. However, since our main interest is to examine the impact of $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$ and $\Delta\mathrm{Stock}_t^C$ to $\Delta\mathrm{GDP}_t^M$, we only present the following VECM model for $\Delta\mathrm{GDP}_t^M$ in the reduced model

$$\Delta\mathrm{GDP}_t^M =$$
$$-0.02\mathrm{ECM}_{t-1} + 0.879\Delta\mathrm{GDP}_{t-1}^M + 0.013\Delta\mathrm{CPI}_{t-3}^W + 0.007\Delta\mathrm{Stock}_{t-2}^C + \varepsilon_{1t}, \quad (5.2)$$

(-6.868***) (45.018***) (2.470*) (2.613**)

where $\mathrm{ECM}_{t-1} = \mathrm{GDP}_t^M + 6.48 - 1.28\mathrm{Ex.rate}_t^C + 0.49\mathrm{Ex.rate}_t^M - 1.44\mathrm{GDP}_t^C + 0.03\mathrm{FDI}_t^M + 0.04\mathrm{Stock}_t^C + 0.05\mathrm{CPI}_t^W - 0.03\mathrm{Coal}_t$ and the respective t-statistics are given in brackets.

Table 5

The VECM model for $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{GDP}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{FDI}_t^M$ and $\Delta\mathrm{Stock}_t^C$.

	$\Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{Ex.rate}_t^C$	$\Delta\mathrm{Coal}_t$	$\Delta\mathrm{CPI}_t^W$	$\Delta\mathrm{FDI}_t^M$	$\Delta\mathrm{GDP}_t^C$	$\Delta\mathrm{Ex.rate}_t^M$	$\Delta\mathrm{Stock}_t^C$
ECM_{t-1}	-0.03***	-0.09*	-0.107**	-0.051	-0.156***	0.004**	-0.043	-0.091
$\Delta\mathrm{GDP}_{t-1}^M$	0.83***	0.060	-0.431	-1.778*	-1.531*	0.024	0.554	-0.663

ΔGDP^{M}_{t-2}	-0.040	0.360	1.299	2.093	-1.061	-0.029	0.276	-1.227
ΔGDP^{M}_{t-3}	0.018	-0.235	-1.314	0.701	0.835	-0.014	-0.379	-1.343
ΔGDP^{M}_{t-4}	0.050	0.065	0.155	-0.806	0.467	0.038	0.161	2.887*
$\Delta Ex.rate^{C}_{t-1}$	-0.017	0.091	-0.040	0.436	0.050*	-0.006	0.051	0.043
$\Delta Ex.rate^{C}_{t-2}$	0.005	-0.092	-0.420	-0.261	0.527	0.004	-0.101	0.381
$\Delta Ex.rate^{C}_{t-3}$	-0.001	-0.019	0.024	0.003	0.138	0.007	0.017	0.358
$\Delta Ex.rate^{C}_{t-4}$	-0.011	0.004	0.115	0.104	0.105	-0.004	0.0221	-0.167
$\Delta Coal_{t-1}$	0.010	-0.012	0.244***	0.055	0.048	0.005*	-0.017	-0.163
$\Delta Coal_{t-2}$	0.002	-0.018	0.035	0.107	-0.029	0.001	-0.015	0.060
$\Delta Coal_{t-3}$	0.011	-0.008	0.016	0.059	-0.016	0.004	-0.014	0.032
$\Delta Coal_{t-4}$	-0.001	0.100	-0.017	-0.021	0.014	-0.001	0.099	-0.198*
ΔCPI^{W}_{t-1}	-0.008	-0.018	0.127**	0.24***	-0.005	0.001	0.016	0.161
ΔCPI^{W}_{t-2}	-0.002	0.053	-0.026	0.033	-0.029	0.000	0.044	-0.008
ΔCPI^{W}_{t-3}	0.01**	0.066	0.043	-0.057	0.008	0.002	0.060	-0.182*
ΔCPI^{W}_{t-4}	0.000	0.034	0.023	0.012	0.056	-0.003	0.034	0.047
ΔFDI^{M}_{t-1}	-0.008	0.025	-0.117*	0.118	0.405***	0.002	0.044	0.054
ΔFDI^{M}_{t-2}	-0.006	-0.053	-0.024	-0.016	0.049	0.002	-0.036	-0.44***
ΔFDI^{M}_{t-3}	-0.004	0.025	0.034	-0.023	0.029	0.002	0.041	0.61***
ΔFDI^{M}_{t-4}	-0.009	-0.47***	-0.010	-0.062	-0.026	0.002	-0.46***	-0.48***
ΔGDP^{C}_{t-1}	0.074	0.811	1.281	2.363	2.921	0.84***	0.007	1.472
ΔGDP^{C}_{t-2}	0.113	-0.411	-0.793	-3.767	2.617	0.050	-0.387	5.126
ΔGDP^{C}_{t-3}	-0.020	-1.131	-0.390	0.899	-2.366	0.009	-0.877	-3.741
ΔGDP^{C}_{t-4}	-0.057	1.201	0.543	0.143	-0.419	-0.046	1.202	-1.997
$\Delta Ex.rate^{M}_{t-1}$	0.010	-0.496	-0.031	-0.504	-0.106	0.009	-0.450	-0.033
$\Delta Ex.rate^{M}_{t-2}$	-0.022	-0.495	0.374	0.189	-0.520*	0.003	-0.408	-0.533
$\Delta Ex.rate^{M}_{t-3}$	-0.007	-0.104	-0.064	-0.073	-0.106	-0.002	-0.098	-0.173
$\Delta Ex.rate^{M}_{t-4}$	-0.023	-0.268	-0.127	-0.185	-0.034	0.017**	-0.095	0.080
$\Delta Stock^{C}_{t-1}$	0.004	0.059*	0.025	0.033	0.024	0.000	0.063*	-0.022
$\Delta Stock^{C}_{t-2}$	0.01**	-0.009	0.067**	0.034	0.076***	0.000	-0.018	0.034
$\Delta Stock^{C}_{t-3}$	0.003	0.001	0.013	0.011	-0.061**	-0.002	-0.001	-0.081
$\Delta Stock^{C}_{t-4}$	0.003	0.12***	0.063**	0.059*	-0.030	-0.001	0.117***	-0.044
C	0.000	-0.02**	-0.003	0.001	-0.009	0.001**	-0.014*	0.003
Adj.R^2	0.905	0.287	0.105	0.053	0.395	0.849	0.312	0.112
F-stat.	89.338	4.728	2.089	1.518	7.064	53.172	5.201	2.171

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively, and the symbol Δ stands for first order difference.

Equation (5.2) exhibits both short-run effects and linear causality from the independent variables to $\Delta\mathrm{GDP}_t^M$. We find that $\Delta\mathrm{GDP}_{t-1}^M$, $\Delta\mathrm{CPI}_{t-3}^W$, and $\Delta\mathrm{Stock}_{t-2}^C$ have positive significant effects on $\Delta\mathrm{GDP}_t^M$. In addition, the error correction term ecm_{t-1} in the model is statistically significant and correctly signed. This confirms that Mongolia's GDP has an adjustment mechanism and that the economy responds to deviations from equilibrium in a balancing manner. The value of -0.02 for the coefficient of error correction term suggests that Mongolia's economy will converge towards its long-run equilibrium level at a moderate speed after the shocks or fluctuations of other variables.

To further examine the relationships among the variables, we investigate the linear and nonlinear causality from the group of $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$, and $\Delta\mathrm{Stock}_t^C$ to $\Delta\mathrm{GDP}_t^M$ in both multivariate and bivariate situations. We note that conducting both multivariate and bivariate linear causality is helpful as the two settings address different types of causality. We first conduct the multivariate linear Granger causality test from all independent variables to $\Delta\mathrm{GDP}_t^M$ and present the results in Table 7.

Table 7

Multivariate linear causality test.

	$\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{FDI}_t^M$, $\Delta\mathrm{Stock}_t^C \rightarrow \Delta\mathrm{GDP}_t^M$
Lags	4
F-Stat	133.3346***

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively, and the symbol Δ stands for the first order difference. The notation "→" indicates the direction of causality and "A → B" indicates causality from A to B.

Table 7 illustrates that there is strong significant multivariate linear causality from the group of $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$ and $\Delta\mathrm{Stock}_t^C$ to $\Delta\mathrm{GDP}_t^M$. However, the results cannot tell whether there is any significant linear causality from each of $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$, and $\Delta\mathrm{Stock}_t^C$ to the return of Mongolia's GDP. To overcome this limitation and to examine whether there is any individual causality, we additionally conduct bivariate linear causality test from each of $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$, and $\Delta\mathrm{Stock}_t^C$ to the return of Mongolia's GDP and present the results in Table 8.

Table 8

Bivariate linear causality test.

	$\Delta\mathrm{Ex.rate}_t^C \rightarrow \Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{Coal}_t \rightarrow \Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{CPI}_t^W \rightarrow \Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{Stock}_t^C \rightarrow \Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{Ex.rate}_t^M \rightarrow \Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{GDP}_t^C \rightarrow \Delta\mathrm{GDP}_t^M$	$\Delta\mathrm{FDI}_t^M \rightarrow \Delta\mathrm{GDP}_t^M$
Lags	1	1	1	1	25	13	1
F-Stat	0.7177	5.8057*	0.0708	0.0276	1.9265**	3.1107***	1.9292

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively, and the symbol Δ stands for the first order difference. The notation "→" indicates the direction of causality and "A → B" indicates causality from A to B.

Table 8 shows that there is a strong significant linear causality from each of $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{Ex.rate}_t^M$, and $\Delta\mathrm{GDP}_t^C$ to the change in Mongolia's GDP, but not from the remainder variables. This implies that the change in Mongolia's GDP can be linearly predicted by using past values of $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{Ex.rate}_t^M$, and $\Delta\mathrm{GDP}_t^C$. However, as linear causality and nonlinear causality could be independent (Chiang et al., 2010; Chow et al., 2018a, 2018b; Owyong et al., 2015; Qiao et al., 2008a, 2008b, 2009), we need to conduct both multivariate and bivariate nonlinear causality tests to examine whether there is any nonlinear causality from $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$, and $\Delta\mathrm{Stock}_t^C$ to the return of Mongolia's GDP. We next conduct the multivariate nonlinear causality test to examine whether there is any nonlinear causality from the group of $\Delta\mathrm{GDP}_t^C$, $\Delta\mathrm{Coal}_t$, $\Delta\mathrm{CPI}_t^W$, $\Delta\mathrm{Ex.rate}_t^M$, $\Delta\mathrm{Ex.rate}_t^C$, $\Delta\mathrm{FDI}_t^M$, and $\Delta\mathrm{Stock}_t^C$ to the return of Mongolia's GDP, and present the results in Table 9.

Table 9

Multivariate nonlinear causality test.

Lags	$\Delta Coal_t$, ΔCPI_t^W, ΔGDP_t^C, $\Delta Ex.rate_t^C$, $\Delta Ex.rate_t^M$, ΔFDI_t^M, $\Delta Stock_t^C \rightarrow \Delta GDP_t^M$
1	4.091250***
2	3.750674***
3	3.375074***
4	2.964916***
5	2.605708***
6	2.270700**
7	1.882954**
8	1.554895*
9	1.215177
10	0.961681

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively, and the symbol Δ stands for the first order difference. The notation "→" indicates the direction of causality and "A → B" indicates causality from A to B.

From Table 9, we conclude that there exists significant multivariate nonlinear causality from ΔGDP_t^C, $\Delta Coal_t$, ΔCPI_t^W, $\Delta Ex.rate_t^M$, $\Delta Ex.rate_t^C$, ΔFDI_t^M, and $\Delta Stock_t^C$ to the return of Mongolia's GDP. However, the results cannot tell whether there is any significant nonlinear causality from each of ΔGDP_t^C, $\Delta Coal_t$, ΔCPI_t^W, $\Delta Ex.rate_t^M$, $\Delta Ex.rate_t^C$, ΔFDI_t^M, and $\Delta Stock_t^C$ to the return of Mongolia's GDP. To circumvent the limitation and to examine whether this is an individual nonlinear causality from each of the independent variables to the return of Mongolia's GDP, we conduct the bivariate linear causality test from each of ΔGDP_t^C, $\Delta Coal_t$, ΔCPI_t^W, $\Delta Ex.rate_t^M$, $\Delta Ex.rate_t^C$, ΔFDI_t^M, and $\Delta Stock_t^C$ to the return of Mongolia's GDP and exhibit the results in Table 10.

Table 10

Bivariate nonlinear causality test.

lags	$\Delta Ex.rate_t^C \rightarrow \Delta GDP_t^M$	$\Delta Coal_t \rightarrow \Delta GDP_t^M$	$\Delta CPI_t^W \rightarrow \Delta GDP_t^M$	$\Delta Stock_t^C \rightarrow \Delta GDP_t^M$	$\Delta Ex.rate_t^M \rightarrow \Delta GDP_t^M$	$\Delta GDP_t^C \rightarrow \Delta GDP_t^M$	$\Delta FDI_t^M \rightarrow \Delta GDP_t^M$
1	-1.218467	0.442313	-1.7581**	0.307706**	0.066157	0.805753	-1.482848*
2	-0.731696	0.673272	-1.33146*	0.307706	-0.297631	0.538867	-1.502956*
3	-0.429922	-0.358396	-1.29639*	-0.266520	1.086861	0.248927	-1.525303*
4	1.087622	-0.554484	-0.188709	0.557265	1.224281	-0.068693	-1.548092*
5	1.075829	-1.240929	-0.541810	0.446649	0.804111	-0.389923	-1.572101*

6	1.062302	-1.568316*	-0.664165	1.150890	0.566865	-0.733718	-1.587311*
7	1.060224	-1.68130**	-0.739846	2.761696***	0.222620	-1.081559	-1.599932*
8	1.079006	-1.615062*	-0.897734	2.589037***	0.809334	-1.393055*	-1.606813*
9	1.072026	-1.88470**	-0.721788	2.417923***	0.296337	-1.69262**	-1.611590*
10	1.088206	-1.287935*	-1.42424*	2.211673**	-0.100906	-1.93063**	-1.604911*

Note: The symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively. And the symbol Δ stands for first order difference. The notation "→" indicates causality and "A → B" indicates causality from A to B.

Table 10 shows that there exists weakly significant nonlinear causality from $\Delta \mathrm{FDI}_t^M$ to the return of Mongolian's GDP in any lag at the level of 10% and from $\Delta \mathrm{Coal}_t$ to the return of Mongolian's GDP for all large lags from lag 6 onward. The similar results are obtained by $\Delta \mathrm{Stock}_t^C$ and $\Delta \mathrm{GDP}_t^C$. In addition, there exists a strongly significant nonlinear causality from $\Delta \mathrm{Stock}_t^C$ to the return Mongolia's GDP but not from $\Delta \mathrm{Ex.rate}_t^C$ and $\Delta \mathrm{Ex.rate}_t^M$, implying that the present return of Mongolia's GDP can be predicted by using the nonlinear part of the past of $\Delta \mathrm{GDP}_t^C$, $\Delta \mathrm{Coal}_t$, $\Delta \mathrm{CPI}_t^W$, $\Delta \mathrm{FDI}_t^M$, and $\Delta \mathrm{Stock}_t^C$, but not from the nonlinear part of the past of $\Delta \mathrm{Ex.rate}_t^C$ and $\Delta \mathrm{Ex.rate}_t^M$.

5.5. Summary of cointegration and bivariate causality results

The findings of the cointegration and bivariate causality results from independent variables to Mongolia's GDP are summarized and presented in Table 11.

Table 11:

Summaries of cointegration and bivariate causality results from independent variable to GDP_t^M.

Independent Variable	Cointegration	causality	
		Linear	nonlinear
GDP_t^C	√***	√***	√**
Coal_t	√**	√*	√**
CPI_t^W	×	×	√**
$\mathrm{Ex.rate}_t^M$	√***	√**	×

$\mathrm{Ex.rate}_t^C$	√***	×	×
FDI_t^M	√*	×	√*
Stock_t^C	×	×	√***

Note: √ denotes the relationship exists and × denotes otherwise. And the symbols *, **, and *** denote the significance at the 10%, 5%, and 1% levels, respectively.

Table 11 shows that significant cointegration relationships from each of GDP_t^C, Coal_t, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, and GDP_t^Mcan be found. Among them, the cointegration relationships from GDP_t^C, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$ to GDP_t^M are significant at 1 percent level, from Coal_t to GDP_t^M is significant at 5 percent level, and from FDI_t^M to GDP_t^M is 10 percent level. The results also demonstrate that there exist significant linear causality relationships from GDP_t^C, Coal_t, and $\mathrm{Ex.rate}_t^M$ to GDP_t^M. Among them, the linear causality from GDP_t^C to GDP_t^M is significant at 1 percent level, from $\mathrm{Ex.rate}_t^M$ to GDP_t^M is at 5 percent level, and from Coal_t to GDP_t^M is at 10 percent level. In addition, the results demonstrate that there exists a significant nonlinear causality relationship from GDP_t^C, Coal_t, CPI_t^W, FDI_t^M, and Stock_t^C to GDP_t^M. Among them, the nonlinear causality relationships from GDP_t^C, Coal_t, and CPI_t^W to GDP_t^M are significant at the 5 percent level, from Stock_t^C to GDP_t^M at the 1 percent level, and from FDI_t^M to GDP_t^M at the 10 percent level.

The table also shows that there are significant cointegration and linear and nonlinear causality relationships from both GDP_t^C and Coal_t to GDP_t^M, implying that not only there exist both linear and nonlinear components from both GDP_t^C and Coal_t can be used to predict GDP_t^M, but also the present levels of both GDP_t^C and Coal_t can influence GDP_t^M with immediate effect. On the other hand, only the present level, but not any of the linear and nonlinear components of the past levels of $\mathrm{Ex.rate}_t^M$ can influence GDP_t^M, and only some of the nonlinear components of the past levels of CPI_t^Wcan influence GDP_t^M.

6. Implications

What can academics, practitioners, and policymakers learn from our findings? First, faster economic growth could be due to real exchange rate depreciation as an exchange rate depreciation will increase exports, make the trade sector become more profitable, which leads to an expansion of the economy. This also applies to Mongolia and based on our analysis, a one percent exchange rate slowdown in Mongolia will increase GPD ranging from 0.49 percent (full model) to 0.999 percent (R4 model). We can use a similar argument to find that an increase in coal prices will lead to a boom in the economy, given that an abundance of available natural resources in the country plays an important in its economic growth. Our results show that coal prices have a significantly positive impact on growth such that a one percent increase in coal prices will lead to around a 0.19 percent increase (R4 model) in Mongolia's GDP.

Our findings also lead to examine other factors that could play an important role in the Mongolian economy. It could be country-specific factors, including the quality of institutions, governance, the type of commodity specialization or the effect that natural resources crowd out human capital (see Gylfason et al., 1999). In general, FDI can boom the economy in the host countries through diffusion, technology transfer, and spillover effects. However, our findings show that FDI and GDP are negatively related. As such, FDI in Mongolia does not exert a positive impact on growth, and one percent increase in the foreign direct investment index will make Mongolia's GDP drop by around 0.03 percent. This suggests that the country should reconsider their rapid expansion of tax incentives, infrastructure subsidies, import duty exemptions, and other measures that were adopted to attract FDI. Our results also show that consumer prices and the economic growth in Mongolia do not move linearly together, while the price level has a nonlinear impact on economic growth. The exchange rate of China, the GDP of China and the stock market of China all have a significant impact on the economic growth in Mongolia. It turns out that the intimate relationship between China and Mongolia and quantifies assessment of the impact of China on Mongolia. China's GDP has a significantly positive effect on Mongolia's GDP. This is consistent with our expectation and with the realities in the Mongolian economy. The estimates show that a one percent increase in China's GDP will lead to around a 1.5 percent increase in Mongolia's GDP. We also conclude that the exchange rate in China, as well as the Chinese stock market, has significant positive effects on Mongolia's GDP. For example, the estimates show that a one percent increase in the exchange rate of China will lead to an increase in Mongolia's GDP ranging from 1.28 percent to 2.16 percent. Hence, our empirical results seem to confirm the current economic connection between China and Mongolia. China's economy has slowed down through declining imports, reducing demand, creating a bearish market for commodity prices globally. Mongolia should consider these factors to adjust policies.

7. Concluding Remarks

Given the size of China's economy and its border with Mongolia, one would expect that China exerts enormous influence on the stability and economic growth in Mongolia. Furthermore, due to the performance of Mongolia's economy in the past few decades, researchers and economists are interested in studying the given growth determinants. In this paper, we fill a gap in the literature and examine the determinants of growth in Mongolia, with the assessment of the impact of China on Mongolia. To do so, we employ cointegration, vector error correction and linear as well as nonlinear causality approaches. We thereby examine during the period from January 1992 to August 2017 whether there is any long-term co-movement, short-term impact, and linear and nonlinear causality from the Gross Domestic Products of China (GDP_t^C), coal prices (Coal_t), the consumer price index (CPI_t^W), the Shanghai stock index (Stock_t^C), foreign direct investment (FDI_t^M) and the exchange rates, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, to the GDP of Mongolia (GDP_t^M). To this aim, we also include lagged observations.

We first find that all the variables we studied contain unit roots, and thus, we can apply cointegration analysis to examine whether there is any long-term co-movement, from all independent variables to Mongolia' GDP. Our results from the Johansen cointegration test confirm that there exists at least one cointegration relationship among GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, Stock_t^C, and GDP_t^M, implying that there is an equilibrium long-run co-movement among the variables that rules out any spurious correlation and implies that at least one direction of influence. Our cointegration equation shows that there are significant long run relationships between GDP_t^C, Coal_t, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, and GDP_t^M, with all variable exhibiting significantly positive effects except $\mathrm{Ex.rate}_t^M$. We find that one percent increase of China's GDP will lead to around 1.5 percent increase in Mongolia's GDP and one percent increase in exchange rate in China will lead to around 1.28 percent increase in Mongolia's GDP, one percent exchange rate slowdown in Mongolia will increase nearly 1.3 percent in Mongolia's GDP, one percent increase in coal price will lead to around 0.19 percent increase in Mongolia's GDP. However, one percent increase in the foreign direct investment index will make Mongolia's GDP drop by around 0.03 percent and one percent exchange rate slowdown in Mongolia will increase nearly 1.3 percent in Mongolia's GDP. In sum, we conclude that Mongolia's GDP can be explained by $\mathrm{Ex.rate}_t^C$, $\mathrm{Ex.rate}_t^M$, GDP_t^C, FDI_t^M, and Coal_t in the long-run cointegration.

According to the results of the cointegration test, we decide to check whether there exists any one variable or multiple variables can cause the economic growth of Mongolia. The results of the multivariate linear and nonlinear causality show that there exists strongly significant linear and nonlinear causality from the group of variables consisting of GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, $\mathrm{Ex.rate}_t^C$, FDI_t^M, and Stock_t^C to GDP_t^M. However, the results of bivariate linear causality show that there exists a strongly significant linear causality from GDP_t^C to GDP_t^M. There exists a significant linear causality from $\mathrm{Ex.rate}_t^M$ to GDP_t^M, while there exists a weak significant linear causality from Coal_t to GDP_t^M. In addition, the results of bivariate nonlinear causality demonstrate that there exists a significant nonlinear causality from each of GDP_t^C, Coal_t, and CPI_t^W to GDP_t^M. There exists a strongly significant nonlinear causality from Stock_t^C to GDP_t^M and there exists a weak significant nonlinear causality from FDI_t^M to GDP_t^M.

In sum, employing cointegration test and linear and nonlinear causality in bivariate and multivariate situations, we show that all the variables using in this paper, namely, GDP_t^C, Coal_t, CPI_t^W, $\mathrm{Ex.rate}_t^M$, FDI_t^M, Stock_t^C, and $\mathrm{Ex.rate}_t^C$, play significant roles in influencing Mongolia's GDP with some variables, for example, GDP_t^C and Coal_t, that not only exist both linear and nonlinear components from past of both GDP_t^C and Coal_t that can be used to predict GDP_t^M, but also have the present levels of both GDP_t^C and Coal_t that can influence GDP_t^M with immediately effect. On the other hand, the present level of some variables, for example, $\mathrm{Ex.rate}_t^M$, but not any of the linear and nonlinear components of the past levels can influence GDP_t^M and only some of the nonlinear components of the past levels of CPI_t^W can influence GDP_t^M. Our empirical results to assess the impact of some variables on Mongolia economy is of utmost importance for academics, practitioners, and policymakers and are very useful for policymakers in making decisions regarding the developmental path of Mongolia's economy, in assessing the impact of the "Belt and Road" initiative launched by China to create the world's largest platform for economic cooperation, and evaluating the impact of the trade war between China and the USA to Mongolia.

References

Aghion, P., Bacchetta, P., Ranciere, R., Rogoff, K., 2009. Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics*, 56(4), 494-513.

Alexeev, M., Conrad, R., 2009. The elusive curse of oil. *Review of Economics and Statistics*, 91(3), 586-598.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., Sayek, S., 2004. FDI and economic growth: the role of local financial markets. *Journal of International Economics*, 64(1), 89-112.

Apergis, N., Lyroudi, K., Vamvakidis, A., 2008. The relationship between foreign investment and economic growth: evidence from transition countries. *Transition Studies Review*, 15(1), 37-51.

Apergis, N., Payne, J.E., 2010. Coal consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy*, 38(3), 1353-1359.

Aitken, B.J., Harrison, A.E., 1999. Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *American Economic Review*, 89(3), 605-618.

Atje, R., Jovanovic, B., 1993. Stock markets and development. *European Economic Review*, 37(2-3), 632-640.

Baek, E.G., Brock, W.A., 1992. A nonparametric test for independence of multivariate time series. *Statistica Sinica*, 2(1), 137-156.

Bai, Z.D., Hui, Y.C., Jiang, D.D., Lv, Z.H., Wong, W.K., Zheng, S.R., 2018. A New Test of Multivariate Nonlinear Causality. *PLoS One*, 13(1): https://doi.org /10.1371/journal.pone.0185155

Bai, Z.D., Li, H., Wong, W.K., Zhang, B.Z., 2011. Multivariate Causality Tests with Simulation and Application. *Statistics and Probability Letters*, 81(8), 1063-1071.

Bai, Z.D., Wong, W.K., Zhang, B.Z., 2010. Multivariate linear and nonlinear causal causality tests. *Mathematics and Computers in Simulation*, 81(1), 5-17.

Balasubramanyam, V.N., Salisu, M., Sapsford, D., 1996. Foreign direct investment and growth in EP and IS countries. *Economic Journal,* 106(433), 92-105.

Balasubramanyam, V.N., Salisu, M., Sapsford, D., 1999. Foreign direct investment as an engine of growth. *Journal of International Trade and Economic Development*, 8(1), 27-40.

Barro, R.J., 1991. Economic growth in a cross section of countries. *Quarterly Journal of Economics*, 106(2), 407-443.

Bloch, H., Rafiq, S., Salim, R., 2012. Coal consumption, CO_2 emission and economic growth in China: Empirical evidence and policy responses. *Energy Economics*, 34(2), 518-528.

Blomstrom, M., Lipsey, R.E., Zejan, M., 1994. What explains the growth of developing countries? In: Baumol, W.J., Nelson, R.R., Wolff, E.N. (eds.). Convergence of productivity: Cross-national studies and historical evidence. Oxford University Press, Oxford.

Borensztein, E., De Gregorio, J., Lee, J.W., 1998. How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1), 115-135.

Borensztein, E., De Gregorio, J., Lee, J.W., 1995. How does foreign direct investment affect growth? NBER Working Paper Series, (5057).

Bosworth, B., Collins, S.M., Chen, Y.C., 1995. Accounting for differences in economic growth. Working Paper No. 115, Brookings Institution, Washington D.C.

Brunnschweiler, C.N., Bulte, E.H., 2008. The natural resource curse revisited and revised: A tale of paradoxes and red herrings. *Journal of Environmental Economics and Management*, 55(3), 248-264.

Carkovic, M., Levine, R., 2005. Does Foreign Direct Investment Accelerate Economic Growth? in Moran, T.H., Graham, E.M., Blomstrom, M. and Blomström, M. (eds.): Does foreign direct investment promote development? Institute for International Economics and Center for Global Development, Washington D.C.

Cheng, B.S., Lai, T.W., 1997. An investigation of cointegration and causality between energy consumption and economic activity in Taiwan. *Energy Economics,* 19(4), 435-444.

Chiang, T.C., Qiao, Z., Wong, W.K., 2010. New evidence on the relation between return volatility and trading volume. *Journal of Forecasting*, 29(5), 502-515.

Choe, J.I., 2003. Do foreign direct investment and gross domestic investment promote economic growth? *Review of Development Economics*, 7(1), 44-57.

Chow, S.C., Cunado, J., Gupta, R., Wong, W.K. 2018, Causal Relationships between Economic Policy Uncertainty and Housing Market Returns in China and India: Evidence from Linear and Nonlinear Panel and Time Series Models, *Studies in Nonlinear Dynamics and Econometrics*, 22(2), 1-15.

Chow, S.C., Vieito, J.P., Wong, W.K. 2018. Do both demand-following and supply-leading theories hold true in developing countries? *Physica A: Statistical Mechanics and its Applications*, forthcoming

Chowdhury, A., Mavrotas, G., 2006. FDI and growth: What causes what? *World*

Economy, 29(1), 9-19.

Collier, P., Goderis, B., 2012. Commodity prices and growth: An empirical investigation. *European Economic Review*, 56(6), 1241-1260.

De Mello Jr, L.R., 1997. Foreign direct investment in developing countries and growth: A selective survey. *Journal of Development Studies*, 34(1), 1-34.

De Mello Jr, L.R., 1999. Foreign direct investment-led growth: evidence from time series and panel data. *Oxford Economic Papers*, 51(1), 133-151.

Deaton, A., 1999. Commodity prices and growth in Africa. *Journal of Economic Perspectives*, 13(3), 23-40.

Deaton, A., Miller, R.I., 1993. Commodity prices and macroeconomic management in Africa. Institute for Policy Reform.

Deb, S.G., Mukherjee, J., 2008. Does stock market development cause economic growth? A time series analysis for the Indian economy. *International Research Journal of Finance and Economics*, 21(3), 142-149.

Demirgüç-Kunt, A., Levine, R., 1996a. Stock markets, corporate finance, and economic growth: An overview. *World Bank Economic Review*, 10(2), 223-239.

Demirgüç-Kunt, A., Levine, R., 1996b. Stock Market Development and Financial Intermediaries: Stylized Facts. *World Bank Economic Review*, 10(2), 291-321.

Denker, M., Keller, G., 1983. On U-statistics and v. Mises' statistics for weakly dependent processes. Zeitschrift für Wahrscheinlichkeitstheorie und Verwandte Gebiete, 64(4), 505-522.

Dollar, D., 1992. Outward-oriented developing economies really do grow more rapidly: Evidence from 95 LDCs, 1976-1985. *Economic Development and Cultural Change*, 40(3), 523-544.

Doppelhofer, G., Miller, R.I., 2004. Determinants of long-term growth: A Bayesian averaging of classical estimates (BACE) approach. *American Economic Review*, 94(4), 813-835.

Easterly, W., 2005. What did structural adjustment adjust? The association of policies and growth with repeated IMF and World Bank adjustment loans. *Journal of Development Economics*, 76(1), 1-22.

Eichengreen, B., 2008. The European economy since 1945: Coordinated capitalism and beyond, Princeton University Press, Princeton.

Enders, W., 2008. Applied econometric time series. John Wiley & Sons, New York.

Engle, R.F., Granger, C.W., 1987. Cointegration and error correction: Representation, estimation, and testing. *Econometrica*, 55(2), 251-276.

Enisan, A.A., Olufisayo, A.O., 2009. Stock market development and economic growth: Evidence from seven sub-Sahara African countries. *Journal of Economics and Business*, 61(2), 162-171.

Erol, U., Yu, E.S., 1987. On the causal relationship between energy and income for industrialized countries. *Journal of Energy and Development*, 13(1), 113-122.

Feasel, E., Kim, Y., Smith, S.C., 2001. Investment, exports, and output in South Korea: A VAR approach to growth empirics. *Review of Development Economics*, 5(3), 421-432.

Ferdinand, P., 2016. Westward ho—The China dream and 'one belt, one road': Chinese foreign policy under Xi Jinping. *International Affairs* 92(4), 941-957.

Glasure, Y.U., Lee, A.R., 1998. Cointegration, error-correction, and the relationship between GDP and energy: The case of South Korea and Singapore. *Resource and Energy Economics*, 20(1), 17-25.

Gonzalo, J., 1994. Five alternative methods of estimating long-run equilibrium relationships. *Journal of Econometrics*, 60(1-2), 203-233.

Govindaraju, V.C., Tang, C.F., 2013. The dynamic links between CO_2 emissions, economic growth and coal consumption in China and India. *Applied Energy*, 104(2013), 310-318.

Granger, C.W., 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3), 424-438.

Granger, C.W., 1981. Some properties of time series data and their use in econometric model specification. *Journal of Econometrics*, 16(1), 121-130.

Grier, K.B., Tullock, G., 1989. An empirical analysis of cross-national economic growth 1951–1980. *Journal of Monetary Economics*, 24(2), 259-276.

Gylfason, T., Herbertsson, T.T., Zoega, G., 1999. A mixed blessing: Natural resources and economic growth. *Macroeconomic Dynamics*, 3(2), 204-225.

Haber, S., Menaldo, V., 2011. Do natural resources fuel authoritarianism? A reappraisal of the resource curse. *American Political Science Review*, 105(1), 1-26.

Haddad, M., Harrison, A., 1993. Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco. *Journal of Development Economics*, 42(1), 51-74.

Haddad, M., Pancaro, C., 2010. Can real exchange rate undervaluation boost exports and growth in developing countries? Yes, but not for long. *Economic Premise* No. 20, World Bank, Washington, D.C.

Harris, R.D., 1997. Stock markets and development: A re-assessment. *European Economic Review*, 41(1), 139-146.

Harrison, A., 1994. The role of multinationals in economic development: The benefits of FDI. *Columbia Journal of World Business*, 29(4), 6-11.

Hausmann, R., Pritchett, L., Rodrik, D., 2005. Growth accelerations. *Journal of Economic Growth*, 10(4), 303-329.

Hiemstra, C., Jones, J. D., 1994. Testing for linear and nonlinear Granger causality in the stock price-volume relation. *Journal of Finance*, 49(5), 1639-1664.

Holtz-Eakin, D., Newey, W., Rosen, H.S., 1988. Estimating vector autoregressions with panel data. *Econometrica*, 56(6),1371-1395.

Hu, J.L., Lin, C.H., 2008. Disaggregated energy consumption and GDP in Taiwan: A threshold cointegration analysis. *Energy Economics*, 30(5), 2342–2358.

Johansen, S., 1991. Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, 59(6), 1551-1580.

Jumbe, C.B., 2004. Cointegration and causality between electricity consumption and GDP: Empirical evidence from Malawi. *Energy Economics*, 26(1), 61-68.

King, R.G., Levine, R., 1993a. Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics*, 108(3), 717-737.

King, R.G., Levine, R., 1993b. Finance, entrepreneurship and growth. *Journal of Monetary Economics*, 32(3), 513-542.

Kormendi, R.C., Meguire, P.G., 1985. Macroeconomic determinants of growth: Cross-country evidence. *Journal of Monetary Economics*, 16(2), 141-163.

Kraft, J., Kraft, A., 1978. On the relationship between energy and GNP. *Journal of Energy and Development*, 3(2), 401-403.

Lederman, D., Maloney, W.F., 2007. Neither curse nor destiny: Introduction to natural resources and development. *Natural Resources*, 1(2007), 1-396.

Levine, R., Zervos, S., 1996. Stock market development and long-run growth. *World Bank Economic Review*, 10(2), 323-339.

Li, R., Leung, G.C., 2012. Coal consumption and economic growth in China. *Energy Policy*, 40(2012), 438-443.

Jinke, L., Hualing, S., Dianming, G., 2008. Causality relationship between coal consumption and GDP: Difference of major OECD and non-OECD countries. *Applied Energy*, 85(6), 421-429.

Masih, A.M., Masih, R., 1997. On the temporal causal relationship between energy consumption, real income, and prices: Some new evidence from Asian-energy dependent NICs based on a multivariate cointegration/vector error-correction approach. *Journal of Policy Modeling*, 19(4), 417-440.

Masih, A.M., Masih, R., 1998. A multivariate cointegrated modelling approach in testing temporal causality between energy consumption, real income and prices with an application to two Asian LDCs. *Applied Economics*, 30(10), 1287-1298.

Nair-Reichert, U., Weinhold, D., 2001. Causality tests for cross country panels: A new look at FDI and economic growth in developing countries. *Oxford Bulletin of Economics and Statistics*, 63(2), 153-171.

Nyasha, S., Odhiambo, N.M. 2015. Economic growth and market-based financial systems: A review, *Studies in Economics and Finance*, 32(2), 235-255.

Odhiambo, N.M., 2009. Electricity consumption and economic growth in South Africa: A trivariate causality test. *Energy Economics*, 31(5), 635-640.

Owyong, D., Wong, W.K., Horowitz, I., 2015. Cointegration and causality among the onshore and offshore markets for China's currency. *Journal of Asian Economics*, 41(2015), 20-38.

Paul, S., Bhattacharya, R.N., 2004. Causality between energy consumption and economic growth in India: A note on conflicting results. *Energy Economics*, 26(6), 977-983.

Qiao, Z., Chiang, T.C., Wong, W.K., 2008. Long-run equilibrium, short-term adjustment, and spillover effects across Chinese segmented stock markets and the Hong Kong stock market. *Journal of International Financial Markets, Institutions and Money*, 18(5), 425-437.

Qiao, Z., Li, Y., Wong, W.K., 2008. Policy change and lead-lag relations among China’s segmented stock markets. *Journal of Multinational Financial Management*, 18(3), 276–289.

Qiao, Z., Li, Y., Wong, W.K., 2011. Regime-dependent relationships among the stock markets of the US, Australia, and New Zealand: A Markov-switching VAR approach. *Applied Financial Economics*, 21(24), 1831-1841.

Qiao, Z., McAleer, M., Wong, W.K., 2009. Linear and nonlinear causality between changes in consumption and consumer attitudes. *Economics Letters*, 102(3), 161-164.

Rapetti, M., Skott, P., Razmi, A., 2012. The real exchange rate and economic growth: Are developing countries different? *International Review of Applied Economics*, 26(6), 735-753.

Rodrik, D., 2008. The real exchange rate and economic growth. *Brookings Papers on Economic Activity*, 2008(2), 365-412.

Sachs, J.D., Warner, A.M., 1997. Sources of slow growth in African economies. *Journal of African Economies*, 6(3), 335-376.

Sachs, J.D., Warner, A.M., 2001. The curse of natural resources. *European Economic Review*, 45(4-6), 827-838.

Sari, R., Soytas, U., 2004. Disaggregate energy consumption, employment, and income in Turkey. *Energy Economics*, 25(1), 335–344.

Singh, A., 1997. Stock markets, financial liberalization and economic development. *Economic Journal*, 107(442), 771-782.

Soytas, U., Sari, R., 2003. Energy consumption and GDP: Causality relationship in G-7 countries and emerging markets. *Energy Economics*, 25(1), 33-37.

Thoma, M., 2004. Electrical energy usage over the business cycle. *Energy Economics*, 26(3), 463-485.

Toda, H.Y., 1995. Finite sample performance of likelihood ratio tests for cointegrating ranks in vector autoregressions. *Econometric Theory*, 11(5), 1015-1032.

Toda, H.Y., Yamamoto, T., 1995. Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1-2), 225-250.

Wolde-Rufael, Y., 2010. Coal consumption and economic growth revisited. *Applied Energy*, 87(1),160-167.

Yamada, H., Toda, H.Y., 1998. Inference in possibly integrated vector autoregressive models: Some finite sample evidence. *Journal of Econometrics*, 86(1), 55-95.

Yang, H.Y., 2000a. Coal consumption and economic growth in Taiwan. *Energy Sources*, 22(2), 109-115.

Yang, H.Y., 2000b. A note on the causal relationship between energy and GDP in Taiwan. *Energy Economics*, 22(3), 309-317.

Yoo, S.H., 2006. Causal relationship between coal consumption and economic growth in Korea. *Applied Energy*, 83(11), 1181-1189.

Yu, E.S., Choi, J.Y., 1985. The causal relationship between energy and GNP: An international comparison. *Journal of Energy and Development*, 10(2), 249-272.

Zhang, K.H., 2001. Does foreign direct investment promote economic growth? Evidence from East Asia and Latin America. *Contemporary Economic Policy*, 19(2), 175-185.

Zhang, X., Daly, K., 2011. The determinants of China's outward foreign direct investment. *Emerging Markets Review*, 12(4), 389-398.