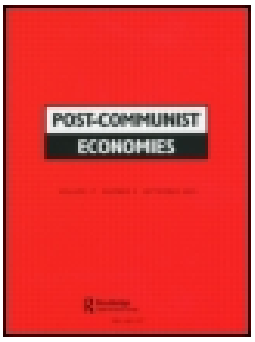


Post-Communist Economies

ISSN: 1463-1377 (Print) 1465-3958 (Online) Journal homepage: https://www.tandfonline.com/loi/cpce20

The mining sector boom in Mongolia: did it cause the Dutch disease?

Kadirbyek Dagys, W. J. M. Heijman, Liesbeth Dries & Bakyei Agipar

POST-COMMUNIST ECONOMIES
https://doi.org/10.1080/14631377.2019.1689002

The mining sector boom in Mongolia: did it cause the Dutch disease?

Kadirbyek Dagys[a], W. J. M. Heijman[b], Liesbeth Dries[b] and Bakyei Agipar[c]

[a]Agricultural Economics and Rural Policy group, Wageningen University, Wageningen, the Netherlands and Management Department, Mongolian University of Life Sciences, Ulaanbaatar, Mongolia; [b]Agricultural Economics and Rural Policy group, Wageningen University, Wageningen, the Netherlands; [c]Agricultural Economics and Innovation Development Centre, Mongolian University of Life Sciences, Ulaanbaatar, Mongolia

ABSTRACT

The mining sector has become one of the main pillars in the Mongolian economy. Although the sector is the main driver of better export performance, it may also have a negative effect on traditional tradeable sectors and worsen their competitiveness. The study focuses on whether the Dutch disease symptoms have appeared in the Mongolian economy. A time series model is developed using quarterly data from the period of 2004 to 2012, the so-called mining boom years in Mongolia. Econometric results are derived from the autoregressive distributed lag (ARDL) bounds testing approach and suggest that the Dutch disease symptoms, the spending effect as well as the resource movement effect, have appeared during the researched period in Mongolia.

ARTICLE HISTORY
Received 22 July 2019
Accepted 1 November 2019

KEYWORDS
Mining sector; non-trading sector; real effective exchange rate; traditional sector; the core model; time series analysis

1. Introduction

A booming sector has beneficial effects on the development of a country. However, it may also have adverse effects on the output of traditional sectors due to real exchange rate appreciation of the national currency (Corden & Neary, 1982). This phenomenon, which was observed in the Dutch economy when natural gas discoveries were made in the 1960s, is called the 'Dutch disease'. The term first appeared in The Economist in 1977: 'That enviable reputation which the Dutch economy enjoyed for many years has been losing its shine. Every European country has suffered from the post-OPEC recession, but Holland has been particularly badly hit. … This contrast – between external health and internal ailments – is the symptom of "the Dutch disease" … ' (The Economist, 1977).

Mongolia possesses enormous deposits of mineral resources, and the country has experienced strong economic growth because of a boom in the mining sector during the last decade, in particular between 2004 and 2012. Mongolian economic growth rose to an unprecedented 17.3% in 2011, making Mongolia one of the fastest-growing economies in the world (World Bank, 2012). Mining extraction and exports have grown substantially, and the economy is heavily dependent on revenues from the export of mineral commodities, such as copper, coal and gold.

CONTACT Kadirbyek Dagys kadirbyek@muls.edu.mn

Following the core model of Corden and Neary (1982), the booming mining sector can influence the economy via two channels: spending and resource movement. The influx of foreign currency, mainly US dollars, increases due to the sharp growth of the mining sector and the appreciation of the national currency. In turn, the real exchange rate appreciation adversely influences the competitiveness of the traditional sector, that is the manufacturing sector exports, directly causing deindustrialisation. This effect is the 'spending effect' of the mining boom. Furthermore, employees shift away from the traditional manufacturing sector to the mining sector due to the increased wages of mining employees. This shift has adverse effects on the output of traditional sectors, causing indirect deindustrialisation. Collectively these effects are called the 'resource movement effect' of the mining boom.

A number of papers have investigated the Dutch disease effects in Mongolia and used different approaches in their study (Ariunaa & Kim, 2012; Avralt-Od et al., 2012; Batsukh & Avralt-Od, 2012; Ge & Kinnucan, 2017; Khan & Gottschalk, 2017). Ge and Kinnucan (2017) used a time series model that focused on the effects of foreign direct investment (FDI) and the gross national product (GNP) on the exchange rate and the exchange rate effect on the agricultural sector output. They found that the FDI attracted by the mining industry in Mongolia strengthened the national currency,[1] named tugrik or tögrög (MNT), but that the currency appreciation did not suppress the agricultural sector. In other words, they did not find evidence that the Dutch disease appeared in the Mongolian economy. Khan and Gottschalk (2017) examined the transmission mechanism behind the Dutch disease effects on the Mongolian economy using a computable general equilibrium (CGE) model. They conclude that not only the real exchange rate but also many relative prices change. Furthermore, not only the tradable sector but also all sectors of the economy are affected by a scaling up of mining production. Batsukh and Avralt-Od (2012) analysed the impacts of large capital inflows, i.e. FDI, and commodity price shocks on the Mongolian economy to verify whether these shocks caused the Dutch disease in the economy. The paper concludes that a boom in natural resource exploitation causes an increase in wages and in the production of the marginal products in the non-tradable sector. This effect, in turn, leads to an increase in labour demand and a decline in manufacturing production, while the production of non-tradable goods rises and the domestic currency appreciates. Ariunaa and Kim (2012) used an ordinary least squares (OLS) model with the real effective exchange Rate (REER) as a dependent variable. The paper is inconclusive as to whether the Dutch disease occurs in Mongolia. Finally, Avralt-Od et al. (2012) only used graphical representations and concluded that the Dutch disease has been apparent in the Mongolian economy since 2010, reporting evidence of both the resource movement and spending effect.

However, none of the authors of the existing papers except Ge and Kinnucan (2017) applied a time series model to assess the risks of the Dutch disease effects in terms of both the spending and resource movement effect on the Mongolian economy. This paper, therefore, intends to test the Dutch disease effects on the Mongolian economy in the booming mining period of 2004 to 2012 using time series models, i.e. the autoregressive distributed lag (ARDL) approach.

The paper is organised as follows: The next section reviews the relevant literature on the Dutch disease effects for 'natural resource-rich' countries and explains the theoretical framework based on a literature review. Section 3 explains the data and methodology used in the paper. Section 4 discusses the main indicators related to the Dutch disease in Mongolia. Section 5 presents the empirical results. Finally, section 6 summarises the main conclusions of the paper on whether the Dutch disease effects are present in the economy of Mongolia.

2. Theoretical framework

Numerous studies have focused on the Dutch disease phenomena that have occurred in different countries at different times. The Dutch disease effects have been analysed since the core model was developed by Corden and Neary (1982). There are three sectors in the core model, of which two are traded. The energy and manufacturing sectors are the two traded sectors, and the third, non-traded sector is the services sector. The booming sector, namely energy, plays a major role in the economy. According to the core model, the two main effects of the booming sector on the other two sectors are the resource movement effect and the spending effect. Likewise, the two effects of mining sector growth (Figure 1) are:

Spending effect: exports of mineral products and FDI generate an appreciation of the real exchange rate, increase government spending and cause the expansion of the non-tradable sector.

Resource movement effect: as a result of the expansion of the mining sector, there is a shift of labour from the traditional manufacturing sector to the mining sector. The appreciation of the real exchange rate negatively influences the export of non-mineral products, i.e. exports from the manufacturing sector.

Following the core model, several theoretical models of the Dutch disease were developed by Enders and Herberg (1983), Herberg and Enders (1984), Edwards and Aoki (1983), Buiter and Purvis (1983), Corden (1984) and Vanwijnbergen (1984). In addition, many empirical studies, such as those of Bruno and Sachs (1982), Auty and Gelb (1986) and Scherr (1989), have been conducted to find relationships between different macroeconomic indicators such as the real exchange rate, capital inflows, the traditional industry and the non-tradable industry. Notable, recent contributors are Bjørnland and Thorsrud (2016), Ge and Kinnucan (2017) and Ito (2017). An overview of empirical studies that focus on the Dutch disease phenomenon is provided in Appendix 1.

Most of the empirical studies regarding the Dutch disease are based on the traditional core model, which focuses on relationships between the growth of the resource-based industry, the increase in government expenditures, the appreciation of the real exchange

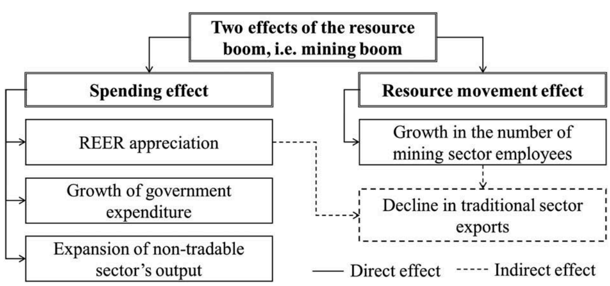


Figure 1. The core model (Corden & Neary, 1982).

rate and the decline of the traditional industry or deindustrialisation. Several papers report that the effects of Dutch disease are visible in natural resource-rich economies (Dülger, Lopcu, Burgaç, & Ballı, 2013; Treviño, 2011). However, studies also emphasise that the Dutch disease effects differ across countries that have different development processes and other non-Dutch disease factors (Athukorala & Rajapatirana, 2003; David, 1996; Dobrynskaya & Turkisch, 2010; Hasanov, 2013; Ito, 2017, 2019; Lartey, 2007, 2011; Lartey, Mandelman, & Acosta, 2012; Oomes & Kalcheva, 2007; Rosenberg & Saavalainen, 1998; Saborowski, 2011).

Several empirical studies have attempted to explain the spending effect of the Dutch disease based on the core model, focusing on interpreting the nexus between the real exchange rate and mining capital inflows through export revenues from mineral commodities (Arezki & Ismail, 2013; Egert & Leonard, 2008; Frankel, 2007; Kutan & Wyzan, 2005; Oomes & Kalcheva, 2007). Although the spending effect of the Dutch disease in terms of capital inflows is associated with a booming natural resource sector, many papers attempt to explain it in terms of non-mining capital influx, for example, through foreign direct investment, foreign aid, remittances, loans and portfolio investment. Moreover, some argue that the real exchange problem differs from country to country depending on the size of the economy, the development and the openness of the economy and policy factors such as the type of exchange rate regime and the degree of financial openness (Athukorala & Rajapatirana, 2003; Ito, 2019; Lartey, 2007, 2011; Lartey et al., 2012; Saborowski, 2011). Martins (2011), on the other hand, argues that neither foreign aid nor workers' remittances have any effect on REER appreciation or depreciation. Specifically, the openness of the economy has a negative impact on the long-run value of the REER, while external terms of trade shocks have a positive impact on the REER.

Besides the papers on the spending effect of the Dutch disease, there are a number of analyses dealing with the resource movement effect of the Dutch disease. Bruno and Sachs (1982) performed a simulation model for the UK and concluded that the net effect of the booming energy sector is to reduce the long-run production of other tradables and to improve the economy's terms of trade on final goods and that the size of the effect depends on the government budget policies. Furthermore, Ismail (2010) tested the effect of commodity price shocks on manufacturing output and concluded that permanent increases in the oil price negatively affect manufacturing output, particularly in the manufacturing sectors that require a large labour force.

Based on the literature review and the theoretical framework of the core model, the following hypotheses are formulated to test the (spending and resource movement) effects of the Dutch disease in Mongolia:

Hypothesis 1: increased exports and FDI related to the mining sector will lead to the expansion of the non-tradable sector.

Hypothesis 2: increased exports of mineral products and FDI related to the mining sector will generate appreciation of the real exchange rate.

Hypothesis 3: increased exports of mineral products and FDI related to the mining sector will lead to an increase in government spending.

Hypothesis 4: the export of manufacturing products decreases due to the appreciation of the real exchange rate.

Hypothesis 5: as a result of the expansion of the mining sector, there is a shift of labour from other sectors to the mining sector, i.e. the number of employees of the mining sector grows.

3. Data and methodology

3.1. Data

Quarterly macroeconomic time series data covering the booming period in Mongolia, i.e. the 1st quarter of 2004 until the 4th quarter of 2012, are used in the study. Data related to exports, sectoral outputs and government expenditure were collected from the monthly bulletins of the National Statistical Office of Mongolia (NSO). Data on the real effective exchange rate and FDI were obtained from the Central Bank of Mongolia (MB). Variables and descriptive statistics of the dataset are summarised in Table 1.

Table 1. Summary descriptive statistics of the dataset.

Variable	Description	Mean	Std. dev.	Min	Max
REER*	Real effective exchange rate, 2005 = 1.0	1.13	0.14	0.93	1.41
MX	Export of mineral products**	311.76	172.60	98.54	743.84
FDI	Foreign direct investment**	219.13	234.89	1.00	725.82
TX	Export of non-mineral products of the manufacturing sector**	125.21	58.90	31.93	255.45
MSO	Mining sector output**	176.35	31.57	93.72	242.35
SSO	Output of non-tradables, i.e. output of the service sector**	570.59	183.02	342.28	998.85
GS	Government spending, i.e. state budget expenditure**	303.19	159.84	131.46	813.90
E	Number of employees in the mining sector	15376.36	1832.69	12790	19652

*Derivation of the REER of Mongolian Tugrik (MNT) is shown in Appendix 2.
**Values in billion MNT by the real value of 2005.

To reduce the sensitivity to outliers and ensure consistency, the natural logarithmic forms of the variables were used. The use of this form makes it possible to define the relationships between the variables in terms of elasticities. The pairwise correlation matrix of the variables is included in Appendix 3, and it shows that most of the variables have moderate to strong correlations with high statistical significance.

3.2. Model and methodology

This paper attempts to test the aforementioned hypotheses based on the literature review and the theoretical framework. The relationships between variables are shown in Figure 2.

In Figure 2 the initial ‘L’ denotes the logarithmic form of a variable; arrows denote the effects of the variables; solid lines imply direct effects, while dashed lines imply indirect effects. Moreover, positive effects, negative effects and ambiguous effects are expressed as ‘+’, ‘-’ and ‘±’, respectively. ‘H1’ to ‘H5’ denote the hypotheses that were put forward at the end of section 2. In line with these hypotheses, five models will be estimated.

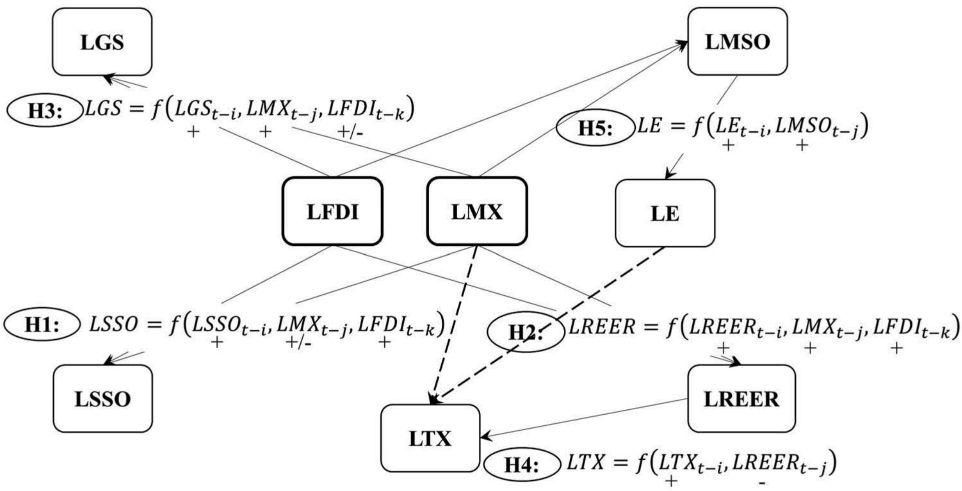


Figure 2. The relationships between the variables.

There are several techniques to test long-run relationships or cointegration using time series data (Engle & Granger, 1987; Johansen, 1988; Pesaran & Shin, 1999; Pesaran, Shin, & Smith, 2001; Phillips & Ouliaris, 1990). In this paper, we employ the autoregressive distributed lag (ARDL) modelling approach developed by Pesaran and Shin (1999) and the ARDL approach extension, i.e. the bounds testing procedure developed by Pesaran et al. (2001).

ARDL has several advantages over conventional cointegration testing. The main advantage is that it is applicable to test long-run relationships regardless of whether the regressors are purely $I(0)$, $I(1)$ or mutually cointegrated, i.e. a mixture of both. Moreover, the technique can be applied to studies that have a finite or a relatively small sample size (Narayan, 2005; Narayan & Smyth, 2005; Pesaran et al., 2001).

The ARDL bounds testing approach involves two stages. The first step is to detect the presence of a long-run relationship. For this purpose, *F*-tests and *t*-tests are used to test the joint significance of the coefficients of unrestricted error-correction models (UECM) with up to four lagged levels. There are four levels due to the quarterly nature of the data. The Akaike information criterion (AIC) (Akaike, 1973) and the Schwartz Bayesian information criterion (BIC) (Schwarz, 1978) are used for the optimal lag selection. In the second step, short-run and long-run elasticities and the error-correction term, i.e. the speed adjustment, are estimated using a restricted error-correction model (RECM).

The basic form of ARDL (m, n, p) models, which determine the relationships between the variables shown in Figure 2, can be expressed as the following equations:

$$LSSO_t = \beta_0 + \sum_{i=1}^{m} \beta_i LSSO_{t-i} + \sum_{j=0}^{n} \gamma_j LMX_{t-j} + \sum_{k=0}^{p} \delta_k LFDI_{t-k} + \varepsilon_t \quad (1)$$

$$LREER_t = \beta_0 + \sum_{i=1}^{m} \beta_i LREER_{t-i} + \sum_{j=0}^{n} \gamma_j LMX_{t-j} + \sum_{k=0}^{p} \delta_k LFDI_{t-k} + \varepsilon_t \quad (2)$$

$$LGS_t = \beta_0 + \sum_{i=1}^{m} \beta_i LGS_{t-i} + \sum_{j=0}^{n} \gamma_j LMX_{t-j} + \sum_{k=0}^{p} \delta_k LFDI_{t-k} + \varepsilon_t \quad (3)$$

$$LTX_t = \beta_0 + \sum_{i=1}^{m} \beta_i LTX_{t-i} + \sum_{j=0}^{n} \gamma_j LREER_{t-j} + \varepsilon_t \quad (4)$$

$$LE_t = \beta_0 + \sum_{i=1}^{m} \beta_i LE_{t-i} + \sum_{j=0}^{n} \gamma_j LMSO_{t-j} + \varepsilon_t \quad (5)$$

In each equation, β_0 is a constant term. β_i, γ_j and δ_k are respective regression coefficients, i.e. representatives of elasticities. m, n and p are lag orders. t is the time period and ε_t is an error term where t = 1,2, …, T, $\varepsilon_t \sim IID(0, \sigma^2)$.

Without explicit information about the long-run relationships between the variables, UECMs are estimated for all models, taking each of the variables in turn as a dependent variable. The equations, (A1), …, (A13), for our five models are listed in Appendix 4. The bounds tests for analysing the existence of long-run relationships between the variables can be conducted using F-tests and t-tests. The F-tests and t-tests investigate the joint significance of the coefficients of the variables in the equations (A1), …, (A13). The null hypothesis for no cointegration amongst the variables in equation (A1) is H_0, where $\theta_{1LSSO} = \theta_{2LSSO} = \theta_{3LSSO} = 0$. The argument against the null hypothesis is H_1, where $\theta_{1LSSO} \neq \theta_{2LSSO} \neq \theta_{3LSSO} \neq 0$. The approximate critical values for the F-tests and t-tests are obtained from Pesaran et al. (2001). There are two sets of critical value bounds, a lower and an upper bound, for the classification of the regressors into purely $I(1)$, purely $I(0)$ or mutually cointegrated. If the computed F-statistics and t-statistics are both more extreme than the upper bounds of the critical values, the null hypothesis of no cointegration is rejected. In contrast, if the computed F-statistics and t-statistics are both lower than the lower bounds of the critical values, either the null hypothesis of no cointegration cannot be rejected or there are no long-run relationships between the variables. If either the computed F-statistics, the computed t-statistics or both of them are between the two bounds levels, the cointegration test is inconclusive.

After testing the long-run relationships between the variables of the models, in the second stage, we estimate RECM to determine the short-run elasticities, the long-run elasticities and the speed adjustments of the selected models. The equations, (A14), …, (A18), for conventional ECM or RECM are presented in Appendix 5. ECT_{t-1} are the error-correction terms and $\vartheta_1, \ldots, \vartheta_5$ are the speed-of-adjustments, i.e. the coefficients of the error-correction terms. The other variables are described similarly to those found in equations (1), …, (5).

4. Dutch disease in the mongolian economy – descriptive statistics

Official statistics indicate that the export of mineral products increased in value by 280% from MNT 544 billion to MNT 2,093 billion and the FDI grew by 920% from MNT 229 billion to MNT 2,343 billion in 2012 compared to 2005 (MB, 2004-2012; NSO, 2004-2012). FDI inflows are also heavily concentrated in the mining sector, i.e. 80% of the total inflows in 2011 (Avralt-Od et al., 2012; Batsukh & Avralt-Od, 2012; Davaakhuu, Sharma, & Oczkowski,

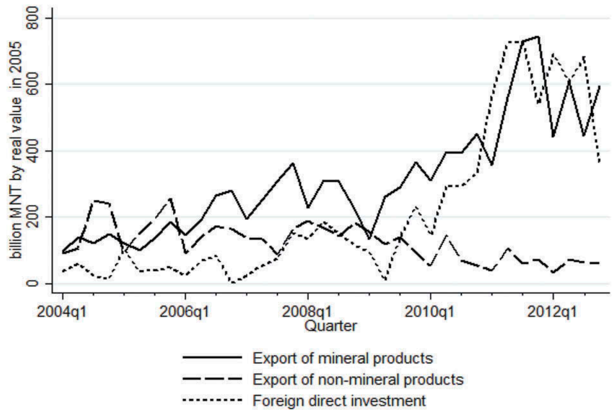


Figure 3. Export of mineral and non-mineral products and FDI.[1,2]

2015). The export of non-mineral products, on the other hand, reduced in value by 65% from MNT 723 billion to MNT 253 billion in the same period. Consequently, the share of mineral products in total exports increased from 43% to 90%, whereas the share of products of the manufacturing sector declined from 57% to 10% (MB, 2004-2012; NSO, 2004-2012) (Figure 3).

The growth of exploitation and exportation of mineral products has led to a large flow of capital into the country. On the one hand, the inflow of capital has created opportunities to implement large-scale projects to develop the economy and infrastructure and to solve social problems such as unemployment, poverty, education and health service, but, on the other hand, it has caused the MNT to appreciate (Ariunaa & Kim, 2012; Avralt-Od et al., 2012; Batsukh & Avralt-Od, 2012; Ge & Kinnucan, 2017). The appreciation was highest in the 2nd quarter of 2012, with a value of almost 50% compared to the 1st quarter of 2004 (MB, 2004-2012) (Figure 4). This appreciation of the national currency is termed the spending effect, and it is regarded as the main symptom of the Dutch disease.

Revenues of the central government increased through taxes and royalties paid by mining companies. A major portion of the spending of these additional funds were oriented to the non-tradable sector, especially infrastructure investments and social

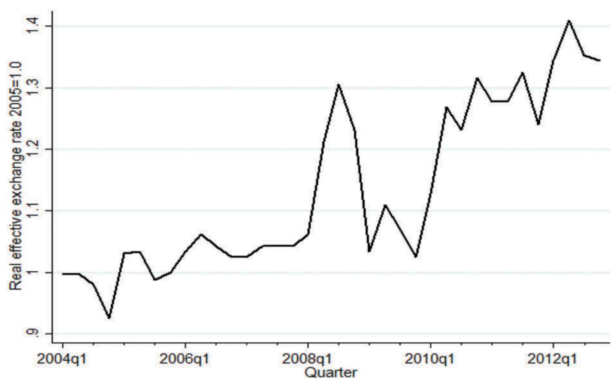


Figure 4. Change of the real effective exchange rate.[2]

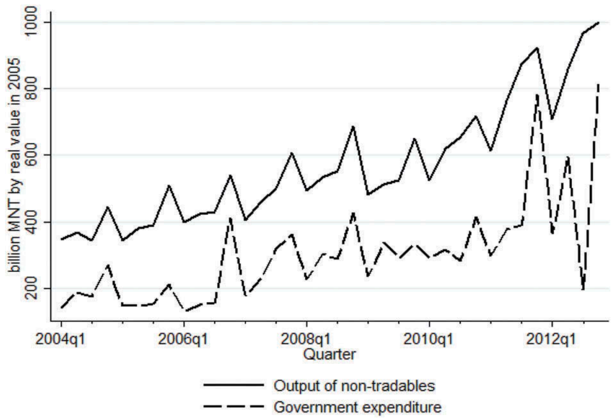


Figure 5. Output of non-tradables and government expenditure.[1]

projects. The share of the non-tradable sector in the total gross domestic product (GDP) has thus expanded since 2010. According to official statistics, government expenditure almost tripled in Mongolia between 2004 and 2012 from MNT 657 billion to MNT 1,967 billion. Furthermore, the total production of the non-tradable sector grew in value by about two times from MNT 1,622 billion to MNT 3,535 billion. The share of the sector in GDP increased by 11 percentage points, from 53% to 64%, in the same period (NSO, 2004–2012). The increase in government expenditures and the expansion of the non-tradable sector is another symptom of the spending effect (Figure 5).

Due to the growth of the mining sector, employment in the sector has grown steadily. Batsukh and Avralt-Od (2012) and Avralt-Od et al. (2012) conclude that the average wage of the mining industry is growing because of the increased profitability of the industry. The growth in wages is also attracting workers from other tradable sectors. Specifically, the number of employees in the mining sector has increased by around 54% from 12,790 at the end of 2004 to 19,652 at the end of 2012 (NSO, 2004–2012) (Figure 6). This increase is evidence of the so-called resource movement effect.

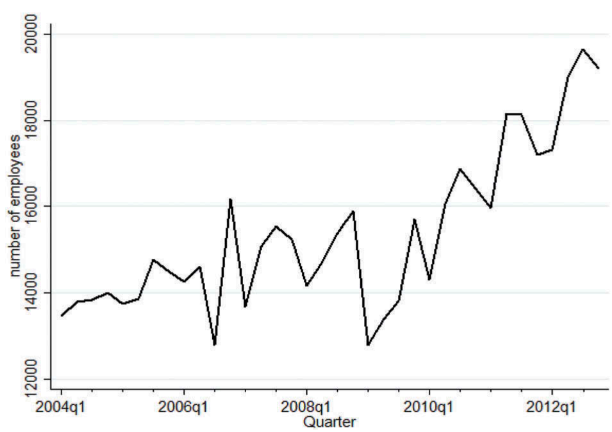


Figure 6. Number of employees in the mining sector [1.]

Note. Source of data: [1]National Statistical Office of Mongolia, [2]Central Bank of Mongolia

5. Results

STATA version 13.0 (StataCorp, 2013) and user-written STATA packages *kpss* (Baum, 2000b), *cusum* (Baum, 2000a) and *ardl* (Kripfganz & Schneider, 2016) are used for the analysis.

5.1. Testing stationarity

The starting point of the time series analysis is conducting a test for stationarity. Since the integration of order two, i.e. $I(2)$, is not applicable in ARDL, it is important to test whether the time series is not $I(2)$. We applied the augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979, 1981) and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) (Kwiatkowski, Phillips, Schmidt, & Shin, 1992) tests to check for the presence of unit roots. The stationarity test results based on the ADF and the KPSS are summarised in Table 2. These results suggest that some of the variables are stationary in the level $I(0)$ while others are stationary at the level $I(1)$. More importantly, none of the variables are integrated at the level $I(2)$. Therefore, it is appropriate to use the ARDL bounds testing approach to find the long- and short-run relationships between variables of the models 1 to 5.

Table 2. Unit-root test results.

	Levels		First differences	
Variable	With trend	Without trend	With trend	Without trend
Augmented Dickey-Fuller (ADF) test H_0: Non-stationary				
LREER	−3.525*	−1.340	−5.934***	−6.018***
LMX	−4.142**	−1.832	−7.758***	−7.901***
LFDI	−4.807***	−2.774*	-	-
LTX	−5.445***	−3.159**	-	-
LMSO	−7.419***	−5.116***	-	-
LSSO	−5.934***	−1.470	−10.100***	−10.198***
LGS	−7.858***	−3.635**	-	-
LE	−3.878**	−1.983	−9.643***	−9.679***
Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test H_0: Stationary				
LREER	0.079***	1.20	0.032***	0.042***
LMX	0.072***	1.26	0.040***	0.046***
LFDI	0.097***	1.07	0.047***	0.048***
LTX	0.191*	0.97	0.051***	0.102***
LMSO	0.064***	1.08	0.064***	0.083***
LSSO	0.138**	1.36	0.047***	0.071***
LGS	0.060***	1.27	0.071***	0.091***
LE	0.221	1.05	0.055***	0.101***

*, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

5.2. Testing for cointegration

As none of the series are found to be $I(2)$, we apply the ARDL bounds testing approach to examine the long-run relationship between the variables for all models. The *F*-test and *t*-test results of the variables in equations (A1), …, (A13) are summarised in Table 3.

Both the *F*-test and *t*-test statistics for at least one of the equations in models 1 and 2 are greater than the upper bound critical value and statistically significant at the 1% level. Moreover, the null hypothesis of no-cointegration for the equations in models 4 and 5 are

Table 3. ARDL bounds testing results.

Equation no.	Model	Optimal lag length	F-statistic (p-value)	t-statistic (p-value)
Model 1				
(A1)	$f(LSSO_t\|LMX_t, LFDI_t)$	ARDL (4,4,2)	15.345*** (0.000)	−5.016*** (0.004)
(A2)	$f(LMX_t\|LSSO_t, LFDI_t)$	ARDL (4,4,2)	2.583 (0.368)	−2.656 (0.208)
(A3)	$f(LFDI_t\|LMX_t, LSSO_t)$	ARDL (2,4,4)	3.738 (0.177)	−3.241* (0.091)
Model 2				
(A4)	$f(LREER_t\|LMX_t, LFDI_t)$	ARDL (4,4,4)	12.734*** (0.001)	−6.155*** (0.001)
(A5)	$f(LMX_t\|LREER_t, LFDI_t)$	ARDL (4,4,4)	0.907 (0.847)	−1.528 (0.574)
(A6)	$f(LFDI_t\|LMX_t, LREER_t)$	ARDL (4,4,4)	2.410 (0.407)	−2.546 (0.230)
Model 3				
(A7)	$f(LGS_t\|LMX_t, LFDI_t)$	ARDL (4,0,3)	6.430** (0.029)	−1.322 (0.694)
(A8)	$f(LMX_t\|LGS_t, LFDI_t)$	ARDL (1,4,3)	0.638 (0.920)	−1.176 (0.729)
(A9)	$f(LFDI_t\|LMX_t, LGS_t)$	ARDL (3,0,4)	3.618 (0.188)	−3.067 (0.124)
Model 4				
(A10)	$f(LTX_t\|LREER_t)$	ARDL (4,2)	0.129 (0.978)	−0.264 (0.908)
(A11)	$f(LREER_t\|LTX_t)$	ARDL (2,4)	6.255* (0.052)	−3.480** (0.036)
Model 5				
(A12)	$f(LE_t\|LMSO_t)$	ARDL (1,3)	6.418** (0.046)	−3.512** (0.033)
(A13)	$f(LMSO_t\|LE_t)$	ARDL (3,1)	6.432** (0.046)	−3.578** (0.029)

*, ** and *** denote the cointegration is significant at the 10%, 5% and 1% level, respectively, i.e. the null hypothesis of no-cointegration is rejected.

rejected at the 10% and 5% significance level, respectively. The results, therefore, suggest that there is at least one cointegration among the variables in these models. The*F*-test and *t*-test statistics for the equations of model 3 are not significant because both the*F*-test and *t*-test values of the equations are lower than the lower bound critical value. Therefore, the null hypothesis of no-cointegration for model 3 cannot be rejected.

5.3. Model results

In the next step, long-run and short-run coefficients as well as error-correction terms (ECTs) for equations (A14), …, (A18) are obtained using RECMs. After each regression, there are standard diagnostic tests used to test serial correlation, heteroskedasticity, model specification and white noise. Moreover, the dynamic stability of the models is tested by the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUM squared). The plots for the CUSUM and the CUSUM squared are shown in Appendix 6. The CUSUM and the CUSUM squared plots for all five models indicate that the estimates of the models are dynamically stable.

Testing Hypothesis 1: increased exports and FDI related to the mining sector will lead to the expansion of the non-tradable sector.

The empirical results for model 1, including the long-run and short-run results and the results of the diagnostic tests, are reported in Table 4. The model shows that the signs for the long-run results and the ECT are in line with theoretical predictions and are statistically significant at the 1% level. The results suggest that the export of mineral products has a larger effect on the service sector output than the FDI. For instance, a 1% increase in the export of mineral products leads to a 0.4% growth of the service sector output, while the

Table 4. Time series estimation results, Model 1 – ARDL (4 4 2).

1. Model results				
	Dependent variable: *LSSO* Log likelihood = 59.530** Adj. R-squared = 0.9232			
	Regressors	Coefficients	t-statistics	p-values
Constant term	β_0	2.797***	4.70	0.000
Adjustment term	$LSSO_{t-1}$	−0.745***	−5.02	0.000
Long-run results	LMX_{t-1}	0.401***	8.38	0.000
	$LFDI_{t-1}$	0.082***	3.90	0.000
Short-run results	$\Delta LSSO_{t-1}$	−0.295*	−1.92	0.070
	$\Delta LSSO_{t-2}$	−0.384**	−2.68	0.015
	$\Delta LSSO_{t-3}$	−0.540***	−4.73	0.000
	ΔLMX_t	0.133***	3.12	0.006
	ΔLMX_{t-1}	−0.122	−1.68	0.110
	ΔLMX_{t-2}	−0.108	−1.67	0.112
	ΔLMX_{t-3}	−0.117*	−2.07	0.053
	$\Delta LFDI_t$	0.012	1.35	0.194
	$\Delta LFDI_{t-1}$	−0.020*	−1.96	0.064

2. Diagnostic test results		
Diagnostic tests	Test statistics	p-values
Breusch-Godfrey (χ^2) – H_0: no serial correlation	2.12	0.145
Durbin's alternative (χ^2) – H_0: no serial correlation	1.28	0.258
Ramsey RESET (F) – H_0: model has no omitted variables	0.68	0.577
Breusch-Pagan (χ^2) – H_0: constant variance	1.17	0.280
Portmanteau test for white noise (χ^2) – H_0: white noise	13.50	0.487

*, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

effect of a 1% increase in FDI is only 0.09%, *ceteris paribus*. The ECT is highly statistically significant and has a negative sign. This result confirms that a long-run equilibrium relationship exists between the variables. The ECT coefficient is −0.75, which suggests that convergence to equilibrium after a shock to the service sector output is very rapid.

The relationships between the variables are mixed in the short run. The lagged variables of the service sector output have a negative effect on the current output of the sector. The effect of the 3rd lag is the strongest and statistically significant at the 1% level. The current value of the export of mineral products has a positive effect on the growth of the output of the service sector, which is statistically significant at the 1% level. A 1% increase in the export of mineral products leads to a 0.13% increase in the service sector output, other things being equal. This statistic implies that the export of mineral products directly leads to the expansion of the service sector. However, the 3rd lag of mineral exports has a negative effect on the output of the service sector, and this is statistically significant at the 10% level. This result is unexpected. Meanwhile, the 1st and 2nd lags have a negative sign, although they are statistically insignificant in each case. The FDI has a lower effect on the output of the service sector. The 1st lag of the FDI has a negative sign that is statistically significant at the 10% level, and the current value of the FDI has a statistically insignificant positive effect.

All the diagnostic tests fail to reject the null hypotheses. The Breusch-Godfrey test and Durbin's alternative test suggest that there is no serial correlation. The RESET test indicates that the model has no omitted variables. The Breusch-Pagan test result indicates that the model has no problem with heteroskedasticity. The Portmanteau test shows that the model residuals are white noise.

Testing Hypothesis 2: increased exports of mineral products and FDI related to the mining sector will generate appreciation of the real exchange rate

The empirical results, including the long-run and short-run results, for model 2 and the diagnostic tests are reported in Table 5. The model shows that the signs for the long-run results and the ECT are in line with theoretical predictions and statistically significant at the 1% level. The results suggest that the export of mineral products has a larger effect on the REER than on the FDI. Specifically, a 1% increase in the export of mineral products contributes to a 0.09% rise in the REER, while the effect of the FDI is only a 0.05%, other things being equal. The ECT is highly statistically significant with a negative sign. This result confirms that a long-run equilibrium relationship exists between the variables. The ECT coefficient is −1.87, suggesting convergence to equilibrium after a shock to the REER is very rapid.

Table 5. Time series estimation results, Model 2 – ARDL (4 4 4).

1. Model results				
	Dependent variable: *LREER* Log likelihood = 69.513** Adj. R-squared = 0.6401			
	Regressors	Coefficients	t-statistics	p-values
Constant term	β_0	−1.175***	−5.24	0.000
Adjustment term	$LREER_{t-1}$	−1.865***	−6.15	0.000
Long-run results	LMX_{t-1}	0.093***	5.94	0.000
	$LFDI_{t-1}$	0.051***	7.64	0.000
Short-run results	$\Delta LREER_{t-1}$	0.890***	4.37	0.000
	$\Delta LREER_{t-2}$	0.404**	2.33	0.032
	$\Delta LREER_{t-3}$	0.382**	2.47	0.025
	ΔLMX_{t}	0.060*	1.99	0.063
	ΔLMX_{t-1}	−0.148***	−3.43	0.003
	ΔLMX_{t-2}	−0.102**	−2.49	0.023
	ΔLMX_{t-3}	−0.062	−1.62	0.125
	$\Delta LFDI_{t}$	0.012	1.63	0.121
	$\Delta LFDI_{t-1}$	−0.076***	−4.53	0.000
	$\Delta LFDI_{t-2}$	−0.049***	−3.73	0.002
	$\Delta LFDI_{t-3}$	−0.027***	−2.97	0.009

2. Diagnostic test results		
Diagnostic tests	Test statistics	p-values
Breusch-Godfrey (χ^2) – H_0: no serial correlation	5.03	0.024
Durbin’s alternative (χ^2) – H_0: no serial correlation	2.99	0.084
Ramsey RESET (*F*) – H_0: model has no omitted variables	0.99	0.428
Breusch-Pagan (χ^2) – H_0: constant variance	0.07	0.785
Portmanteau test for white noise (χ^2) – H_0: white noise	19.02	0.164

*, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

The relationships between the variables are mixed in the short run. The lagged variables of the REER have a statistically significant positive effect on the current REER. As a result of a 1% rise of the 1st, 2nd and 3rd lags of the REER, the current level of the REER will appreciate by 0.89%, 0.40% and 0.38%, respectively, *ceteris paribus*. The current value of the export of mineral products has a positive, while the 1st and 2nd lags have a negative effect on the REER, with all effects being statistically significant. The lagged variables of the FDI have a lower effect on the REER, while the current value of the FDI has a positive but statistically insignificant effect. The REER and the FDI have a weak relationship in the short run. With respect to the 1st, 2nd and 3rd lags of the FDI, a 1% increase induces a 0.08%, 0.05% and 0.03% fall in the current value of the REER, respectively.

The results of the Breusch-Godfrey test and the Durbin's alternative test reject the null hypotheses and suggest that there is a serial correlation problem. This correlation may have been caused by our selection of the maximum lag length, which enabled us to see the effects of variable lags on the REER. Reducing the number of lags, however, did not provide an improvement in the results. Therefore, the lag selection remained at the maximum lag length. The remaining diagnostic tests failed to reject the null hypotheses. From the results of the diagnostic tests, we can conclude that there are no omitted variables, there is no problem of heteroskedasticity and the model residuals are white noise.

Testing Hypothesis 3: increased exports of mineral products and FDI related to the mining sector will lead to an increase in government spending

The empirical results for model 3 are reported in Table 6. The model shows that the signs for the long-run results and the ECT are in line with theoretical predictions, although the results are statistically insignificant. The ECT being statistically insignificant means that a long-run equilibrium relationship does not exist between the variables.

The 1st and 3rd lagged variables of the government spending have a statistically significant negative effect on the current spending. As a result of a 1% rise in the 1st and 3rd lag of government spending, the current level of spending will fall by 0.62% and 0.50%, respectively, *ceteris paribus*. The current value of the export of mineral products has a statistically significant positive effect on government spending, as expected. The results suggest that a 1% rise in the export of mineral

Table 6. Time series estimation results, Model 3 – ARDL (4 0 3).

1. Model results

	Dependent variable: *LGS* Log likelihood = 9.993 Adj. R-squared = 0.8345			
	Regressors	Coefficients	t-statistics	p-values
Constant term	β_0	−0.607	−0.58	0.568
Adjustment term	LGS_{t-1}	−0.317	−1.32	0.200
Long-run results	LMX_{t-1}	1.657	1.39	0.180
	$LFDI_{t-1}$	−0.361	0.45	0.428
Short-run results	ΔLGS_{t-1}	−0.618***	−2.83	0.010
	ΔLGS_{t-2}	−0.225	−1.08	0.294
	ΔLGS_{t-3}	−0.498***	−3.27	0.004
	ΔLMX_t	0.525***	4.32	0.000
	$\Delta LFDI_t$	−0.081*	−1.87	0.075
	$\Delta LFDI_{t-1}$	0.019	0.38	0.708
	$\Delta LFDI_{t-2}$	0.088*	2.01	0.057

2. Diagnostic test results

Diagnostic tests	Test statistics	p-values
Breusch-Godfrey (χ^2) – H_0: no serial correlation	0.02	0.891
Durbin's alternative (χ^2) – H_0: no serial correlation	0.01	0.911
Ramsey RESET (*F*) – H_0: model has no omitted variables	1.18	0.343
Breusch-Pagan (χ^2) – H_0: constant variance	2.20	0.138
Portmanteau test for white noise (χ^2) – H_0: white noise	6.28	0.959

*, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

products leads to a 0.53% expansion of government spending, other things being equal. The current value of the FDI has a negative effect, and the 2nd lag has a positive effect. Both results are statistically significant at the 10% level. However, the relationship between the FDI and government spending is much weaker.

All the diagnostic tests failed to reject the null hypothesis. Thus, there is no evidence of serial correlation, omitted variables, or heteroskedasticity, and residuals are white noise.

Testing Hypothesis 4: the export of manufacturing products decreases due to the appreciation of the real exchange rate

The empirical results for model 4 are reported in Table 7. The model shows that the sign for the long-run result of REER and the ECT are in line with theoretical predictions, although the results are statistically insignificant. Hence, a long-run equilibrium relationship does not exist between the variables.

The lagged variables of the manufacturing sector output have a statistically significant negative effect on the current output. The 1st lag of REER has a statistically significant positive sign, which is an unexpected result. The reason may be that there was an intervention effect of the Mongol Bank to depreciate the currency.

The diagnostic tests show that there is no serial correlation and no heteroskedasticity and that the residuals are white noise. However, the RESET test indicates that the model has omitted variables. We have tried to increase the lag selection of the regressors in order to solve the problem, but this change created problems of serial correlation. The omitted variables problem is, therefore, not overcome.

Testing Hypothesis 5: as a result of the expansion of the mining sector there is a shift of labour from other sectors to the mining sector, i.e., the number of employees of the mining sector grows

Table 7. Time series estimation results, Model 4 – ARDL (4 2).

1. Model results

Dependent variable: *LTX*
Log likelihood = −5.335
Adj. R-squared = 0.5735

	Regressors	Coefficients	t-statistics	p-values
Constant term	β_0	0. 331	0.21	0.837
Adjustment term	LTX_{t-1}	−0.081	−0.26	0.794
Long-run result	$LREER_{t-1}$	−6.185	−0.46	0.650
Short-run results	ΔLTX_{t-1}	−0.771***	−2.78	0.010
	ΔLTX_{t-2}	−0.599**	−2.59	0.016
	ΔLTX_{t-3}	−0.629***	−3.70	0.001
	$\Delta LREER_t$	−0.730	−0.58	0.564
	$\Delta LREER_{t-1}$	2.051*	1.84	0.078

2. Diagnostic test results

Diagnostic tests	Test statistics	p-values
Breusch-Godfrey (χ^2) – H_0: no serial correlation	0.16	0.692
Durbin's alternative (χ^2) – H_0: no serial correlation	0.11	0.736
Ramsey RESET (*F*) – H_0: model has no omitted variables	3.87	0.024
Breusch-Pagan (χ^2) – H_0: constant variance	0.25	0.617
Portmanteau test for white noise (χ^2) – H_0: white noise	15.67	0.333

*, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 8. Time series estimation results, Model 5 – ARDL (1 3).

1. Model results				
	Dependent variable: *LE* Log likelihood = 25.081 Adj. R-squared = 0.3998			
	Regressors	Coefficients	t-statistics	p-values
Constant term	β_0	2.663***	2.75	0.010
Adjustment term	LE_{t-1}	−0.560***	−3.51	0.002
Long-run result	$LMSO_{t-1}$	0.947***	5.81	0.000
Short-run results	$\Delta LMSO_t$	0.403***	6.50	0.000
	$\Delta LMSO_{t-1}$	−0.203**	−2.20	0.036
	$\Delta LMSO_{t-2}$	−0.031	−0.48	0.634

2. Diagnostic test results		
Diagnostic tests	Test statistics	p-values
Breusch-Godfrey (χ^2) – H_0: no serial correlation	0.07	0.795
Durbin's alternative (χ^2) – H_0: no serial correlation	0.05	0.818
Ramsey RESET (*F*) – H_0: model has no omitted variables	1.77	0.180
Breusch-Pagan (χ^2) – H_0: constant variance	0.93	0.333
Portmanteau test for white noise (χ^2) – H_0: white noise	15.01	0.377

*, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

The empirical results for model 5 are reported in Table 8. The long-run results and the ECT are in line with theoretical predictions and highly statistically significant at the 1% level. The results suggest that the growth of the mining sector output attracts employees from other sectors. A 1% increase in the mining sector output leads to a 0.95% rise in the employment of the sector in the long run. The ECT confirms that a long-run equilibrium relationship exists between the variables. The ECT coefficient is −0.56 and suggests that convergence to equilibrium after a shock to the mining sector employment is rapid.

The lagged variables of the mining sector output have a mixed effect on the employment of the sector. The current value of the output has a positive, and the 1st lag has a negative effect. Both results are statistically significant at the 1% and 5% level, respectively. A 1% increase in the current value of the mining sector output leads to a 0.40% rise, while a 1% increase of the 1st lag of the regressor induces a 0.20% fall in the employment of the sector. The 2nd lag of the regressor has a negative sign, but it is statistically insignificant. The latter results can be explained by the seasonal effect of the labour demand: labour demand in agriculture increases during warm seasons, and it decreases during cold seasons.

The diagnostic tests show that there is no serial correlation, no omitted variables and, no heteroskedasticity and that the residuals are white noise.

6. Conclusions

The paper examined whether Dutch disease symptoms have appeared in Mongolia in the period 2004–2012, i.e. the mining boom years. First, trends and patterns of the Mongolian macroeconomic performance were presented. Secondly, Dutch disease symptoms were analysed using the ARDL bounds testing approach proposed by Pesaran et al. (2001). The empirical evidence indicates that Dutch disease symptoms were present in the Mongolian economy during the booming period.

Amongst the key long-run results, the export of mineral products and the FDI have a highly statistically significant and positive impact on the output of the non-tradable sector and the REER. This outcome provides evidence of the main symptom of the Dutch disease, the so-called 'spending effect'. Moreover, the mining sector output has a positive effect on employment growth in the mining sector, implying that the 'resource movement effect' is also present. These effects are direct effects of the Dutch disease according to the core model (Corden & Neary, 1982), showing that the results are consistent with the theory.

The main findings in the short run show an ambiguous picture and suggest that the current and lagged values of the variables can have both positive and negative effects, with some of them having a highly statistically significant effect while others having an insignificant one. An explanation might be that in the short run some variables such as non-tradable sector performance, REER, government expenditure and exports of the traditional manufacturing sector have been affected by external shocks, government policy and/or central bank policy.

Our findings are consistent with other empirical papers and the papers of Avralt-Od et al. (2012), Batsukh and Avralt-Od (2012), and Ge and Kinnucan (2017).

Note

1. Official Daily Foreign Exchange Rate in 1 March 2019: USD 1 = MNT 2,635.34 (https://www.mongolbank.mn/dblistofficialdailyrate.aspx?vYear=2019&vMonth=3&vDay=1).

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Kadirbyek Dagys http://orcid.org/0000-0003-0833-6070

References

in English

Akaike, H. (1973). *Information theory as an extension of the maximum likelihood principle*. Paper presented at the Second International Symposium on Information Theory, Budapest.

Arezki, R., & Ismail, K. (2013). Boom-bust cycle, asymmetrical fiscal response and the Dutch disease. *Journal of Development Economics*, *101*, 256–267.

Ariunaa, K., & Kim, H.-J. (2012). Diagnosing Dutch disease: Doeas Mongolia have the symptoms? *Series of Academic Publications, Mongolian State University of Science and Technology*, *2/125*, 20.

Athukorala, P.-C., & Rajapatirana, S. (2003). Capital inflows and the real exchange rate: A comparative study of Asia and Latin America. *The World Economy*, *26*(4), 613–637.

Auty, R., & Gelb, A. (1986). Oil windfalls in a small parliamentary democracy - their impact on Trinidad-and-Tobago. *World Development*, *14*(9), 1161–1175.

Batsukh, T., & Avralt-Od, P. (2012). *Risk assessment of "Dutch Disease" in Mongolia*. Ulaanbaatar: The Economic Research Institute (ERI), National University of Mongolia and the IRIS Center at the University of Maryland.

Baum, C. F. (2000a). *CUSUM6: Stata module to compute cusum, cusum^2 stability tests*. Statistical Software Components S408601. Boston: Boston College Department of Economics.

Baum, C. F. (2000b). *KPSS: Stata module to compute Kwiatkowski-Phillips-Schmidt-Shin test for stationarity*. Statistical Software Components S410401 Boston: Boston College Department of Economics.

Bjørnland, H. C., & Thorsrud, L. A. (2016). Boom or gloom? Examining the Dutch disease in two-speed economies. *The Economic Journal*, n/a-n/a. doi:10.1111/ecoj.12302

Bruno, M., & Sachs, J. (1982). Energy and resource-allocation - a dynamic-model of the Dutch disease. *Review of Economic Studies*, *49*, 845–859.

Buiter, W., & Purvis, D. (1983). Oil, disinflation and export competitiveness: A model of the "Dutch Disease". In J. S. Bhandari & B. H. Putnam (Eds.), *Economic interdependence and flexible exchange rates* (pp. 221–248). Cambridge: Massachusetts Institute of Technology Press.

Corden, W. M. (1984). Booming sector and Dutch disease economics: Survey and consolidation. *Oxford Economic Papers*, *36*(3), 359–380.

Corden, W. M., & Neary, J. P. (1982). Booming sector and de-industrialisation in a small open economy. *The Economic Journal*, *92*(368), 825–848.

Davaakhuu, O., Sharma, K., & Oczkowski, E. (2015). Has foreign investment played a role in Mongolia's export success? *Post-Communist Economies*, *27*(2), 256–267.

David, R. (1996). *An empirical analysis of Dutch disease: Developing and developed countries*. Bloomington: Illinois Wesleyan University.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366), 427–431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, *49*(4), 1057.

Dobrynskaya, V., & Turkisch, E. (2010). Economic diversification and Dutch disease in Russia. *Post-Communist Economies*, *22*(3), 283–302.

Dülger, F., Lopcu, K., Burgaç, A., & Ballı, E. (2013). Is Russia suffering from Dutch Disease? Cointegration with structural break. *Resources Policy*, *38*(4), 605–612.

The Economist. (1977, November 26). The Dutch disease. *The Economist*, *265*(7004), 82–83.

Edwards, S., & Aoki, M. (1983). Oil export boom and Dutch-disease. *Resources and Energy*, *5*(3), 219–242.

Egert, B., & Leonard, C. S. (2008). Dutch disease scare in kazakhstan: Is it real? *Open Economies Review*, *19*(2), 147–165.

Enders, K., & Herberg, H. (1983). The Dutch disease - causes, consequences, cures and calmatives. *Weltwirtschaftliches Archiv-Review of World Economics*, *119*(3), 473–497.

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

Fardmanesh, M. (1991). Dutch disease economics and oil syndrome: An empirical study. *World Development*, *19*(6), 711–717.

Frankel, J. (2007). On the rand: Determinants of the South African exchange rate. *The South African Journal of Economics*, *75*(3), 425–441.

Ge, W., & Kinnucan, H. W. (2017). The effects of Mongolia's booming mining industry on its agricultural sector: A test for Dutch disease. *Agricultural Economics*, *48*(6), 781–791.

Hasanov, F. (2013). Dutch disease and the Azerbaijan economy. *Communist and Post-communist Studies*, *46*(4), 463–480.

Herberg, H., & Enders, K. (1984). *More on the consequences of a resource boom and the cures of the Dutch disease*. Lecture Notes in Economics and Mathematical Systems. Berlin, Heidelberg: Springer. Retrieved from <Go to ISI>://A1984RW73400003

Ismail, K. (2010). *The structural manifestation of the Dutch disease': The case of oil exporting countries* (145520062X). Washington, D.C.: International Monetary Fund.

Ito, K. (2017). Dutch disease and Russia. *International Economics*, *151*, 66–70.

Ito, K. (2019). Remittances and the Dutch disease: Evidence from Georgia. *Post-Communist Economies*, 1–7. doi:10.1080/14631377.2018.1537733

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2–3), 231–254.

Khan, T. S., & Gottschalk, J. (2017). *Investigating the transmission channels behind dutch disease effects: Lessons from Mongolia using a CGE model*. Washington, DC: The World Bank.
Kripfganz, S., & Schneider, D. C. (2016). *ardl: Stata module to estimate autoregressive distributed lag models*. 2016 Stata Conference 18, Chicago, Stata Users Group.
Kutan, A. M., & Wyzan, M. L. (2005). Explaining the real exchange rate in Kazakhstan, 1996–2003: Is Kazakhstan vulnerable to the Dutch disease? [Exchange-rate economics in transition countries]. *Economic Systems*, *29*(2), 242–255.
Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, *54*(1–3), 159.
Lartey, E. K. K. (2007). Capital inflows and the real exchange rate: An empirical study of sub-Saharan Africa. *Journal of International Trade & Economic Development*, *16*(3), 337–357.
Lartey, E. K. K. (2011). Financial openness and the Dutch disease. *Review of Development Economics*, *15*(3), 556–568.
Lartey, E. K. K., Mandelman, F. S., & Acosta, P. A. (2012). Remittances, exchange rate regimes and the Dutch disease: A panel data analysis. *Review of International Economics*, *20*(2), 377–395.
Mansilla, M., & Cerutti, E. (2004). *Bolivia: The hydrocarbons boom and the risk of Dutch disease* (128284105X). Washington, D.C.: International Monetary Fund.
Martins, P. M. G. (2010). *Do capital inflows hinder competitiveness? The real exchange rate in Ethiopia*. The Nottingham: University of Nottingham, CREDIT Research Paper.
Martins, P. M. G. (2011). Do large capital inflows hinder competitiveness? The Dutch disease in Ethiopia. *Applied Economics*, *45*(8), 1075–1088.
MB. (2004-2012). *Monthly statistical bulletin*. Ulaanbaatar: Central Bank of Mongolia.
Narayan, P., & Smyth, R. (2005). Trade liberalization and economic growth in Fiji. An empirical assessment using the ARDL approach AU. *Journal of the Asia Pacific Economy*, *10*(1), 96–115.
Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests AU. *Applied Economics*, *37*(17), 1979–1990.
NSO. (2004-2012). *Monthly Bulletin of Statistics*. Ulaanbaatar: National Statistical Office of Mongolia.
Oomes, N., & Kalcheva, K. (2007). *Diagnosing Dutch disease: Does Russia have the symptoms?*. Washington, D.C.: International Monetary Fund.
Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed-lag modelling approach to cointegration analysis. In S. Strøm (Ed.), *Econometrics and economic theory in the 20th century: The Ragnar Frisch Centennial Symposium* (pp. 371–413). Cambridge: Cambridge University Press.
Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326.
Phillips, P. C. B., & Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration. *Econometrica*, *58*(1), 165–193.
Rosenberg, C. B., & Saavalainen, T. (1998). *How to deal with Azerbaijan's oil boom? Policy strategies in a resource-rich transition economy*. Washington, D.C.: International Monetary Fund.
Saborowski, C. (2009). *Capital inflows and the real exchange rate: Can financial development cure the Dutch disease?* (1451871678).
Saborowski, C. (2011). Can financial development cure the Dutch disease? *International Journal of Finance & Economics*, *16*(3), 218–236.
Scherr, S. J. (1989). Agriculture in an export boom economy: A comparative analysis of policy and performance in Indonesia, Mexico and Nigeria. *World Development*, *17*(4), 543–560.
Schwarz, G. (1978). Estimating the Dimension of a Model. *Annals of Statistics*, *6*(2), 461–464.
StataCorp. (2013). *Stata statistical software: Release 13*. College Station, TX: Author.
Treviño, J. P. (2011). *Oil-price boom and real exchange rate appreciation: Is there Dutch disease in the CEMAC?* (1463939639).
Vanwijnbergen, S. (1984). The Dutch disease - a disease after all. *The Economic Journal*, *94*(373), 41–55.
World Bank. (2012). *Mongolia quarterly economic update, February 2012*. Washington, DC. Retrieved from https://openknowledge.worldbank.org/handle/10986/27240

in Mongolian

Avralt-Od, P., Gan-Ochir, D., Davaadalai, B., Dulamzaya, B., Tsend-Ayush, B., & Undral, B. (2012). *Монголын эдийн засаг дахь Голланд өвчний шинж тэмдэг [Dutch Disease symptoms in the economy of Mongolia]*. Research Series (Miscellany No. 8). Ulaanbaatar: Bank of Mongolia.

MB. (2012). *Төгрөгийн нэрлэсэн ба бодит үйлчилж буй ханшийн индексийг тооцох аргачлал [Methodology on estimating the nominal and real effective exchange rate index of Mongolian currency (Tugrik)]*. Ulaanbaatar: Central Bank of Mongolia.

Appendix

Appendix 1. Summary of empirical studies regarding the Dutch disease

Studies	Data	Methodology	Dependent variables	Explanatory variables
(Arezki & Ismail, 2013)	Data for 32 oil-exporting countries for the period 1992–2009	Time series, OLS, GMM	Log of the REER	Lagged log of the REER (ln RER t-1) Log of the current spending (ln cepus) Lagged log of the current spending (ln cepus t-1) Log of the capital expenditure (ln caxus) Lagged log of the capital expenditure (ln caxus t-1) First difference in log of the GDP (growthppp)
			Log of the current spending adjusted by PPP (ln cepusppp) (The model is estimated using data on all countries and data in terms of counties fiscal rules)	Lagged log of the current spending adjusted by PPP (ln cepusppp) Log of the cumulating series of increases in the maximum historical oil unit export value (oevmax) Log of the cumulating series of increases in the minimum historical oil unit export value (oevmin) Log of the cumulating series of increases recovery of oil unit export value (oevrec) First difference in the log of the GDP (growthppp)
			Log of the capital spending (ln caxus) (The model is estimated using data on all countries and data in terms of counties fiscal rules)	Lagged log of the capital spending (ln caxus) Log of the cumulating series of increases in the maximum historical oil unit export value (oevmax) Log of the cumulating series of increases in the minimum historical oil unit export value (oevmin) Log of the cumulating series of increases recovery of oil unit export value (oevrec) First difference in log of the GDP (growthppp)
(Hasanov, 2013)	Quarterly data of Azerbaijan for the period 2000–2007	Time series, VAR and VECM	Log of the non-oil tradable sector output	Log of the price of oil Time trend
			Log of the non-oil tradable sector export	Log of the FDI inflow Log of the REER

(*Continued*)

(Continued).

Studies	Data	Methodology	Dependent variables	Explanatory variables
(Ariunaa & Kim, 2012)	Macroeconomic data of Mongolia during the years 2000–2010	Time series, OLS	REER	Price of gold Price of copper Government consumption Net official international reserves Inflation rate Nominal exchange rate Labour productivity Value added in mining sector International transparency index of corruption Gross domestic product
(Lartey et al., 2012)	Panel data set of 109 developing and transition countries during the years 1990–2003	Dynamic panel data model	RER	Share of the remittances to the GDP Share of the remittances to the GDP * fixed exchange rate regime (FER) Remittances, USD per capita Share of the FDI to the GDP Share of the non-FDI to the GDP Government expenditure FER GDP per capita Share of the money supply to the GDP Terms of trade Trade openness GDP growth
			Tradable/non-tradable ratio (TNT)	Share of remittances to the GDP Share of remittances to the GDP_{t-1} Share of remittances to the GDP_{t-2} Share of the FDI to the GDP Share of the non-FDI to the GDP Government expenditure Share of investment to the GDP Share of remittances to the GDP * fixed exchange rate regime (FER) FER GDP per capita Share of money supply to the GDP Terms of trade Trade openness GDP growth

(*Continued*)

(Continued).

Studies	Data	Methodology	Dependent variables	Explanatory variables
(Martins, 2011)	Quarterly data for the period 1995–2008	UECM, DOLS, FMOLS	Log of the RER (LRER)	Log of the ratio of total trade flows to the GDP (LOPEN) Log of the terms of trade (LTOT) Ratio of foreign aid flows to the GDP (AID) Ratio of private transfers to the GDP (REM) Trend (TREND) - One period lags for all explanatory variables
(Treviño, 2011)	14 oil rich countries of the Central African Economic and Monetary Community	Panel data analysis, OLS	Real exchange rate changes	GDP growth Non-oil GDP growth
			Real exchange rate	GDP growth Non-oil GDP growth
(Lartey, 2011)	Panel data of 109 developing and transition countries for the period 1990–2003	Panel data analysis, GMM	Tradable/non-tradable ratio (TNT)	Lagged variables of TNT Foreign direct investment FDI Lagged variables of FDI Non-FDI NONFDI Capital account openness KAOPEN Current account openness CURROPEN as a proxy for trade restrictions Growth rate of the GDP GGDP Growth rate of the money supply (M2GDP) Terms of trade (TT) Gross domestic investment (INVGDP) Growth rate of government expenditure (GEXP)
			RER	Lagged variables of the RER Capital account openness (KAOPEN) Lagged variables of FDI Non-FDI (NONFDI) KAOPEN* FDI I(KAOPEN)* FDI Current account openness (CURROPEN) Growth rate of the money supply (M2GDP) Terms of trade (TT) Growth rate of government expenditure (GEXP)

(Continued)

(Continued).

Studies	Data	Methodology	Dependent variables	Explanatory variables
(Ismail, 2010)	The annual data of manufacturing during the years 1997–2004, 90 countries including 15 oil-exporting countries	The Heckscher-Ohlin factor endowment model	Log of the output of sectors	Dummies associated with industry, country, and time Log of the oil windfall shocks (permanent and transitory shocks of crude oil spot prices) Labour units of industries Capital units of industries Wage period for industries Weighted average price of capital goods Index for capital market openness - (FDI assets+FDI liabilities)/GDP
(Martins, 2010) Working paper	Quarterly data of Ethiopia for the period 1981–2008	Time series, UECM (ARDL), dynamic OLS, fully modified OLS, unobserved components model, seasonal unit root test (levels and first difference)	Log of the RER	Proxy for the terms of trade (LTOT) Log of the ratio of total trade flows to the GDP (LOPEN) Log of the ratio of foreign aid flows to the GDP (AID) Log of the ratio of private transfers to the GDP (REM) The black-market premium The change in international reserves as shares relative to the GDP The government consumption relative to the GDP The excess money growth Lagged variables of LOPEN, LTOT, AID, LTOT, and RER Seasonal dummy variables
(Saborowski, 2009)	Panel data of 84 countries for the period 1995–2006	Dynamic panel data, Behavioural model of the exchange rate	Log of the RER	Lagged RER Share of the foreign direct investment (FDI) to the GDP Share of the other capital inflows (OCI) to the GDP Share of the net outward investments by residents (ASSETS) relative to the GDP Log of the economy's terms of trade (TOT) Log of the productivity growth relative to trading partners (RELPROD) Log of the trade openness (TRADEOPEN)
(Egert & Leonard, 2008)	Data of Kazakhstan for the period 1996–2005	The monetary model and dynamic OLS	Log of nominal exchange rate	Log of the money demand of the home country Log of the money demand of the foreign country Log of the income of the home country Log of the income of the foreign country Log of the interest rate of the home country Log of the interest rate of the foreign country Log of the price of oil

(*Continued*)

(Continued).

Studies	Data	Methodology	Dependent variables	Explanatory variables
			Log of nominal exchange rate	Log of the money demand of the home country Log of the money demand of the foreign country Log of the income of the home country Log of the Income of the foreign country Log of the Interest rate of the home country Log of the Interest rate of the foreign country Log of the income from oil
(Frankel, 2007)	Quarterly data over 1984–2007	Time series regression	Log of RER (CPI based)	Log of the lagged RER Log of real-world mineral price index Real interest differential (RID) Capital liberalisation as a dummy (CapLib) CapLib dummy * RID
			Log of the RER (PPI based)	Log of the lagged RER Log of the real-world mineral price index Real interest differential (RID) Capital liberalisation as a dummy (CapLib) CapLib dummy * RID
			Log of the RER (GDP deflator based)	Log of the lagged RER Log of the real-world mineral price index Real interest differential (RID) Capital liberalisation as a dummy (CapLib) CapLib dummy * RID
(Oomes & Kalcheva, 2007)	Monthly time series data during the period of April 1997 to December 2005	Time series, behavioural equilibrium exchange rate, OLS	Log of the REER	Log of the price of oil Log of the government consumption Log of the net international reserves (NIR) Log of the productivity differential Log of the corruption index
			Log of the index of the different manufacturing sectors (5 sector)	Log of the price of oil Log of the foreign demand of products from different sectors Four lags for different sectors
(Kutan & Wyzan, 2005)	Annual time series data of Kazakhstan from 1996–2003	The extended version of the Balassa-Samuelson model, ARCH model	RER	Changes in productivity Changes of oil prices Changes of consumer price inflation Impacts of the Russian crisis Exchange rate regime change Potential persistence in the real exchange rate

(*Continued*)

(Continued).

Studies	Data	Methodology	Dependent variables	Explanatory variables
(Mansilla & Cerutti, 2004)	Time series data from 1990–2006	Time series, Johansen's maximum likelihood estimation procedure, VEC model	Log of the RER	Log of the terms of trade Log of the productivity Fiscal balances as a percentage of the GDP Net FDI as a percentage of the GDP Banking sector NFA as a percentage of the GDP
(Athukorala & Rajapatirana, 2003)	Time series data from 1985–2000 of eight Asian and six Latin American countries	Time series, OLS	Log of RER	Foreign direct investment (FDI) Capital inflow excluding FDI (OCFW) Excess money growth (EXMNS) Government expenditure (GEXP) Change in nominal exchange rate (DNER) Openness (OPEN) Slope dummy variable LA*OCFW Slope dummy variable LA*FDI Slope dummy variable LA*EXMS Slope dummy variable LA*GEXP Slope dummy variable LA*DNER Slope dummy variable LA*OPEN
(Rosenberg & Saavalainen, 1998)	Time series monthly data from 1995–1997	The standard Dutch disease model uses graph indications and does not undertake an econometric analysis		
(David, 1996)	The Netherland's manufacturing sector, Nigeria's and Indonesia's agriculture sectors, yearly time series data of 1960–1990	Time series, OLS	Share of the manufacturing sector in the GDP	Government expenditures Annual rate of growth in the money supply Real GDP Ratio of the price of manufacturing goods of MDCs to LDCs
			Share of the agricultural sector in the GDP	Real exchange rate Annual rate of growth in money supply Ratio of the price of manufacturing goods of MDCs to LDCs Per capita income in dollars

(Continued)

(Continued).

Studies	Data	Methodology	Dependent variables	Explanatory variables
(Fardmanesh, 1991)	Time series annual data for the period 1966–1986 of five oil exporting countries, specifically Algeria, Ecuador, Indonesia, Nigeria, and Venezuela.	Time series, reduced form of three-sector model	Share of the agricultural output in nonoil GDP	Ratio of oil revenues The index of the world price of manufactured goods relative to agricultural products for LDCs
			Share of the manufacturing output in nonoil GDP	Ratio of oil revenues The index of the world price of manufactured goods relative to agricultural products for LDCs
			Share of the non-traded output in nonoil GDP	Ratio of oil revenues The index of the world price of manufactured goods relative to agricultural products for LDCs

Note. ARDL (autoregressive distributed lag) ARCH (autoregressive conditional heteroscedasticity)
DOLS (dynamic ordinary least square) FMOLS (fully modified dynamic ordinary least square)
GDP (gross domestic product) GMM - generalised method of moments
LDCs (less developed countries) MDCs (more developed countries)
OLS (ordinary least square) R(E)ER (real (effective) exchange rate)
UECM (unrestricted error-correction model) VAR (vector auto regression)
VECM (vector error-correction model)

Appendix 2. The equation to estimate the REER

Real effective exchange rate (REER) is a measure of the value of the Mongolian Tugrik against a weighted average of the currencies of trade partner countries adjusted by the price index (MB, 2012).

$$REER_{t,i} = \prod_{i=1}^{n} \left(\frac{S_{i,t}^{*}}{p_{i,t}^{*}} \right)^{w_{i,y-2/12}} * REER_{y-2/12}$$

$$S_{i,t}^{*} = \frac{S_{i,t}}{S_{i,y-2/12}}$$

$$S_{i,t} = \frac{1}{E_{\frac{usd}{mnt},t} * E_{i,USD,t}}$$

$$p_{i,t}^{*} = \frac{PI_{i,t}}{PI_{Mon,t}}$$

$$NEER_{t,i} = \prod_{i=1}^{n} S_{i,t}^{*w_{i,y-2/12}} * NEER_{y-2/12}$$

$i = \overline{1,n}$ - number of trade partner countries (i.e. country further)
$S_{i,t}^{*}$ - bilateral nominal exchange rate index of the Mongolian Tugrik against the currency of country i at the end of period t
$S_{i,t}$ - bilateral nominal exchange rate of the Mongolian Tugrik against the currency of country i at the end of period t
$S_{i,y-2/12}$ - bilateral nominal exchange rate of the Mongolian Tugrik against the currency of country i at the end of base period (December of 2 years prior to period t)
$E_{\frac{usd}{mnt},t}$ - nominal exchange rate of the Mongolian Tugrik against the US Dollar at the end of period t
$E_{i,USD,t}$ - nominal exchange rate of the currency of country i against the US Dollar at the end of period t
$p_{i,t}^{*}$ - ratio of domestic price index and price index of country i at the end of period t
$PI_{i,t}$ - price index of country i at the end of period t
$PI_{Mon,t}$ - price index of Mongolia at the end of period t
$w_{i,y-2/12}$ - weight of trade turnover of country i in total external trade turnover at the end of the base period
$REER_{y-2/12}$ – REER at the end of base period

Appendix 3. Pairwise correlation matrix of the variables

	LREER	LMX	LFDI	LTX	LMSO	LSSO	LGS	LE
LREER	1.00							
LMX	**0.80** (0.00)	1.00						
LFDI	**0.75** (0.00)	**0.67** (0.00)	1.00					
LTX	**−0.64** (0.00)	−0.55 (0.00)	−0.59 (0.00)	1.00				
LMSO	0.56 (0.00)	**0.74** (0.00)	0.35 (0.03)	−0.26 (0.13)	1.00			
LSSO	**0.84** (0.00)	**0.92** (0.00)	**0.68** (0.00)	−0.53 (0.00)	**0.73** (0.00)	1.00		
LGS	**0.63** (0.00)	**0.81** (0.00)	0.41 (0.01)	−0.36 (0.03)	**0.68** (0.00)	**0.82** (0.00)	1.00	
LE	**0.80** (0.00)	**0.81** (0.00)	0.61 (0.00)	−0.56 (0.00)	**0.72** (0.04)	**0.88** (0.00)	0.67 (0.18)	1.00

The numbers in the parentheses indicate the p-values of the correlations.
The numbers in bold print indicate the strong correlations with high statistical significance.

Appendix 4. Unrestricted error correction forms of models

Model 1

$$\Delta LSSO_t = \beta_{0LSSO} + \sum_{i=1}^{m-1} \beta_{iLSSO}\Delta LSSO_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLSSO}\Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLSSO}\Delta LFDI_{t-k} + \theta_{1LSSO}LSSO_{t-i} + \theta_{2LSSO}LMX_{t-j} + \theta_{3LSSO}LFDI_{t-k} + \varepsilon_{1t} \quad (A1)$$

$$\Delta LMX_t = \beta_{0LMX} + \sum_{i=0}^{m-1} \beta_{iLMX}\Delta LSSO_{t-i} + \sum_{j=1}^{n-1} \gamma_{jLMX}\Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLMX}\Delta LFDI_{t-k} + \theta_{1LMX}LSSO_{t-i} + \theta_{2LMX}LMX_{t-j} + \theta_{3LMX}LFDI_{t-k} + \varepsilon_{2t} \quad (A2)$$

$$\Delta LFDI_t = \beta_{0LFDI} + \sum_{i=0}^{m-1} \beta_{iLFDI}\Delta LSSO_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLFDI}\Delta LMX_{t-j} + \sum_{k=1}^{p-1} \delta_{kLFDI}\Delta LFDI_{t-k} + \theta_{1LFDI}LSSO_{t-i} + \theta_{2LFDI}LMX_{t-j} + \theta_{3LFDI}LFDI_{t-k} + \varepsilon_{3t} \quad (A3)$$

Model 2

$$\Delta LREER_t = \beta_{0LREER} + \sum_{i=1}^{m-1} \beta_{iLREER}\Delta LREER_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLREER}\Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLREER}\Delta LFDI_{t-k} + \theta_{1LREER}LREER_{t-i} + \theta_{2LREER}LMX_{t-j} + \theta_{3LREER}LFDI_{t-k} + \varepsilon_{1t} \quad (A4)$$

$$\Delta LMX_t = \beta_{0LMX} + \sum_{i=0}^{m-1} \beta_{iLMX} \Delta LREER_{t-i} + \sum_{j=1}^{n-1} \gamma_{jLMX} \Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLMX} \Delta LFDI_{t-k} + \theta_{1LMX} LREER_{t-i} + \theta_{2LMX} LMX_{t-j} + \theta_{3LMX} LFDI_{t-k} + \varepsilon_{2t} \tag{A5}$$

$$\Delta LFDI_t = \beta_{0FDI} + \sum_{i=0}^{m-1} \beta_{iLFDI} \Delta LREER_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLFDI} \Delta LMX_{t-j} + \sum_{k=1}^{p-1} \delta_{kLFDI} \Delta LFDI_{t-k} + \theta_{1LFDI} LREER_{t-i} + \theta_{2LFDI} LMX_{t-j} + \theta_{3LFDI} LFDI_{t-k} + \varepsilon_{3t} \tag{A6}$$

Model 3

$$\Delta LGS_t = \beta_{0LGS} + \sum_{i=1}^{m-1} \beta_{iLGS} \Delta LGS_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLGS} \Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLGS} \Delta LFDI_{t-k} + \theta_{1LGS} LGS_{t-i} + \theta_{2LGS} LMX_{t-j} + \theta_{3LGS} LFDI_{t-k} + \varepsilon_{1t} \tag{A7}$$

$$\Delta LMX_t = \beta_{0LMX} + \sum_{i=0}^{m-1} \beta_{iLMX} \Delta LGS_{t-i} + \sum_{j=1}^{n-1} \gamma_{jLMX} \Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLMX} \Delta LFDI_{t-k} + \theta_{1LMX} LGS_{t-i} + \theta_{2LMX} LMX_{t-j} + \theta_{3LMX} LFDI_{t-k} + \varepsilon_{2t} \tag{A8}$$

$$\Delta LFDI_t = \beta_{0LFDI} + \sum_{i=0}^{m-1} \beta_{iLFDI} \Delta LGS_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLFDI} \Delta LMX_{t-j} + \sum_{k=1}^{p-1} \delta_{kLFDI} \Delta LFDI_{t-k} + \theta_{1LFDI} LGS_{t-i} + \theta_{2LFDI} LMX_{t-j} + \theta_{3LFDI} LFDI_{t-k} + \varepsilon_{3t} \tag{A9}$$

Model 4

$$\Delta LTX_t = \beta_{0LTX} + \sum_{i=1}^{m-1} \beta_{iLTX} \Delta LTX_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLTX} \Delta LREER_{t-j} + \theta_{1LTX} LTX_{t-i} + \theta_{2LTX} LREER_{t-j} + \varepsilon_{1t} \tag{A10}$$

$$\Delta LREER_t = \beta_{0LREER} + \sum_{i=0}^{m-1} \beta_{iLREER} \Delta LTX_{t-i} + \sum_{j=1}^{n-1} \gamma_{jLREER} \Delta LREER_{t-j} + \theta_{1LREER} LTX_{t-i} + \theta_{2LREER} LREER_{t-j} + \varepsilon_{2t} \tag{A11}$$

Model 5

$$\Delta LE_t = \beta_{0LE} + \sum_{i=1}^{m-1} \beta_{iLE} \Delta LE_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLE} \Delta LMSO_{t-j} + \theta_{1LE} LE_{t-i} + \theta_{2LE} LMSO_{t-j} + \varepsilon_{1t} \tag{A12}$$

$$\Delta LMSO_t = \beta_{0MSO} + \sum_{i=0}^{m-1} \beta_{iMSO} \Delta LE_{t-i} + \sum_{j=1}^{n-1} \gamma_{jMSO} \Delta LMSO_{t-j} + \theta_{1MSO} LE_{t-i} + \theta_{2MSO} LMSO_{t-j} + \varepsilon_{2t} \tag{A13}$$

Appendix 5. Restricted error correction forms of models

$$\Delta LSSO_t = \beta_0 + \sum_{i=1}^{m-1} \beta_{iLSSO} \Delta LSSO_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLSSO} \Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLSSO} \Delta LFDI_{t-k} + \vartheta_1 ECT_{t-1} + \varepsilon_{1t} \quad \text{(A14)}$$

$$\Delta LREER_t = \beta_0 + \sum_{i=1}^{m-1} \beta_{iLREER} \Delta LREER_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLREER} \Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLREER} \Delta LFDI_{t-k} + \vartheta_2 ECT_{t-1} + \varepsilon_{2t} \quad \text{(A15)}$$

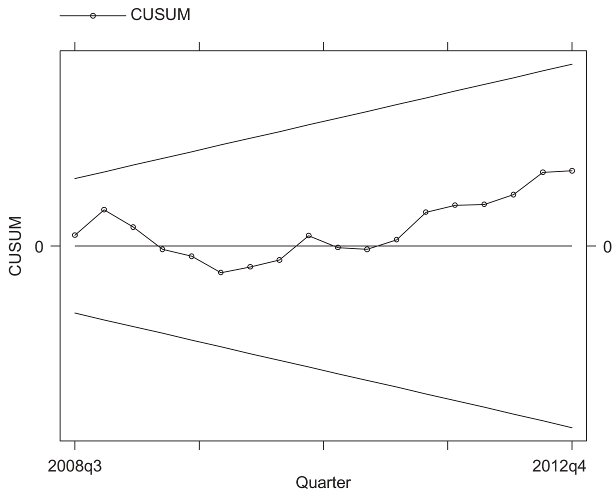
$$\Delta LGS_t = \beta_0 + \sum_{i=1}^{m-1} \beta_{iLGS} \Delta LGS_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLGS} \Delta LMX_{t-j} + \sum_{k=0}^{p-1} \delta_{kLGS} \Delta LFDI_{t-k} + \vartheta_3 ECT_{t-1} + \varepsilon_{3t} \quad \text{(A16)}$$

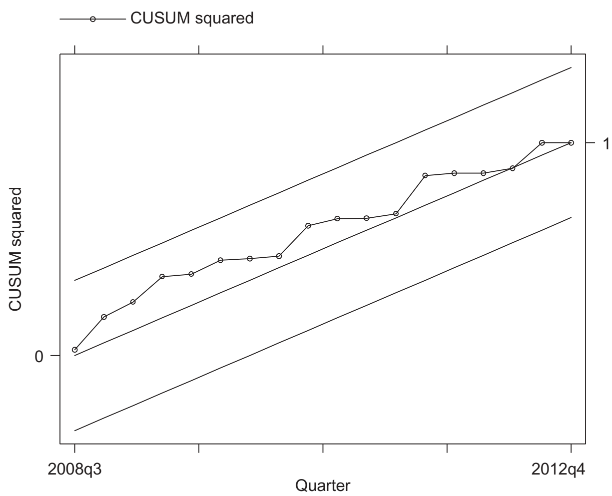
$$\Delta LTX_t = \beta_0 + \sum_{i=1}^{m-1} \beta_{iLTX} \Delta LTX_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLTX} \Delta LREER_{t-j} + \vartheta_4 ECT_{t-1} + \varepsilon_{4t} \quad \text{(A17)}$$

$$\Delta LE_t = \beta_0 + \sum_{i=1}^{m-1} \beta_{iLE} \Delta LE_{t-i} + \sum_{j=0}^{n-1} \gamma_{jLE} \Delta LMSO_{t-j} + \vartheta_5 ECT_{t-1} + \varepsilon_{5t} \quad \text{(A18)}$$

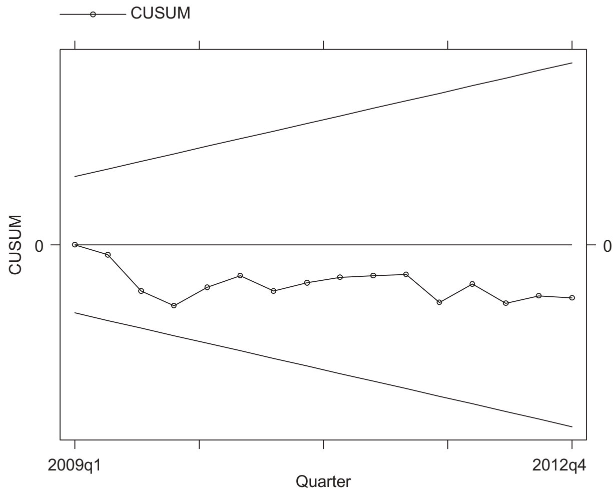
Appendix 6. CUSUM plots

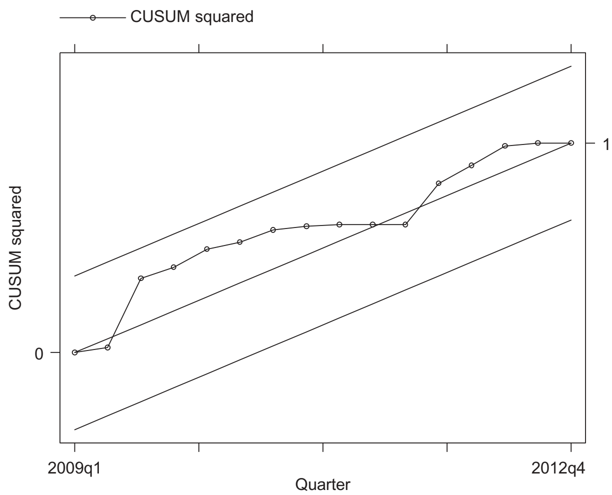
Model 1



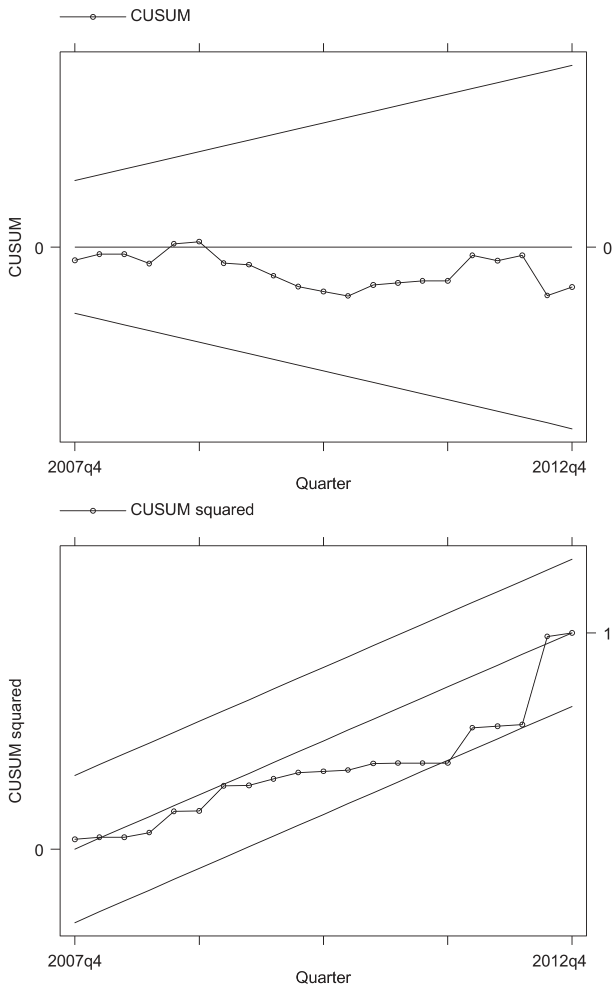


Model 2

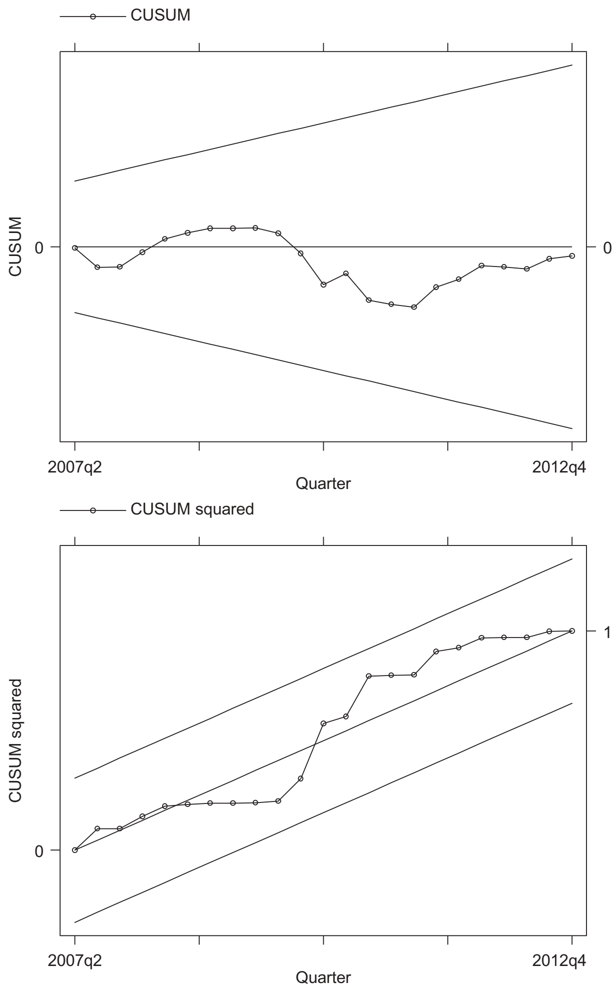

CUSUM
CUSUM
0
0
2009q1
2012q4
Quarter


CUSUM squared
CUSUM squared
0
1
2009q1
2012q4
Quarter

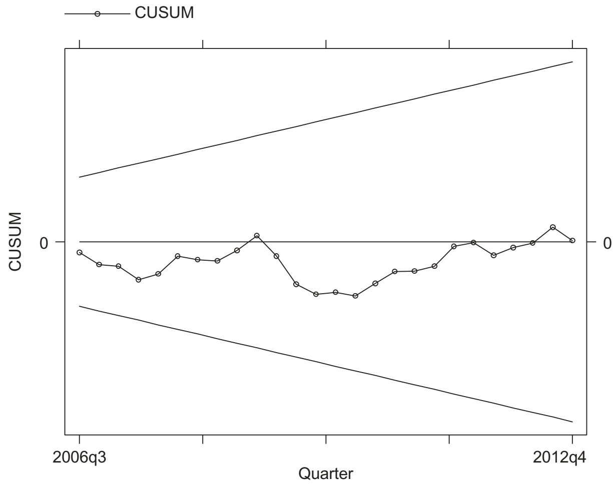
Model 3

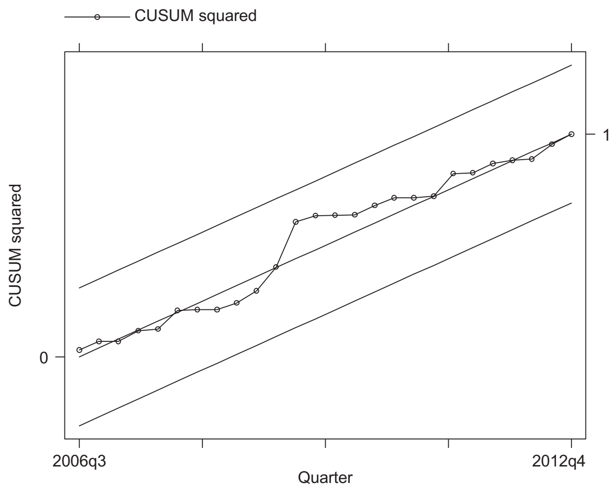

CUSUM
0
0
CUSUM
2007q4
2012q4
Quarter
CUSUM squared
1
0
CUSUM squared
2007q4
2012q4
Quarter

Model 4


CUSUM
CUSUM
0
0
2007q2
2012q4
Quarter
CUSUM squared
CUSUM squared
1
0
2007q2
2012q4
Quarter

Model 5


CUSUM
CUSUM
0
0
2006q3
2012q4
Quarter


CUSUM squared
CUSUM squared
0
1
2006q3
2012q4
Quarter