Does Dutch Disease Hit Mongolia?

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ABSTRACT

Mongolia is a comparatively small country in the world and the limited domestic demand makes it rely on the trade with other countries. In recent years, Mongolia's extensive mineral deposits and attendant growth in mining-sector activities have transformed Mongolia's economy which traditionally has been dependent on herding and agriculture. An equilibrium displacement model based on the macro-economy conditions in Mongolia is conducted to test whether the development of the mining sector has come at the expense of the agricultural sector, as suggested by the "Dutch Disease" hypothesis. Base on the classic economic model developed by Corden and Neary (1982) to describe Dutch Disease: in an open small economy (Mongolia), the booming tradable sector (mining) would suppress the lagging or non-booming sector (agriculture). How the booming mining industry affects the traditional agriculture industry (including grazing) is the main point of this paper.

Key words: Dutch disease, agriculture, mining, Mongolia

INTRODUCTION

As mining grows in Mongolia, its status as a transitional economy depends on continuing to attract foreign investment. According to World Bank figures, Mongolia has attracted over US $14 billion of foreign direct investment between 1990 and 2013, of which 73.3% or US $10 billion poured into the mining industry. Inward investment is essential in order to exploit its extensive mineral deposits across Mongolia. Mongolia is a resource-rich country and also a small open economy which relies on the international trade. The international trade will affect both mining and agricultural industries. According to the data, the value of Mongolian Tugrik (MNT) per US Dollar (USD) decreased from 2009 to 2011 and increased from 2011 to 2013 significantly. The appreciation of MNT would decrease the exports of agricultural products and decrease the total demand; on the other side, the depreciation of MNT will increase the exports of agricultural products as well as the total demand. The increase in the export of minerals and the increase of the FDI induced by the exploitation may suppress the export of other products, in particular, agricultural products (e.g. mutton, beef, etc.) through the appreciation of the currency. From this perspective, the development of the mining sector may come at the expense of agriculture, which is known as the "Dutch Disease". "Dutch disease" was coined in 1977 by *The Economist* magazine to describe the decline of the manufacturing sector in the Netherlands after the discovery of a large natural gas field in 1959. In economics, the Dutch disease is the apparent relationship between the increase in the economic development of natural resources and a decline in the manufacturing sector (or agriculture). The mechanism is that an increase in revenues from natural resources (or inflows of foreign aid) will make a given nation's currency stronger compared to that of other nations (manifest in an exchange rate), resulting in the nation's other exports become more expensive for other countries to buy. While it most often refers to natural resource discovery, it can also refer to "any development that results in a large inflow of foreign currency, including a sharp surge in natural resource prices, foreign assistance, and foreign direct investment (Ebrahim-zadeh 2003)". The classic economic model describing Dutch Disease was developed by the economist Corden and Neary in 1982. In the model, there is a non-tradable sector (which includes services) and two tradable sectors: the booming sector, and the lagging (or non-booming) tradable sector. The booming sector is usually the extraction of natural resources such as oil, natural gas, copper or gold. The lagging sector is usually manufacturing or agriculture.

A resource boom affects this economy in two ways. In the “resource movement effect”, the resource boom increases demand labor, which causes production to shift toward the booming sector, away from the lagging sector. This shift in labor from the lagging sector to the booming sector is called “direct-deindustrialization”. However, this effect can be negligible, since the hydrocarbon and mineral sectors tend to employ few people. The “spending effect” occurs as a result of the extra revenue brought in by the resource boom. It increases demand for labor in the non-tradable sector (services), at the expense of the lagging sector. This shift from the lagging sector to the non-tradable sector is called “indirect-deindustrialization”. The increase demand for non-traded goods increases their price. However, prices in the traded good sector are set internationally, so they cannot change. This amounts to an increase in the real exchange rate.

Whether “Dutch disease” exists is of interest to the economists. Apergis et al. (2014) found a negative relationship between oil rents and agriculture value added in the long run in Middle East and North African (MENA) countries; Dülger et al. (2013) examined whether Russia suffered from “Dutch Disease” by investigating the real appreciation of the Russian ruble and the relative de-industrialization in the post-Soviet Union-era by using Gregory and Hansen (1996a, 1996b) and Arai and Kurozumi (2007) structural break cointegration frameworks, and they found that the Russian economy exhibited some typical symptoms of “Dutch disease”; Pegg (2010) examined the economy in Botswana and found Botswana did not suffer from “Dutch disease” though it suffered from many of the symptoms of the “Dutch disease”, etc.

The national economy data of Mongolia is shown in table1. In Mongolia, the GDP grew fast from 2006 to 2013, the foreign investment also increased dramatically but dropped in 2013, the contribution of agriculture to GDP was about 20%, the contribution of industry to GDP was about 30%, the contribution of services and others to GDP was about 50% and the imports exceeded the exports in most years. The Mongolian currency appreciated from 2006 to 2008 but depreciated in 2009 and then appreciated again. The general trend of the currency was appreciation from 2006 to 2013. According to the data, the value of MNT (Mongolian Tugrik) per 1 USD (US Dollar) decreased from 2009 to 2011 and increased from 2011 to 2013 significantly. We will test if Dutch disease hits Mongolia in this paper, and as expected, this hypothesis will represent the backbone of the Mongolian economy.

MODEL

A Keynesian style equilibrium displacement model (EDM) is specified to determine the effect of the growth in Mongolia's mining sector on its agricultural sector. When the mining sector grows by one percent, what is the percentage effect on the agricultural sector? How does the answer to this question change when growth in the mining sector causes an increase in domestic income, an increase in the value of Mongolia's currency, or both? Of particular interest is the validity of the "Dutch Disease" (DD) hypothesis. The DD hypothesis posits that to the extent foreign direct investment (FDI) in the mining sector increases the value of the domestic currency, there will be a shift of resources away from the traded goods sector (e.g., agriculture) to the non-traded goods sector (e.g., services). The reduction in export demand for agricultural products associated with currency appreciation could exceed the increase in domestic demand for agricultural products associated with FDI-induced income growth, resulting in a net reduction in the size of the agricultural sector. Since a large share of Mongolia's livestock production is exported, the DD hypothesis has particularly important implications for this subsector and the ecosystem that sustains it.

The Keynesian model of Mongolia's economy is similar to the one developed by Glytsos (2005) to analyze the effects of foreign remittances on the growth of selected Mediterranean economies. The structural model consists of six equations describing domestic consumption, investment, imports, exports, government spending, and foreign direct investment. The model in general function form is as follows:

(1) $C = C(Y)$

(2) $I_{mi} = f(Y, e)$

(3) $I_{ag} = g(Y, e)$

(4) $I_{ots} = h(Y, e)$

(5) $TB = TB(e)$

(6) $e = e(Y,\ \overline{FDI}\ )$

(7) $Y = C + I_{mi} + I_{ag} + I_{ots} + TB + \bar{G} + \overline{FDI}$

where C is personal consumption expenditures, Y is national income; I_{mi} is investment in the mining sector; I_{ag} is investment in the agricultural sector; I_{ots} is investment in other sectors, chiefly services; $TB = X - M$ is the trade balance where X is the value of exports and M is the value of imports; $\bar{G}$ is government expenditures; $\overline{FDI}$ is foreign direct investment; $e = USD/MNT$ is the exchange rate. The exchange rate is defined as foreign currency unit divided by the domestic currency unit. Hence, an increase in e implies currency *appreciation* from Mongolia's perspective.

The model contains seven endogenous variables (C, I_{mi}, I_{ag}, I_{ots}, TB, Y, e) and two exogenous variables exogenous variables ($\bar{G}$, $\overline{FDI}$). Technically, foreign direct investment is apt to be endogenous, dependent on the exchange rate and income. However, in line with Glytsos' (2005) analysis, we ignore this aspect of the problem for simplicity. At issue in the present analysis is the effect of changes in $\overline{FDI}$ on the agricultural sector given the structure defined in equations (1) – (7).

The first step is to express the model in EDM form (e.g., Wohlgenant 2011). This entails totally differentiating each equation and converting partial derivatives to elasticities to yield:

(8) $$C^* = \alpha\, Y^*$$

(9) $$I_{mi}{}^* = \beta_{mi} Y^* + \theta_{mi} e^*$$

(10) $$I_{ag}{}^* = \beta_{ag} Y^* + \theta_{ag} e^*$$

(11) $$I_{ots}{}^* = \beta_{ots} Y^* + \theta_{ots} e^*$$

(12) $$TB^* = \mu\, e^*$$

(13) $$e^* = \varepsilon_Y\, Y^* + \varepsilon_{FDI}\, \overline{FDI}^*$$

(14) $$Y^* = \omega_c C^* + \omega_{mi} I_{mi}{}^* + \omega_{ag} I_{ag}{}^* + \omega_{ots} I_{ots}{}^* + \omega_{TB} TB^* + \omega_G \bar{G}^* + \omega_{FDI} \overline{FDI}^*$$

where $\omega_i = i/Y$ ($i = C,\ I_{mi},\ I_{ag},\ I_{ots},\ TB,\ \bar{G},\ \overline{FDI}$) are income shares that sum to 1. β_{mi}, β_{ag}, β_{ots} are income elasticities that indicate the sensitivity of consumption, investment, trade balance, and the exchange rate to the changes in income; θ_{mi}, θ_{ag}, θ_{ots} are exchange-rate elasticities that indicate the sensitivity of investment and trade balance to changes in the value of the domestic currency; ε_{FDI} is an FDI elasticity that indicates the sensitivity of the exchange rate to changes in resource inflows. Economic theory suggests consumption and investment are positively related to income; hence α, β_{mi}, β_{ag}, and β_{oth} are assumed to be positive in sign.

The Marshall-Lerner condition implies that for small open economics, like Mongolia, currency appreciation reduces the trade balance; hence μ is assumed to be negative in sign.

Theory is less informative about the effects of exchange rates. In a small open economy the price of exported goods is exogenous. Hence, higher domestic consumption will raise the price of non-traded goods only. To the extent that the change in relative prices induces a re-allocation of resources between sectors, the output of traded goods will fall and the output of non-traded goods will rise. The changed composition of output does not necessarily lower social welfare. However, income inequality could worsen if the resources employed in the traded-goods sector are owned primarily by the poor. Also, aggregate production efficiency could decline if the traded-goods sector generates positive externalities. The latter effect in essence is the "Dutch disease." Specifically, income growth induced by a booming natural resource sector decreases aggregate production efficiency by shifting resources away from the relatively efficient traded-goods sector. If increased revenues from natural resources (or increased inflows of FDI) make the domestic currency stronger, imports will increase at the expense of exports, which will erode further the competitiveness of the export-dependent or lagging sectors.

Because Mongolia's mining and agricultural sectors are export dependent, currency appreciation that reduces export demand should decrease investments in these sectors; hence θ_{mi} and θ_{ag} are assumed to be negative in sign. Because currency appreciation increases imports, some of which will compete with locally-produced goods, it seems reasonable to assume that θ_{ots} is negative in sign as well. Since income growth generally is associated with a stronger currency, we will assume that ε_Y is positive in sign, although this assumption may be questioned.

The most important parameter from the standpoint of the DD hypothesis is ε_{FDI}. The standard Dutch Disease model predicts that an increase in FDI causes the real exchange rate to increase, which implies $\varepsilon_{FDI} > 0$. However, as noted by Fielding and Gibson (2013, pp. 3-4) empirical evidence is not fully consistent with this prediction. Accordingly, in the analysis to follow we will assess the extent to which $\varepsilon_{FDI} \leq 0$ affects inferences.

Our analysis proceeds in two steps. First, we solve the model for $I_{ag}{}^*$ in terms of $I_{mi}{}^*$, e^*, and $\overline{FDI}^*$. This step is accomplished by deleting equations (9) and (13) (to treat $I_{mi}{}^*$ and e^* as temporarily exogenous) and solving the remaining equations simultaneously. This step gives the quasi-reduced form relationship between $I_{ag}{}^*$ and $\overline{FDI}^*$. In the second step we solve the quasi-reduced form equation simultaneously with equations (9) and (13) to get the full reduced form. A comparison of the quasi and full reduced form equations for ${I_{ag}}^*$ permits an assessment of how changes in the exchange rate induced by FDI affects the agricultural sector *taking into account its effect on the mining sector*.

The quasi-reduced form equation for investment in the agricultural sector is:

$$(15)\ {I_{ag}}^* = \frac{\beta_{ag}\omega_{mi}}{\Phi}\,{\bar{I}_{mi}}^* + \frac{\beta_{ag}\omega_G}{\Phi}\,\bar{G}^* + \frac{\beta_{ag}\omega_{FDI}}{\Phi}\overline{FDI}^* + \frac{\beta_{ag}(\omega_{ots}\theta_{ots}+\omega_{TB}\mu)+\theta_{ag}\left(1-\frac{\partial C}{\partial Y}-\frac{\partial I_{ots}}{\partial Y}\right)}{\Phi}\,\bar{e}^*$$

where $\Phi = \left(1-\alpha\omega_c-\omega_{ag}\beta_{ag}-\omega_{ots}\beta_{ots}\right) \equiv \left(1-\frac{\partial C}{\partial Y}-\frac{\partial I_{ag}}{\partial Y}-\frac{\partial I_{ots}}{\partial Y}\right)$.

The sign of Φ depends on the relative sizes of the marginal propensities to consume and invest. For purposes of the present analysis, we will assume that the propensities sum to less than 1 so that $\Phi > 0$. With this assumption, and the maintained hypothesis that $\beta_{ag} > 0$, i.e., an increase in income increases investment in the agricultural sector, growth in the mining sector has a positive effect on the agricultural sector, *assuming such growth has no effect on the exchange rate*.

Currency appreciation reduces the agricultural sector *holding constant its effect on the mining sector*. Since the mining sector has a positive effect on the agricultural sector, and the mining sector is assumed to decline with the exchange rate, letting the latter adjust can be expected to magnify the effect of currency appreciation on the agricultural sector. Whether this inference is correct can be determined from the full reduced form, which is as follows:

$$(16)\ {I_{ag}}^* = \frac{\overbrace{\varepsilon_{FDI}\beta_{ag}(\omega_{mi}\theta_{mi}+\omega_{ots}\theta_{ots}+\omega_{TB}\mu)}^{A} + \overbrace{\varepsilon_{FDI}\theta_{ag}\left(1-\frac{\partial C}{\partial Y}-\frac{\partial I_{mi}}{\partial Y}-\frac{\partial I_{ots}}{\partial Y}\right)}^{B} + \overbrace{\omega_{FDI}\left(\beta_{ag}+\theta_{ag}\varepsilon_Y\right)}^{C}}{\Psi}\overline{FDI}^*$$

Where $\Psi = \left(1-\alpha\omega_c-\omega_{mi}\beta_{mi}-\omega_{ag}\beta_{ag}-\omega_{ots}\beta_{ots}\right)-\varepsilon_Y\left(\omega_{mi}\theta_{mi}+\omega_{ag}\theta_{ag}+\omega_{ots}\theta_{ots}+\omega_{TB}\mu\right) > 0$ under the maintained hypothesis that the marginal propensities to consume and invest sum to less than 1. The signs of terms A, B and C are uncertain. Hence, the model yields no prediction about the relationship between the agricultural sector and FDI when the mining sector and the exchange rate are permitted to adjust. The relationship is an empirical issue that rests importantly on the signs and relative magnitudes of ε_{FDI} and ε_Y. Hence, in the empirical analysis we will focus on estimating these parameters.

DEVELOPMENT OF THE EMPIRICAL MODEL

The augmented autoregressive distributed lag (ARDL) model is constructed to examine the short-run and long-run relationship among the exchange rate, FDI, and GDP in this study. Pesaran and Shin (1997) proved that after appropriate augmentation of the order of the ARDL model, the OLS estimators of the short-run parameters were $\sqrt{T}$-consistent with the asymptotically singular covariance matrix, and the ARDL-based estimators of the long-run coefficients were super-consistent, and valid inferences on the long-run parameters could be made using standard normal asymptotic theory. This rehabilitation of the traditional ARDL approach to time series econometric modelling has the advantage of yielding consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(0) or I(1). Then a prior test will be not necessary. The augmented ARDL model makes the analysis of the time-series data less complicated. Pesaran et al (2001) developed the testing approaches to the analysis of level relationship based on the augmented ARDL model. In the end of their paper, they re-examined the earning equations included in the UK Treasury macroeconomic model to check the testing approaches and their results were close to the original results. Since then, the augmented ARDL model has become more and more practical in the area regarding time-series data. Baek and Koo (2009) used the augmented ARDL model to examine the short- and long-run effects of exchange rate on bilateral trade of agricultural products between the United States and its 10 major trading partners.

In order to illustrate the ARDL model, equation (6) (or equation (13)) is expressed in a log linear form as:

(17) $$lne_{i,t} = \alpha + \beta_1 lnFDI_t + \beta_2 lnGDP_t + \varepsilon_t$$

where $e_{i,t}$ is the real exchange rate defined by the nominal exchange rate and the CPI[1]; FDI_t and GDP_t are the real FDI and real GDP in Mongolia respectively, which are defined by the nominal values and the CPI[2]; i stands for foreign currency (US dollar, CN yuan, EURO and Russian ruble); ε_t is the error term.

Equation (17) represents the long-run equilibrium relationship among the exchange rate, FDI, and GDP. The short-run equilibrium relationship is developed by the conditional equilibrium

[1] For instance, real exchange rate (USD/MNT) = nominal exchange rate (USD/MNT)*(CPI_MN/CPI_US); real FDI = nominal FDI /CPI_MN

[2] For instance, real FDI = nominal FDI /CPI_MN

correction formulation (ECM) (Pesaran et al 2001), which can be written as:

(18) $$\Delta lne_{i,t} = \alpha_0 + \alpha_1 t + \beta_1 lne_{i,(t-1)} + \boldsymbol{\beta}_x \boldsymbol{x}_{t-1} + \sum_{i=1}^{p-1} \boldsymbol{\pi}' \Delta \mathbf{z}_{t-i} + \boldsymbol{\gamma}' \Delta \boldsymbol{x}_t + \mu_t$$

where Δ is the difference operator, p is the lag order, and μ_t is assumed serially uncorrelated; the bold English letters represent the vectors of variables, $\boldsymbol{x}_t = (lnFDI_t, lnGDP_t)$, $\mathbf{z}_t = (lne_{i,t}, lnFDI_t, lnGDP_t)' = (lne_{i,t}, \boldsymbol{x}_t{}')'$ and the bold Greek letters represent the vectors of coefficients.

Equation (18) is the ECM associated with the ARDL model (Pesaran et al, 2001). The linear combination of the lagged variables (terms with "β"s) actually replaces the lagged correction term (EC_{t-1}) in a standard error correction model. Whether the trend term is included or not depends on the character of the data as well as the unit root tests in the following section.

DATA AND TESTING PROCEDURE

To examine the effect of FDI and GDP on the exchange rate in Mongolia, we collect annual data from 1993 to 2013 (21 observations). The values of net FDI, GDP and CPI of Mongolia, the exchange rate between US Dollar (USD) and MN Tugrik (MNT), the exchange rate between US Dollar and CN Yuan (CNY), the exchange rate between US Dollar and Russian Ruble, the CPI of the Unite States, China, and Russia are obtained from the World Bank. The exchange rate between USD and EURO is obtained from the PACIFIC Exchange Rate Service, Sauder School of Business, The University of British Columbia. The CPI in the European area is obtained from RateInflation[3] website. The exchange rate between MNT and CNY (EURO, Ruble) is converted into U.S. dollar. Since the exchange rate is expressed as the value of foreign currency (USD, CNY, EURO and Ruble) per unit of the MNT, an increase in the exchange rate indicates an appreciation of the Mongolian currency. The data are shown in table 1. From 1993 to 2013, FDI varied significantly whereas the exchange rates was more stable.

According to equations (17) and (18) in the above section, six variables are constructed by taking the logarithms of the real values: $lnreal\_eusd_t=ln(real\_eusd_t)$, $lnreal\_ecny_t=ln(real\_ecny_t)$, $lnreal\_eeur_t=ln(real\_eeur_t)$, $lnreal\_eeurb_t=ln(real\_eeur_t)$, $lnreal\_fdi_t=ln(real\_fdi_t)$, and $lnreal\_gdp_t=ln(real\_gdp_t)$, where $real\_eusd_t$ is the real exchange rate between USD and MNT,

[3]http://www.rateinflation.com/consumer-price-index/euro-area-historical-cpi?start-year=1993&end-year=2013.

$real\_ecny_t$ is the real exchange rate between CNY and MNT, $real\_eeur_t$ is the real exchange rate between EURO and MNT, $real\_eeurb_t$ is the real exchange rate between Ruble and MNT, $real\_fdi_t$ and $real\_gdp_t$ are the real FDI and real GDP in Mongolia respectively. The time plots of the six variables are shown in figures 1 and 2. Figure 1 shows the deviations from mean real exchange rates. All the exchange rates moved up and down significantly from the mean value. The exchange rates of MNT/USD, MNT/EURO and MNT/CNY show that the Mongolian currency strengthened in the recent years. But the exchange rate of MNT/RUB show that the Mongolian currency became weaker. In early 21th century, the change of MNT/RUB was more significant than other exchange rates. Figure 2 indicates that the real GDP shows a steadily rising trend while FDI increased up to 2010 and decreased afterwards. This suggests that a linear trend should be included in equation (18).

Before constructing a proper augmented ARDL model, the first step is to test if the data are I(0) or I(1), which is required in the model. The Phillips–Perron test results (See table 2) show that the regressors (lnreal_fdi and lnreal_gdp) are I(1) with trend. To determine the appropriate lag length p in equation (18) and confirm whether a time trend should be included, the ECM equation (18) is estimated by LS, with and without a linear time trend, for p=1, 2, 3. All the regressions are run over the same period from 1996 to 2013[4] in order to make them comparable. Akaike's Information Criteria (AIC) and Schwarz's Bayesian Information Criteria (SBC) are used to compare regressions under different orders. Lagrange multiplier (LM) statistics are used to test the hypothesis of no residual serial correlation. F-test and t-tests for testing the existence of a levels relationship (equation (17)), are from the bounding test intervals given in Pesaran et al (2001)'s paper. Since there are four equations, each with one exchange rate, the above test procedure is conducted four times to decide the orders for the four equations respectively. The testing results are shown in table 3. Based on the AIC, SBC and LM, 3 lags are selected when the response variables are $\Delta lnreal\_eusd_t$, $\Delta lnreal\_ecny_t$ and $\Delta lnreal\_erub_t$, and order 1 is chosen when the response variable is $\Delta lnreal\_eeur_t$. The trend is included for each equation as discussed before because equations with trend are better based on AIC and SBC. The results are consistent with the changes of GDP and FDI over time. The critical interval for the F-test is (4.87, 5.85) at the 0.05 bounds. F-value above the upper bound indicates the existence of the level

[4] The observations in the first three years are deleted because of the lag order 3.

relationship, F-value within the interval is inconclusive, and F-value below the lower bound indicates that the level relationship does not exist. Thus there is no statistically significant relationship among the exchange rate, FDI and GDP when the exchange rate is denoted by Euro. In the following part, we will just focus on the level relationship when the exchange rate is denoted by U.S. dollars, Chinese Yuan, and Russian Ruble.

Since the proper lag orders are determined, the next step is to choose the appropriate ARDL model based on the orders. First the orders of an ARDL($p,\ p_1,\ p_2$) model in the three variables ($lne_{i,t},\ lnFDI_t,\ lnGDP_t$) were selected by searching across the 4^3 = 64 ARDL models, spanned by $p = 0,1,2,3$ and $p_n = 0,1,2,3,\ \mathrm{n} = 1,2$, using AIC criteria. The standard ARDL ($p,\ p_1,\ p_2$) model can be expressed as:

(19i)

$$lnreal\_eusd_t = \alpha_{1,0} + \alpha_{1,1}t + \sum_{j=1}^{p} \emptyset_{1,j}\, lnreal\_eusd_{t-j} + \beta_{1,1}lnreal\_fdi_t + \beta_{1,2}lnreal\_gdp_t + \sum_{j=0}^{p_1-1} \gamma_{1,1j}\Delta lnreal\_fdi_{t-j} + \sum_{j=0}^{p_2-1} \gamma_{1,2j}\Delta lnreal\_gdp_{t-j} + \mu_{1,t}$$

(19ii)

$$lnreal\_ecny_t = \alpha_{2,0} + \alpha_{2,1}t + \sum_{j=1}^{p} \emptyset_{2,j}\, lnreal\_ecny_{t-j} + \beta_{2,1}lnreal\_fdi_t + \beta_{2,2}lnreal\_gdp_t + \sum_{j=0}^{p_1-1} \gamma_{2,1j}\Delta lnreal\_fdi_{t-j} + \sum_{j=0}^{p_2-1} \gamma_{2,2j}\Delta lnreal\_gdp_{t-j} + \mu_{2,t}$$

(19iii)

$$lnreal\_erub_t = \alpha_{3,0} + \alpha_{3,1}t + \sum_{j=1}^{p} \emptyset_{3,j}\, lnreal\_erub_{t-j} + \beta_{3,1}lnreal\_fdi_t + \beta_{3,2}lnreal\_gdp_t + \sum_{j=0}^{p_1-1} \gamma_{3,1j}\Delta lnreal\_fdi_{t-j} + \sum_{j=0}^{p_2-1} \gamma_{3,2j}\Delta lnreal\_gdp_{t-j} + \mu_{3,t}$$

where the first numbers “1” “2” and “3” in the subscripts of the coefficients are used to distinguish the coefficients in equation (19i) (19ii) and (19iii); the Greek letters are coefficients; $\mu_{i,t}$($i = 1,2,3$)is the error term.

Their associated level relationships are given by:

(20i) $$lnreal\_eusd_t = \omega_1 + \delta_1 t + \theta_{11}lnreal\_fdi_t + \theta_{12}lnreal\_gdp_t + v_{1t}$$

(20ii) $$lnreal\_ecny_t = \omega_2 + \delta_2 t + \theta_{21}lnreal\_fdi_t + \theta_{22}lnreal\_gdp_t + v_{2t}$$

(20iii) $lnreal\_erub_t = \omega_3 + \delta_3 t + \theta_{31} lnreal\_fdi_t + \theta_{32} lnreal\_gdp_t + v_{3t}$

where the coefficients are calculated by the coefficients in equation (19) like, $\delta_i = \frac{\alpha_{i,1}}{\emptyset_i(1)}$, $\omega_i = \frac{\alpha_{i,0}}{\emptyset_i(1)} - \frac{\sum_{j=1}^{p} \emptyset_{i,j}}{\emptyset_i(1)} \delta_i$, $\theta_{i1} = \frac{\beta_{i,1}}{\emptyset_i(1)}$, $\theta_{i2} = \frac{\beta_{i,2}}{\emptyset_i(1)}$, $\emptyset_i(1) = 1 - \sum_{j=1}^{p} \emptyset_{i,j}$, $i = 1, 2, 3$.

Once the level relationships are obtained, the significance of the estimation in the long-run equations (20i), (20ii) and (20iii) is indicated by standard error calculated by the variance of the coefficient (Pesaran and Shin 1997). The consistent estimator of the variance of $\widehat{\theta_{ik}}$ is given by:

$$V(\widehat{\theta_{ik}}) = \frac{\hat{\sigma}_{i,ut}{}^2}{\emptyset_i(1)} \frac{1}{\sum_{t=1}^{T} (\boldsymbol{x_t} - \overline{\boldsymbol{x}})^2}$$

$$\hat{\sigma}_{i,ut} = T^{-1} (\mu_{i,t})' (\mu_{i,t})$$

where $\widehat{\theta_{ik}}$ represents the estimated long-run effect in the level equations (20i) and (20ii), $i = 1, 2, 3$ inditicates the equation (20i), (20ii) and (20iii), $k = 1,2$ indications the coefficients of $lnreal\_fdi_t$ and $lnreal\_gdp_t$ respectively; $\mu_{i,t}$ is the error term from equation (19i), (19ii) and (19iii); T is the time period from 1996 to 2013 in this study; the bold $\boldsymbol{x_t}$ represents the regressors $lnreal\_fdi_t$ and $lnreal\_gdp_t$.

EMPIRICAL RESULTS

The augmented ARDL models with proper orders are obtained for equation (19i), (19ii) and (19iii) after selection from 192[5] models. They are the ARDL (3, 3, 3) for equation (19i), the ARDL (3, 0, 3) for equation (19ii) and the ARDL (3, 3, 3) for equation (19iii). The regression results of the two augmented ARDL models are shown in table 4, table5 and table 6. Meanwhile their associated level relationship equations as well as significance indicators, standard errors, can be obtained as:

(21i) $lnreal\_usd_t = -26.52 - 0.12t + 0.39*lnreal\_fdi_t + 0.48*lnreal\_gdp_t + e_{1t}$

(0.02) (0.05)

(21ii) $lnreal\_cny_t = -11.95-0.01t + 0.01*lnreal\_fdi_t + 0.26*lnreal\_gdp_t + e_{2t}$

(0.002) (0.007)

(21ii) $lnreal\_rub_t = -4.613-0.14t + 0.54*lnreal\_fdi_t + 0.38*lnreal\_gdp_t + e_{3t}$

(0.000) (0.001)

[5] Each equation has 64 choices and there are three equations (19i), (19ii) and (19iii).

The empirical results show that the coefficients of lnreal_fdi_t are significantly positive. It means that the foreign direct investment will strengthen the exchange rate between MNT and USD, the exchange rate between MNT and CNY, and the exchange rate between MNT and RUB in a long term.

Till now, we get both the long-run and short-run relationship among the exchange rate, FDI and GDP. Compared to the short-run relationship, the long-run is of more interest to this study because the purpose of this study is to understand the effect of the foreign direct investment on the investment in the agricultural sector. According to equation (16), ε_{FDI} is the crucial factor, which is exactly the coefficient of lnreal_fdi_t in the level equations (21i), (21ii) and (21iii).

THE EFFECT OF MINING ON AGRICULTURE

Now look back to equation (16), which can be presented in terms of β_{ag} and θ_{ag} below:

$$(22)\ I_{ag}{}^{*} = \frac{\overbrace{\beta_{ag}[\varepsilon_{FDI}(\omega_{mi}\theta_{mi}+\omega_{ots}\theta_{ots}+\omega_{TB}\mu)+\omega_{FDI}}^{A}]+\theta_{ag}[\overbrace{\varepsilon_{FDI}(1-\frac{\partial C}{\partial Y}-\frac{\partial I_{mi}}{\partial Y}-\frac{\partial I_{ots}}{\partial Y})+\omega_{FDI}\varepsilon_{Y}]}^{B}}{\Psi}\overline{FDI}^{*}$$

The regression estimated the signs of ε_{FDI} and ε_{Y} so part B is negative. Part A is determined by the magnitudes of ω_{FDI} and $\varepsilon_{FDI}(\omega_{mi}\theta_{mi}+\omega_{ots}\theta_{ots}+\omega_{TB}\mu)$ because their signs are different. ω_{FDI} is positive and it varied a lot in the past years. Therefore the effect of mining on the agriculture depends on the contribution of all the industries to the GDP. When the FDI from the mining takes a smaller part of the total GDP, while other industries take a larger part, then part A would be negative. Then the coefficient of FDI on agriculture would be negative. It means that the mining industry suppresses the agriculture. However, if FDI takes a larger part of the GDP, while other industries takes a smaller part, then part A would be positive and that makes the coefficient of FDI on agriculture undetermined. More precise estimations are needed to determine the magnitudes of ω_{FDI} and $\varepsilon_{FDI}(\omega_{mi}\theta_{mi}+\omega_{ots}\theta_{ots}+\omega_{TB}\mu)$.

CONCLUSION

Our work focuses on the economy in Mongolia, in particular the effect of the booming mining industry on the traditional agricultural industry, as stated, if Dutch disease hits Mongolia. A Keynesian style EDM model is introduced to catch the general economic relationships in

Mongolia, which include the interactions between different sectors. And in the empirical part, an ARDL model is used to estimate the signs of the key variables.

The estimations show that both the GDP and the FDI will strengthen the Mongolian currency. It means the “Dutch Disease” might exist in Mongolia. Based on the results from the regression, the effect of the mining on the agriculture is discussed in the previous part. If the FDI from mining takes a smaller part of GDP then the mining will suppress the agriculture. But if the contribution of FDI to the GDP becomes larger, the influence of the mining on the agriculture is undetermined. More details for instance the magnitudes of some key variables are needed in the future studies.

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Table 1. FDI, GDP, Exchange Rate of Mongolia, 1993-2013 (Million USD)

Year	Net FDI	Net FDI (% of GDP)	GDP	Exchange Rate (USD/MNT)	Exchange Rate (CNY/MNT)	Exchange Rate (EUR/MNT)	Exchange Rate (RUB/MNT)
1993	7.70	1.00%	768.40	0.339%	1.953%	0.290%	0.336%
1994	6.90	0.75%	925.82	0.242%	2.088%	0.205%	0.531%
1995	9.80	0.67%	1,452.17	0.223%	1.862%	0.172%	1.016%
1996	15.90	1.18%	1,345.72	0.182%	1.516%	0.146%	0.934%
1997	25.00	2.12%	1,180.93	0.127%	1.049%	0.112%	0.732%
1998	18.90	1.68%	1,124.44	0.119%	0.985%	0.106%	1.154%
1999	30.40	2.87%	1,057.41	0.098%	0.810%	0.092%	2.409%
2000	53.70	4.72%	1,136.90	0.093%	0.769%	0.101%	2.613%
2001	43.00	3.39%	1,268.00	0.091%	0.754%	0.102%	2.657%
2002	77.79	5.57%	1,396.56	0.090%	0.745%	0.096%	2.823%
2003	131.50	8.24%	1,595.30	0.087%	0.722%	0.077%	2.677%
2004	92.90	4.66%	1,992.07	0.084%	0.698%	0.068%	2.431%
2005	184.60	7.32%	2,523.36	0.083%	0.680%	0.067%	2.347%
2006	343.98	10.08%	3,414.05	0.085%	0.676%	0.068%	2.305%
2007	360.00	8.50%	4,234.89	0.085%	0.650%	0.062%	2.186%
2008	838.46	14.91%	5,623.24	0.086%	0.596%	0.059%	2.132%
2009	569.80	12.43%	4,583.83	0.070%	0.475%	0.050%	2.208%
2010	1,629.70	26.28%	6,200.36	0.074%	0.499%	0.056%	2.238%
2011	4,620.10	52.73%	8,761.43	0.079%	0.511%	0.057%	2.322%
2012	4,407.76	42.70%	10,321.97	0.074%	0.465%	0.057%	2.272%
2013	2,109.43	18.32%	11,516.41	0.066%	0.407%	0.049%	2.089%

Table 2. Phillips-Perron Unit Root Test (Trend)

Variables	Tau
lnreal_fdi	-3.59*
lnreal_gdp	-3.27
Δlnreal_fdi	-4.35**
Δlnreal_gdp	-3.33*

***significant at 1%

**significant at 5%

*significant at 10%

Table 3. Results from the testing procedure with trend

	Lag order	AIC	SBC	LM(1)	LM(2)	LM(3)	F-statistics	Decision
$\Delta lnreal\_eusd_t$	3	-63.82	-54.02	0.89	0.99	0.92	14.69	Exist
$\Delta lnreal\_ecny_t$	3	-74.50	-62.92	0.13	0.36	1.14	8.06	Exist
$\Delta lnreal\_eeur_t$	1	-32.76	-26.53	0.05	0.07	1.10	1.85	Not exist
$\Delta lnreal\_erub_t$	3	-70.90	-59.32	2.22	2.38	3.98	14.31	Exist

Table 4. Regression results of the ARDL (3, 3, 3) model for MNT/USD

Variable	Estimate
lnreal_eusd_1	-0.75**
lnreal_eusd_2	-0.31
lnreal_eusd_3	0.18
lnreal_fdi	0.73***
lnreal_gdp	0.91***
dlnreal_fdi	-0.53***
dlnreal_fdi_1	-0.32**
dlnreal_fdi_2	-0.08

dlnreal_gdp	-1.03***
dlnreal_gdp_1	-0.57**
dlnreal_gdp_2	-0.35**
t	-0.23***
Intercept	-49.65***

***significant at 1%

**significant at 5%

*significant at 10%

Table 5. Regression results of the ARDL (3, 0, 3) model for MNT/CNY

Variable	Estimate
lnreal_ecny_1	-0.85***
lnreal_ecny_2	-0.92***
lnreal_ecny_3	-0.68***
lnreal_fdi	0.03
lnreal_gdp	0.91***
dlnreal_gdp	-0.61***
dlnreal_gdp_1	-0.42**
dlnreal_gdp_2	-0.06
t	-0.05***
Intercept	-41.19***

***significant at 1%

**significant at 5%

*significant at 10%

Table 6. Regression results of the ARDL (3, 3, 3) model for MNT/RUB

Variable	Estimate
lnreal_erub_1	-0.57**
lnreal_erub_2	-0.16

lnreal_erub_3	-0.25
lnreal_fdi	0.45**
lnreal_gdp	-0.32*
dlnreal_fdi	-0.32**
dlnreal_fdi_1	-0.24**
dlnreal_fdi_2	-0.04
dlnreal_gdp	0.05
dlnreal_gdp_1	0.08
dlnreal_gdp_2	-0.25**
t	-0.12**
Intercept	-3.9

***significant at 1%

**significant at 5%

*significant at 10%

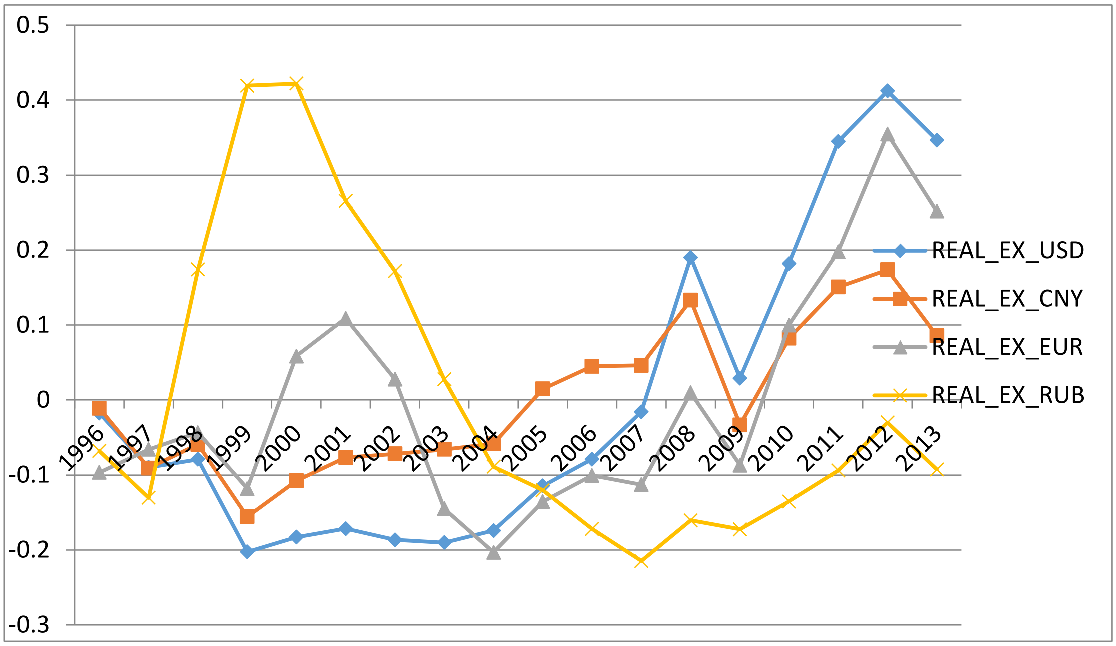

Figure 1. The deviations from mean real exchange rate

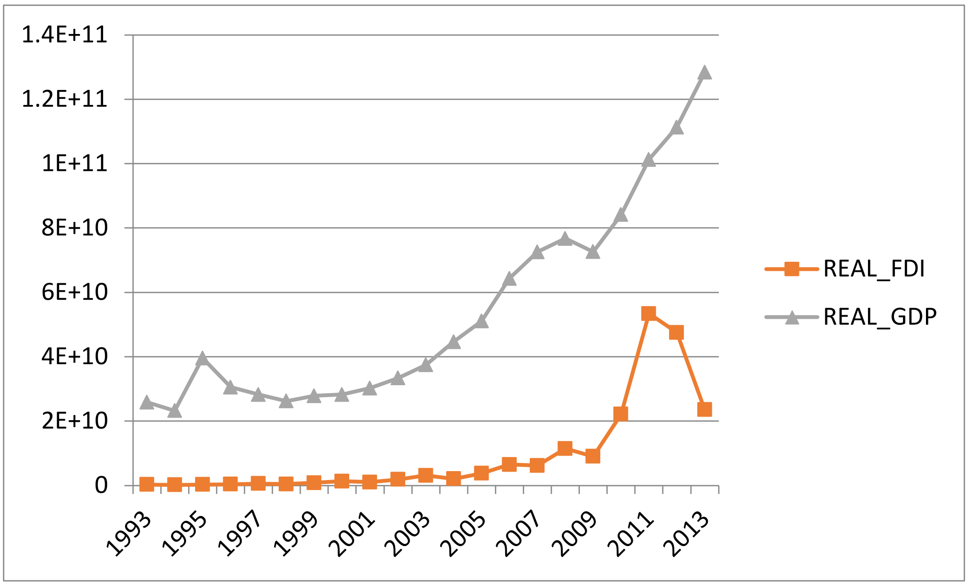

Figure 2. The independent variables (REAL_FDI, REAL_GDP)