Manufacturing in a Small Natural Resource Abundant Economy: Evidence from Mongolia

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Abstract

We argue that the extreme dependence on the natural resource sector has affected a part of the Mongolian economy negatively, thus causing the manufacturing sector to decline. This phenomenon, or the so-called Dutch Disease hypothesis were tested, and the results are supportive of the argument. We found a long-run negative relationship between the growing resource sector and manufacturing: a ten-percent increase in the resource sector brings a two-percent decrease in manufacturing in Mongolia.

Keywords: Manufacturing, Natural resource abundance, Resource curse, Dutch disease, VECM

JEL Classification: F14 , F15 , O13 , O14 , Q33

1 Introduction

The natural resource sector plays considerable role in Mongolian economy. In 2022, it accounts for 24 percent of the country's GDP and 95 percent of its exports. Although Mongolian economy enjoys high resource incomes, there are potential adverse effects of the booming resource sector on other sectors in the economy, in particular, manufacturing. In other words, there perhaps is a potential threat of de-industrialization in the economy. The negative effect, such as this, of the resource windfall to the economy is explained by the phenomenon so-called the Dutch disease.

The mechanism behind the Dutch disease is clear. A part of the resource revenues is spent on non-traded goods (services) which leads to a real appreciation, i.e., a rise in the relative price of non-traded goods in terms of traded goods. This in turn draws resources out of the non-resource traded sector (manufacturing) into the non-traded goods producing sector as Corden and Neary (1982) explained [1].

I conduct statistical analysis looking for evidence of Dutch disease in Mongolian economy. The vector error correction modeling (VECM) approach is used, and the findings suggest that a ten-percentage increase in resource production is followed by a more than two-percentage shrinkage in manufacturing. Variance decomposition results tell us that the share as large as 52 percent of manufacturing variance is attributable to the booming resource sector in a year. I also conducted a robustness check to see if the sample period from 2003 to 2007 make any difference. The robustness check results are in line with the main results.

Although the Mongolian economy is characterized by symptoms of the Dutch disease, no formal statistical work has been applied to this problem. The research fills this gap using monthly data from the National Statistical Office of Mongolia.

The rest of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature of natural resource boom effects on manufacturing. Section 3 explains the Mongolian experience with natural resource discoveries and developments along with the changes in manufacturing sector using the descriptive statistics. Section 4 presents the VECM methodology and data and reports the empirical results. Section 5 summarizes the major findings of the analysis and concludes.

2 Theoretical and empirical literature

Khan et al. (2022)[2], Ploeg (2011)[3], Sachs and Warner (1999)[4] and many recognize the opportunities natural resources provide for economic growth and development. Still, many countries are not doing well despite of the natural resource abundance such as African economies (Sachs and Warner, 1997)[5], Venezuela (Sachs and Rodriguez, 1999)[6], Brazil (Caselli and Michaels, 2013)[7], Azerbaijan (Zulfigarov and Neuenkirch, 2019)[8] etc. Therefore, according to Tovrik (2009)[9] the key question is why resource rich economies such as Botswana or Norway are more successful while others perform badly despite their immense natural wealth. Is it because resource booms induce appreciation of the real exchange rate and makes non-resource sectors less competitive, in other words, is it because of the Dutch disease? More generally as Ploeg (2011)[3] put it, are natural resources a "curse" or a "blessing"?

Ploeg (2011)[3] argues that empirically either outcome is possible. He surveyed a variety of hypotheses and supporting evidence for why some countries benefit and others lose from the presence of natural resources. He summarized the negative effects of the natural resource boom as follows: A resource windfall induces appreciation of the real exchange rate, de-industrialization (Dutch disease) and bad growth prospects, and that these adverse effects are more severe in volatile countries with bad institutions and lack of rule of law, corruption, and underdeveloped financial systems.

There are supporting studies of such adverse effects of resource endowments. Narankhuu (2018)[10] found that the rapid development of the mining sector created significant fiscal and monetary imbalances in the macroeconomy and moreover, the institutional quality and governance in Mongolia have deteriorated noticeably at the same time when Mongolia started experiencing favorable global commodity markets.

Robinson et al (2006)[11] argue that the political incentives that resource endowments generate are the key to understanding whether or not they are a curse. They show that resource booms tend to cause over-extraction of natural resources, and increase resource misallocation in the rest of the economy by providing incentives for the politicians to stay in power by influencing the elections. They conclude that the overall impact of resource booms on the economy depends critically on institutions since these determine the extent to which political incentives map into policy outcomes and countries without institutions that promote accountability and state competence may suffer from a resource curse. Caselli and Michaels (2013)[7] found that oil-rich Brazilian municipalities experienced increases in revenues and reported corresponding increases in spending on public goods and services, however, social transfers, public good provision, infrastructure, and household income increased less (if at all) than one might expect given the higher reported spending.

2.1 Theoretical explanations

Here we discuss the theoretical support and evidence available for the effects of natural resources on the economy, particularly manufacturing.

The Dutch disease hypothesis predicts that natural resource windfalls cause de-industrialization [1]. According to the hypothesis a resource windfall induces appreciation of the real exchange rate, contraction of the traded sector and expansion of the non-traded sectors.

In the short-run resource revenue increases national income and demand. Figure 1 summarizes the spending effect. The *spending effect* works as the extra income from the booming resource sector is spent on the non-traded sector which raises their price, and which leads to real exchange rate appreciation. In Figure 1 we can see that more resources from manufacturing is drawn to the non-traded sector which results in indirect de-industrialization. In addition, because of the real exchange rate appreciation, manufacturing is less competitive compared to the cheap imports [1].

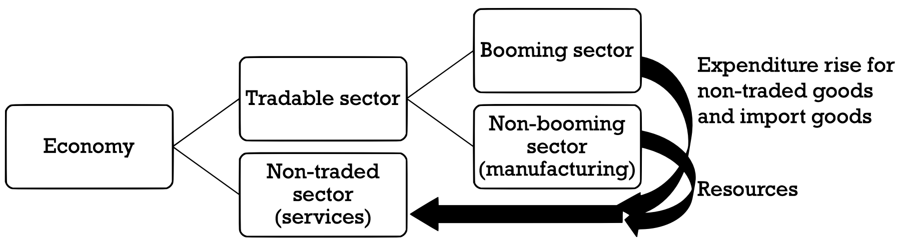

Fig. 1 Spending effect (real exchange rate appreciation). This is the author's imaging based on Corden and Neary (1982)[1]

For the longer run effects one must allow capital and labor to be mobile across sectors and move beyond the specific factors framework. In an open economy Heckscher-Ohlin framework with competitive labor, capital and product markets, and constant returns to scale in the production of traded and non-traded goods, a natural resource windfall induces a higher wage-rental ratio if the non-traded sector is more labor-intensive than the traded sector. In any case, there is a rise in the relative price of non-traded goods leading to an expansion of the non-traded sector and a contraction of the traded sector. Labor and capital shift from the traded to the non-traded sectors.

Morshed and Turnovsky (2004)[12] studied the effects of a resource boom in a dynamic dependent economy with adjustment costs for investment and allowed for costly sectoral reallocation of capital between non-traded and traded sectors. Turnovsky (1996)[13] used a model of endogenous growth in the dependent economy to explore the implications of a resource boom on economic growth.

What happens if the resource exploitation sector uses labor and capital as factor inputs? According to Corden and Neary (1982)[1], apart from the previously discussed spending effects of a resource boom, there is also a resource movement effect which is summarized in Figure 2. The *resource movement effect* explains that due to resource revenue increase, the labor movement from the non-traded and traded sectors towards the resource sector causes direct de-industrialization.

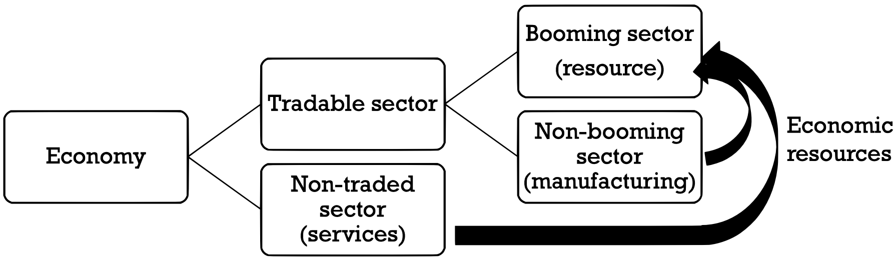

Fig. 2 Resource movement effect. This is the author's imaging based on Corden and Neary (1982)[1]

Looking at the longer run where both factors of production (labor and capital) are mobile between the traded and non-traded sectors and the resource sector only uses labor, it helps to consider a mini-Heckscher-Ohlin economy for the traded and non-traded sectors. The Rybczynski theorem states that the movement of labor out of the non-resource towards the resource sectors causes output of the capital-intensive non-resource sector to expand. This may lead to the paradoxical result of pro-industrialization if capital-intensive manufacturing constitutes the traded sector, despite some offsetting effects arising from the de-industrialization (Corden and Neary, 1982)[1]. If the non-traded sector is more capital-intensive, the real exchange rate depreciates if labor is needed to secure the resource windfall; the Rybczynski theorem then states that the non-traded sector expands and the traded sector contracts. This increase in relative supply of non-traded goods fuels depreciation of the real exchange rate. Real exchange depreciation may also result from a boost to natural resource exports if the traded sector is relatively capital-intensive and capital is needed for the exploitation of natural resources. Since less capital is available for the traded sector, less labor is needed, and thus more labor is available for the non-traded sector. This may lead to a depreciation of the real exchange rate. This also occurs if the income distribution is shifted to consumers with a low propensity to consume non-traded goods (Corden, 1984)[14].

2.2 Empirical evidence of natural resource abundance on manufacturing

Although early evidence for a shrinking manufacturing sector in response to terms of trade shocks and real appreciation has been mixed, more recent evidence by Harding and Venables (2016)[15] based on averages across 1970-2006 for 41 resource net-exporters indicates that the response to a resource windfall is to decrease non-resource exports by 74 percent, and increase imports by 23 percent, implying a negligible effect on foreign savings. The negative impact on exports is larger for manufactures than for other sectors. Thus, on average, resource exports reduce exports of manufactures by 46 percent, service exports by 17 percents, and exports of agriculture and food by 6 percents.

Another study uses detailed, disaggregated sectoral data for manufacturing and obtains similar results: a 10 percent oil windfall is on average associated with a 3.6 percent fall in value added across manufacturing, but less so in countries that have restrictions on capital flows and for sectors that are more capital intensive (Ismail, 2010)[16]. Using as a counterfactual the Chenery-Syrquin (1975) norm for the size of tradables (manufacturing and agriculture), countries in which the resource sector accounts for more than 30 percent of the GDP have a tradables sector 15 percentage points lower than the norm (Brahmbhatt, et al., 2010)[17]. The macroeconomic and sectoral evidence thus seems to offer support for Dutch disease effects.

Interestingly, macro cross-country and micro U.S. county level evidence suggests that resource rich countries experience de-specialization as the least skilled employees move from manufacturing to the non-traded sectors thus leading their traded sectors to be much more productive than resource poor countries (Kuralbayeva and Stefanski, 2013)[18].

Within-country, quasi-experimental evidence on the Dutch disease for Brazil is also notable (Caselli and Michaels, 2013)[7]. The study exploits a dataset on oil dependence for Brazilian municipalities, which is useful as oil fields are highly concentrated geographically and local resource dependence is more likely to be exogenous as it is decided by the national oil company, Petrobras. It turns out that oil discoveries and exploitation do not affect non-oil GDP very much, although that in line with the Dutch disease hypothesis services expand and industry shrinks somewhat. But they do boost local public revenue, 20-25 percent (rather than 10 percent) going to housing and urban development, 15 percent to education, 10 percent to health and 5 percent on welfare. Interestingly, household income only rises by 10 percent, mostly through higher government wages. The lack of migration to oil-rich communities also suggests that oil does not really benefit local communities much. The evidence for Brazil thus offers support for the Dutch disease hypothesis.

There are also a wide range of hypotheses about the effects of natural resources on the economy and society. These include economic growth, institutions, corruption, rent seeking, conflict and policy. Frederik van der Ploeg (2011)[3] provides systematic explanations in this context. The hypothesis regarding the effect of natural resources on economic growth say that if the traded sector is the engine of growth, a resource bonanza will lead to a temporary fall in growth. Early cross-country evidence indeed indicates a negative link between resources and growth. There is the hypothesis that the resource curse can be turned into a blessing for countries with good institutions. Ploeg (2011)[3] provides some evidence in support thereof. In addition, the hypothesis that presidential democracies are more likely to suffer a negative effect of resources on growth; econometric and quasi-experimental evidence for the hypothesis that resource windfalls increase corruption, especially in countries with non-democratic regimes are discussed in his seminal paper. Econometric supports for the hypothesis that the negative effect on growth is less in countries with well-developed financial systems and the hypothesis that resources induce voracious rent seeking and armed conflict are also explained. There is also a discussion of the hypothesis that resource windfalls encourage unsustainable and unwise policies.

Why many resource rich developing countries are unable to fully transform their large stocks of natural wealth into other forms of wealth? Ploeg (2011)[3] explains this with two hypotheses. First, the "anticipation of better times" hypothesis suggests that resource rich countries should borrow in anticipation of higher world prices for resources and improvements in extraction technology in the future. Second, the "rapacious extraction" hypothesis explains how, in absence of effective government intervention, conflict among rival factions induces excessive resource extraction and investment, and negative genuine saving when there is wasteful rent seeking, and short-sighted politicians. There are no studies available yet, which attempt to apply these political economy insights to a formal model addressing the optimal depletion of natural resources.

3 Mongolian Experience: Stylized Facts

Mongolia is abundant in natural resource minerals, such as coal, copper, gold, crude oil, iron, molybdenum, and zinc. Natural resource sector plays large role in the economy, reaching 24 percent of the GDP and more than 90 percent of the exports in 2022. Clearly the economy is heavily dependent on natural resources. In contrast to this, however, the manufacturing sector is underdeveloped and stagnant.

The very first step towards becoming a resource exporter was taken in 1978 by building and utilizing the Erdenet copper mine. The Erdenet mine is one of the largest factories in Asia with annual production of 530 thousand tons of copper concentrate and around 4.5 thousand tons of molybdenum concentrates.[1]

In 2009, the Oyutolgoi mine entered the industry with estimated deposits of 30 million tons of copper and 1.7 million ounces of gold, meaning that it is operable for more than 50 years. This makes Oyutolgoi one of the biggest mines in the world. Mine construction began in 2010 and the first exports were in mid-2013. In 2021, Oyutolgoi earned sales revenue of 1,971 million U.S. dollars from sales of 669 thousand dry metric

[1]Details can be found in the official webpage of the Erdenet mine at www.erdenetmc.mn

tons of concentrate with metal content of 139 thousand tons of copper, 435 thousand ounces of gold, 783 thousand ounces of silver.[2]

Thus the Mongolian economy is vulnerable to the world market resource price volatility due to the heavy resource dependence. For instance, starting from July 2003, the copper price constantly increased from 1700 to 8045 U.S. dollars in May 2006, almost five times higher than the initial level. During these three years, Mongolian economy has enjoyed fast growth of 9 percent and dramatic export increase from 0.5 billion U.S. dollars in 2003 to 1.5 billion in 2006.

The facts associated with Mongolian experience are in many ways consistent with the Dutch Disease argument. The real mineral resources production grew rapidly over the years following the mineral resource booms. Mineral production was close to 7 million tons in 1989 following the resource boom of the Erdenet mine in 1980s and the number was more than 35 million tons in 2014 resulting from the Oyutolgoi mine resource boom, which is more than a five-fold increase.

Productivity increase in the mining sector worked to raise labor incomes in the sector. For example, from 2009 the Oyutolgoi mine resource boom with its investments was followed by an average 55 percent increase in the wages of mining sector for five years. During the period, productivity in mining sector jumped almost five-fold compared to the national level.[3] These observations in fact are consistent with the resource movement effect in the Corden and Neary (1982) framework. In Figure 3 the share of resource in exports grew dramatically and it reached 90 percent on average for the last five years. This clearly shows that the economy is heavily dependent on the resource sector, and thus more importantly this is the indication that the booming resource sector is crowding out the other tradable sector, manufacturing.

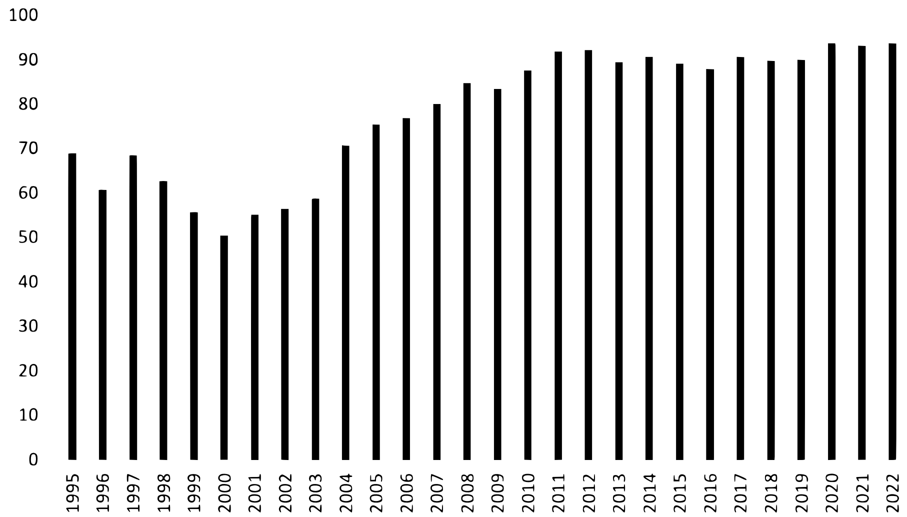

Fig. 3 Mineral Resource Share of Exports. This is the author's calculation based on NSO[19] data.

[2]See details in www.ot.mn
[3]National Statistical Office of Mongolia (NSO)[19]

The government budget is dependent on the mineral resource revenue as well. For instance, in 2006, a windfall tax was introduced in the mining sector, and as a result the mineral resource tax revenues represented almost 45 percent of the total government budget. In 2010, the windfall tax was replaced by a royalty tax and the share decreased to 28 percent. However, starting from 2011, 3-year average tax revenue from the mining sector accounted for one third of the total budget revenue. This rise of the government budget allowed the government sector expansion and was a major reason to aggregate demand and wage increases. Consequently the expenditures on non-traded goods and imports rose, which in turn caused a currency appreciation. Furthermore, an increased foreign direct investment (FDI) aimed at Mongolia's mining sector also strengthened Mongolia's currency (Wei and Kinnucan, 2017)[20]. Thus, these facts imply that the spending effect of the Corden and Neary (1982) framework is in action.

The developments made by the government policies following the budget increase from the resource exports, are explicitly shifting the economy towards a generous welfare state. As a response to their electoral campaign promises, the government started to distribute money in 2008. The government spending increased dramatically as well as the private consumption.

The theory by Corden and Neary (1982)[1] predicts that a resource windfall induces appreciation of the real exchange rate and thus, deindustrialization. The mechanism behind this is clear. Part of the resource revenue is spent on non-traded goods which leads to a real appreciation, i.e., a rise in the relative price of non-traded goods in terms of traded goods. This in turn draws resources out of the non-resource traded sector into the non-traded goods producing sector (Corden and Neary, 1982). This simply means that for example, if the extra income from the resource sector is spent by government spending or private consumption, and not saved, our export price relative to foreign prices increases, making our exports not competitive on foreign market. If this continues in the long run, with the resource movement effect, our already small non-resource export sector or the manufacturing sector vanishes.

Consequently, the main concern of the natural resource dependent economies is the de-industrialization issue or declining of the manufacturing sector.

It is important to recognize, however, the fact that the economy is negatively affected by the natural resource windfall. Once it is recognized, learning from the abundant experiences of the other countries, we would be able to contribute to providing policy implications to avoid further worsening of the de-industrialization process.

Therefore, to see if the resource windfall has a negative effect to the economy, i.e., to see if there is a Dutch disease in the Mongolian economy, we should examine the manufacturing sector, since it is the "victim" of the "disease". Let us see how the manufacturing sector changed from 1990 to 2022. Figure 4 shows the GDP share of the manufacturing and mining. We can see and contrast the sectors. As expected, we see that the Mongolian manufacturing has been declining, or growing slower than the GDP. In contrast to this, the Mongolian mining industry grew rapidly from 2001, or grew faster than the GDP. In 2022, mining to GDP ratio reached 25 percent, while the manufacturing to the GDP ratio is not more than 7 percent. Using descriptive analysis, we thus, have seen the symptoms of the Dutch disease in Mongolia. We now empirically test for evidence.

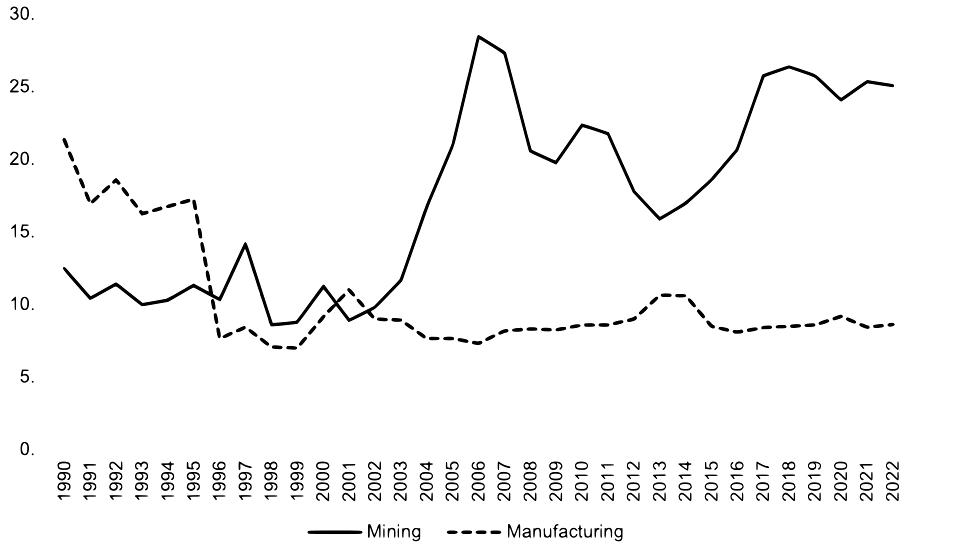

Fig. 4 Mineral Resource Share of Exports. This is the author's calculation based on NSO[19] data.

4 Empirical analysis and results

Before explaining my methodology, it is important to note that most of the studies in the literature use cross-section analysis with many countries (for example, Harding and Venables (2016)[15]) or many industries (for example, Ismail (2010)[16]) in certain point of times. Therefore, it is quite rare to find one country case with time series analysis.

4.1 Methodology and data

It is quite complicated to examine the dynamics of manufacturing sector adjustment due to the natural resource discovery and exploitation. Thus, the underlying structural parameters, the adjustment speeds of the goods and asset markets, as well as the expectations and anticipations will differ from country to country and are difficult to obtain empirically in a structural econometric model. Therefore, I use the vector error correction modeling (VECM) strategy to decompose the variance of manufacturing output fluctuations into different time horizons with corresponding natural resource booms and world resource prices.

This methodology is particularly appropriate in cases such as this with potentially complicated dynamic relationships. The VECM gives me the possibility to create a short-run model with a given long run relationship. The model has a special explanatory variable – the error-correction term – which represents the long-run equilibrium equation. By means of this term, the restricted dynamic short-run model converges to the imposed long-run model.

4.1.1 Methodology

Following Hutchison (1994)[21], I examine a multivariate system (Y_t) that includes real manufacturing output (y_t^m), natural resource production (y_t^r), the money supply (m_t) and real copper price (p_t^{cu}). This is referred to as the basic model. In an extension, the real effective exchange rate (e_t) is also included in (Y_t). The only nominal variable here is money supply and the inclusion of the variable to the model makes possible the consideration of the expansionary government policy effects mentioned earlier to capture the essence of spending effect.

Y_t is assumed to have vector autoregressive (VAR) representation with errors, u_t:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_\rho Y_{t-\rho} + u_t \tag{1}$$

where Y_t is a $\rho \times 1$ (ρ represents the number of variables, it is four in basic model and five in the extended model) vector of time series, $A_1, \ldots, A_\rho$ are $\rho \times \rho$ coefficient matrices and u_t is a $\rho \times 1$ unobservable zero mean white noise process.

In general, economic time series are non-stationary processes and it is useful to take the first difference by subtracting Y_{t-1} from both sides of equation (1). It can be written as:

$$\Delta Y_t = A_0 + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{\rho-1} \Delta Y_{t-\rho+1} + \Pi Y_{t-\rho} + u_t \tag{2}$$

where $\Gamma_i = -(\mathbf{I} - A_1 - \cdots - A_i)$, $i = 1, 2, \ldots, \rho - 1$, and $\Pi = -(\mathbf{I} - A_1 - \cdots - A_\rho)$. Except for the long-run equilibrium term or error correction term $\Pi Y_{t-\rho}$, equation (2) is nothing else but the traditional first difference VAR model.

The coefficient matrix Π contains information about the long-run equilibrium.[4] The rank (r) of Π matrix, is the cointegration rank, i.e., it shows how many long-run relationships exist between the variables of Y_t. Π can be expressed as $\Pi = \alpha\beta^{'}$ where α and β are $\rho \times r$ matrices containing the loading coefficients and the cointegration vectors respectively (Johansen 1991)[22]. The $\beta^{'} Y_t$ is stationary even though Y_t itself is non-stationary. Therefore equation (2) can be interpreted as a vector error correction model (VECM).

Both trace and maximum eigenvalue tests are employed to determine the number of cointegrating vectors. The approach is to test the null hypothesis that there is no cointegration among the elements of vector Y_t; rejection of the null is then taken as evidence of cointegration. The long-run constraints expressed by the estimated cointegrating vectors $\hat{\beta}^{'} Y_t$ are then imposed to the differenced VAR model via error correction terms.

After estimating the VECM, impulse response functions and variance decompositions are calculated with the variables ordered as: manufacturing output, mineral production, money supply and real copper price. This ordering allows the three potential explanatory variables to exert the largest possible influence on manufacturing output movements.

[4] For more detailed explanation see Johansen (1991)[22].

4.1.2 Data

Seasonally adjusted monthly data is used covering the period of 2003M1-2020M6. The variables are measured in natural logarithms. The data consists of real manufacturing output, actual physical production of mineral resources, nominal M2 as money supply, the real dollar price of copper and the real effective exchange rate (REER)[5] . The main sources of data are National Statistics Office of Mongolia (NSO)[19] and the Bank of Mongolia[23]. Complete definitions, units and sources of the data are provided in the appendix A.

4.2 Unit Root Tests

The t-statistics for the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) unit root tests are reported in Table 1. The tests were conducted both in log levels (x) and log first-differences (dx) and each time series includes a constant and both constant and time trend. The null hypothesis states that there exists a unit root in the time series, and failure to reject the null indicates that the variable may be non-stationary. The ADF statistics were estimated using Akaike Information Criterion (AIC) with maximum lag of 13 since it is recommended to use AIC instead of the Schwarz Information Criterion to determine lag length of the autoregressive process for the ADF statistic.[6] The PP test is less restrictive since the error term can follow a more general process.

Table 1 Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests

	Real manufacturing output	Mineral production	Money supply	Real copper price	Real effective exchange rate
ADF intercept (x)	-1.414	-1.248	-1.398	-1.179	-2.724
ADF intercept + trend (x)	-1.670	-1.070	-2.087	-2.901	-2.605
PP intercept (x)	-3.119*	-1.705	-2.249	-1.302	-3.464*
PP intercept+ trend (x)	-7.090**	-5.304**	-1.537	-2.624	-3.773*
ADF intercept (dx)	-4.899**	-3.657**	-2.611	-4.266**	-3.966**
ADF intercept + trend (dx)	-7.090**	-3.746**	-2.813	-4.308**	-4.050**
PP intercept (dx)	-24.836**	-21.253**	-14.495**	-8.757**	-20.910**
PP intercept+ trend (dx)	-24.960**	-21.532**	-14.565**	-8.709**	-20.944**

Note: x and dx refer to the variable listed in log level and log first-difference form respectively. * and ** denote the individual test statistic statistically significant at the 5% and 1% level respectively.

Source: Monthly data from 2003M1 to 2020M6 were used from the NSO.

The ADF and PP tests are consistent in failing to reject the null in log levels (x), meaning the series are likely non-stationary in levels, except for manufacturing and mineral production PP tests. Two tests are consistent in rejecting the unit root

[5]The real effective exchange rate index represents the price compared to the weighted average of the exchange rate index of the Mongolian currency against the currency of foreign trade partner countries.

[6]See Stock and Watson (2011, Chapter 14)[24] for lag length selection in time series regression with multiple predictors.

hypothesis for most of the variables in log first-difference form (dx). However, ADF tests for money supply fail to reject the null. PP tests with and without trend consistently rejecting the null for all the variables in dx. Consequently, we perhaps can say that all five variables appear to be integrated of order one or I(1), i.e., non-stationary in levels and stationary in first-differences. In addition, the change in sample period do not alter the findings.[7]

4.3 Cointegration tests

A linear combination of two or more non-stationary series may be stationary as shown by Engle and Granger (1987)[25]. This stationary linear combination is called the cointegrating equation and can be interpreted as a long-run equilibrium relationship among the variables.

Table 2 Johansen Cointegration Tests

	Critical Value at 1%		Test statistics	
Null hypothesis	Trace	Max-Eigen	Trace	Max-Eigen
		Basic model		
None	54.46	32.24	133.1114*	95.2412*
At most 1	35.65	25.52	37.8702*	19.5636
At most 2	20.04	18.63	18.3066	13.1702
At most 3	6.65	6.65	5.1363	5.1363
		Extended model		
None	76.07	38.77	155.6214*	96.2465*
At most 1	54.46	32.24	59.3749*	32.2629*
At most 2	35.65	25.52	27.1120	14.3243
At most 3	20.04	18.63	12.7877	7.1656
At most 4	6.65	6.65	5.6221	5.6221

Note: * denotes the rejection of the null hypothesis at the 1% significance level. The critical values were taken from the Stata Software edition 17.

Table 2 shows the Johansen cointegration tests consisting of trace and maximum eigenvalue test statistics as well as the critical values at 5 percent significance level for the number of cointegrating vectors. I assumed a linear trend in data and allowed the cointegrating equation to have both intercept term and trend. However, assuming no trend in VAR. These specifications of the VAR are found in Stata software edition 17. The null hypothesis for each test is also included in Table 2.

Johansen tests for the model indicate cointegrating relationships between real manufacturing output, mineral production, and other variables. One cointegrating vector is suggested in both the four-variable and five-variable models by maximum eigenvalue and trace statistics at the 1 percent significance level.

The estimate of cointegrating vector $\beta^{'}$ is reported in Table 3. This is the estimated long-run constraint imposed on the VECM model from which the variance decompositions and impulse response functions are derived. The restriction for $\beta^{'}$ matrix is

[7]The results are robust for the sample period 2003-2007. See Appendix B for the details.

imposed as a negative unity on the variable of primary interest, real manufacturing output (y_t^m). A negative coefficient on mineral production (y_t^r) would indicate a long-run tradeoff, or crowding out, between outputs in the manufacturing and natural resource sectors. Therefore, in the long-run ten percent growth in mineral resource production is estimated to bring more than two percent contraction in the manufacturing output.

Table 3 Cointegration Coefficients in Johansen Estimation

	Basic model	Extended model
Real manufacturing output	-1.00	-1.00
Minerals output	-0.27**	-0.23**
Money supply	0.56**	0.55**
Real copper price	0.02*	0.05
REER		-0.44
Constant	4.42	5.93

Note: The coefficients are normalized with a negative unity on the manufacturing output. A negative coefficient indicates a long-run offset. ** and * denotes statistical significance at 1% and 5% level respectively.

The cointegrating vector suggested by the Johansen test indicates a long-run negative relationship between the resource output and manufacturing in Mongolia. Thus, the estimate of cointegrating vector supports the Dutch Disease hypothesis as a long-run phenomenon. Narrowing the sample period does not alter the result.[8] In summary, there is a statistically significant evidence for the negative impact of the resource abundance on the manufacturing in Mongolia.

4.4 VECM variance decompositions and impulse responses

Table 4 reports the manufacturing output variance decompositions derived from the estimates of the VECM for basic and extended models. The VECM was estimated using the estimated cointegrating vector shown in Table 3. The estimation results suggest that natural resource sector innovations cause a major role in generating manufacturing output fluctuations. The estimated percentage impact of natural resource sector on manufacturing output error variance after a year is as high as 52 percent in the basic model and 47 percent in the extended model. The real copper price shocks seem to play very small role. Monetary factors play relatively small, however, not negligible role in this context.

Figure 5 shows the accumulated impulse response functions of manufacturing output to a one-unit positive shock in mineral sector, real copper price and REER. All three factor shocks have significant and sustainable negative effects on manufacturing output. Thus, we can conclude that the natural resource production innovation has a long run negative effect on manufacturing production in Mongolia.[9]

[8] Narrowing the sample period down to 2003-2007, also shows the same result. See details in Appendix B.
[9] Robustness check has been done with different time span. The change in sample period do not make major difference to the results. See details in Appendix B.

Table 4 Manufacturing variance decompositions (5-year time span)

Months (year)	Four-variable Basic Model			
	Manufacturing	Mineral sector	Money supply	Real copper price
1	100	0	0	0
2	54	40	5	1
12 (a year)	37	52	10	1
24 (2 years)	23	62	13	2
36 (3 years)	17	66	15	2
48 (4 years)	14	69	15	2
60 (5 years)	12	70	16	2

Months (year)	Five-variable Basic Model				
	Manufacturing	Mineral sector	Money supply	Real copper price	REER
1	100	0	0	0	0
6	52	36	5	1	6
12 (a year)	35	47	10	3	5
24 (2 years)	22	58	12	3	5
36 (3 years)	16	62	14	4	4
48 (4 years)	13	64	14	4	5
60 (5 years)	11	65	15	4	5

Note: Variance decompositions report the percentage impact of the n months ahead manufacturing forecast error variance from corresponding variable listed in the column. VECM is ordered as real manufacturing output, mineral production, money supply and real copper price in basic model.REER is the last in order in extended model.

5 Conclusion

The paper reviews the theoretical and empirical explanations of the effects of natural resource windfalls on the manufacturing sector of the economy. Within this context, I examined the experience of Mongolia. Thus, the main hypothesis examined is the argument that natural resource booms cause de-industrialization following Corden and Neary (1982)[1].

The descriptive statistics show that the Mongolian economy is already natural resource dependent with natural resource share of exports exceeding 90 percent in 2022. In contrast, the manufacturing sector stayed stagnant around 7 percent of the GDP. Thus, using the formal cointegration and related VECM analysis, I found a long-run tradeoff: a ten-percentage increase in resource production is followed by a two-percentage contraction in the manufacturing. The variance decompositions derived from the VECM suggest that within a year as large as 52 percentage of manufacturing output variance is attributable to developments in the domestic resource production in Mongolia. Moreover, the impulse response functions show a significant long-term adverse effect on manufacturing arising from resource boom and resource price rise. Overall, the paper presented the empirical evidence of the negative effect of resource abundance on manufacturing in Mongolia.

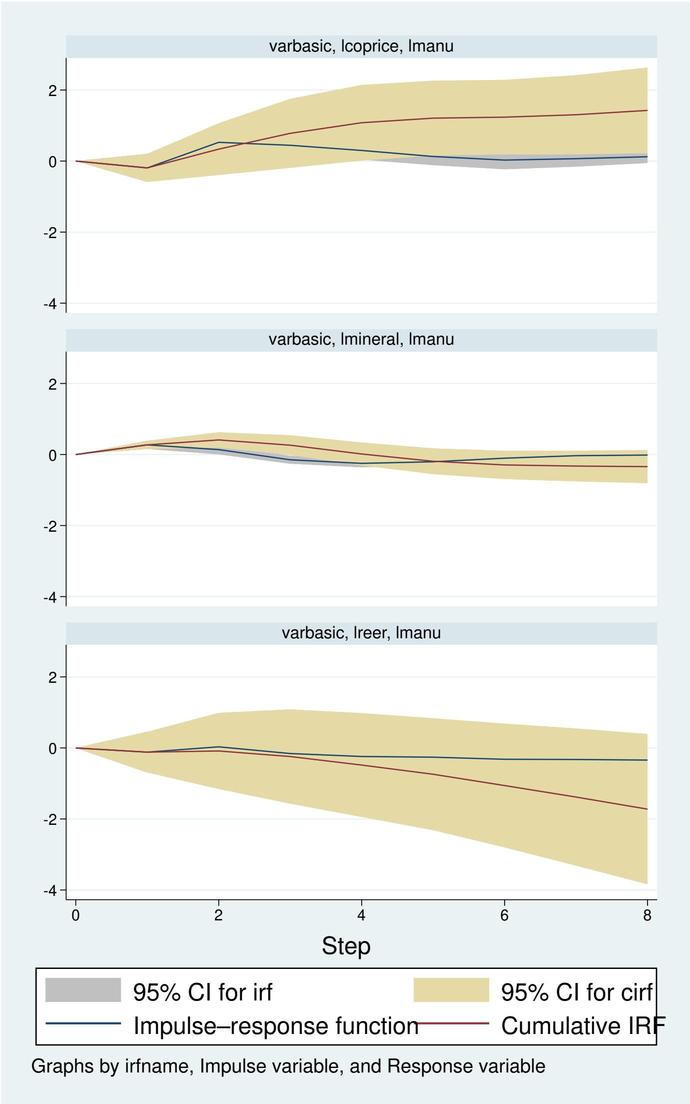

Fig. 5 Impulse responses of manufacturing sector. Figure shows the impulse response functions of manufacturing output to a one-unit positive shock in mineral sector, real copper price and REER, respectively.

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Appendix A Data

Table A1 Data

Variables	Measurements	Source
Manufacturing output	Log of real manufacturing output (Million tugrugs)	National Statistical Office of Mongolia (NSO)
Mineral production	Log of physical mineral production (Thousand tons)	NSO
Money supply	Log of M2 money supply (Billion tugrugs)	NSO
Real copper price	Log of real copper price (US dollar per ton)	London Metal Exchange[26]
Real effective exchange rate (REER)	Log of REER (weighted average of exchange rate indices)	Bank of Mongolia

Manufacturing output and real copper price are deflated by national Consumer Price Index with base year 2005. Minerals considered are coal, crude oil, copper concentrate with 35%, molybdenum concentrate with 47%, gold, flour spar, flour spar concentrate, iron ore, zinc concentrate, copper 99%, metal steel and metal foundries.

Appendix B Robustness check for the period 2000M01-2007M12

Here I have done the exact same analysis with the limited sample of span 2000M01-2007M12 which is a period before the 2008 financial crisis and before the Oyutolgoi ore exploitation. I checked if the results are compatible with the results of the full period basic model. I found statistically significant negative effect of the resource sector on the manufacturing, here as well. However, surprisingly, the magnitude of the long-run trade-off was quite high: a ten-percentage increase in resource production is followed by a fourteen-percentage contraction in the manufacturing. Perhaps this result using the limited period data suggests that further developments in resource sector must have dampened the de-industrializing effect of the natural resource wealth in Mongolia.

Table B2 Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests with sample period 2000M01-2007M12

	Real manufacturing output	Mineral production	Money supply	Real copper price
ADF intercept (x)	1.900	0.770	1.855	-0.709
ADF intercept + trend (x)	-0.401	-1.785	-2.128	-2.178
PP intercept (x)	-2.009	-3.232*	0.604	-0.529
PP intercept+ trend (x)	-4.200**	-4.525**	-3.076	-2.125
ADF intercept (dx)	-4.606**	-9.323**	-1.887	-7.103**
ADF intercept + trend (dx)	-6.481**	-7.464**	-6.559**	-7.075**
PP intercept (dx)	-23.439**	-10.629**	-11.510**	-7.058**
PP intercept+ trend (dx)	-27.981**	-10.633**	-11.528**	-7.030**

Note: x and dx refer to the variable listed in log level and log first-difference form respectively. * and ** denote the individual test statistic statistically significant at the 5% and 1% level respectively.

Table B3 Johansen Cointegration Tests with sample period 2000M01-2007M12

	Critical Value at 1%		Test statistics	
Null hypothesis	Trace	Max-Eigen	Trace	Max-Eigen
None	47.856	27.584	72.313*	46.926*
At most 1	29.797	21.131	25.388	20.731
At most 2	15.494	14.264	4.656	3.141
At most 3	3.841	3.841	1.515	1.515

Note: * denotes the rejection of the null hypothesis at the 5% significance level. The critical values were taken from the Stata Software edition 17.

Table B4 Cointegrating Coefficients in Johansen Estimation with sample period 2000M01-2007M12

	Coefficients
Real manufacturing output	-1.00
Minerals output	-1.43
Money supply	1.57
Real copper price	-0.48

Note: The coefficients are normalized with a negative unity on the manufacturing output. A negative coefficient indicates a long-run offset.

Table B5 Manufacturing variance decompositions (5-year time span) with sample period 2000M01-2007M12)

	Four-variable Basic Model			
Months (year)	Manufacturing	Mineral sector	Money supply	Real copper price
1	100	0	0	0
6	69	26	4	1
12 (a year)	70	23	6	1
24 (2 years)	70	23	7	0
36 (3 years)	70	23	7	0
48 (4 years)	69	23	8	0
60 (5 years)	69	23	8	0

Note: Variance decompositions report the percentage impact of the n months ahead manufacturing forecast error variance from corresponding variable listed in the column. VECM is ordered as real manufacturing output, mineral production, money supply and real copper price.