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An empirical assessment of the Dutch disease channel of the resource curse: the case of Chad

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Abstract

We examine the effects of the 'natural resource curse' on Chad and find little evidence for Dutch disease. Structural vector auto-regression suggests that changes in domestic output and prices are overwhelmingly determined by aggregate demand and supply shocks, and while oil production and high international prices negatively affect agricultural output, the effects are small. Consistent with empirical evidence for neighbouring Cameroon, we observe minimal impact on Chad's manufacturing sector. In this context, increased public expenditures in tradable sectors present the opportunity to make oil revenues an engine of national development.

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1. Introduction

It is likely that Africa hosts about 30 per cent of the world's mineral reserves. Mining and mineral products are vital sources for economic development for many African countries. However, they are a double-edged sword, with both benefits and dangers. As a matter of fact, Sachs and Warner (1995) find an inverse relationship between natural resource intensity and growth between 1970 and 1990, and their results are supported by the fact that there are very few cases of resource-abundant developing countries sustaining 2% per annum growth during this period. Economic theory refers to the resource curse (RC). The reasons cited are: the volatility of commodity prices, weak institutions, crowding out of manufacturing and Dutch disease (DD). Prospects for new minerals and oil reserves in Africa revived interest in the natural resource curse hypothesis. Indeed, estimates refer to 20 the number of oil producing countries in Africa in 2015, against 7 in 2005. The idea is to prevent African countries that are discovering new oil or minerals reserves from being victims of RC.

However, stylized facts show that African countries have a high propensity to favor transmissions channels to RC. Fuels and minerals accounted for about 58% of total African exports. This shows that the volatility of commodity prices makes African economies vulnerable and subject to fluctuations in resource windfalls. Institutions of these countries are fragile and often leave room for conflicts, after the discovery of minerals or oil reserves: Democratic Republic of Congo, Sudan, Angola, Nigeria and Chad. This institutional weakness reduces the ability of governments to make the most of the windfall oil revenue by investing in promising sectors for future generations. Moreover, the boom in oil or mining sectors disturbs most of economic resources (capital and labor) from the manufacturing sector. But, the manufacturing sector is more prone to favor learning by doing. Therefore a decreasing manufacturing sector is a threat for economic growth, Matsuyama (1992). More especially, some studies suggest that DD may be the main channel of RC by promoting de-industrialisation, Neary and Van Wijnbergen (1986). Typical symptoms of DD are a decline of production in tradable sectors such as agriculture and manufacturing, an increase in prices in non-tradable sectors, and an appreciation of an effective exchange rate. Chad discovered and began exploiting oil in 2003. Since then, the value added of agriculture has decreased from 600 billion CFA Franc to 320 billion, and for the manufacturing sector it has increased from 120 billion to 160 billion. The aforementioned evidences suggest that the agricultural sector could be affected by DD and that the manufacturing sector is not affected. This is consistent with the results of some previous studies, such as Benjamin, Devarajan and Weiner (1989) on Cameroon. Another interesting feature is that Ndjamena, the capital of Chad, ranked third with respect to cost of living, just behind Tokyo, in a recent survey.[1] This suggests that people living in Ndjamena pay higher living costs, defined as consumption, in non-tradable sectors.

The second explanation of the RC based on DD effect (beside de-industrialisation) is the role of savings. Among resource-rich countries, empirical evidence has shown that countries with the highest savings rate generally have managed to escape the RC. Unfortunately, the Chadian government spending tripled between 2003 and 2009. This sharp increase is mainly due to transfers, subsidies and military expenditures. The increase in military spending (wages and weapons) is a response to political instability and recurring conflicts that Chad has faced.

[1] See http://www.mercer.com/costoflivingpr in detail. The most expensive city in the world is Luanda in Angola, according to the same survey.

This paper uses a structural VAR (Vector Auto regressive) to question whether Chad is affected by DD which is a channel of RC. We were not able to use an equilibrium real exchange rate method as in Cerutti and Mansilla (2008) and Oomes and Kalcheva (2007), because of data limitations. VAR models are commonly used for forecasting systems of interrelated time series and for analysing the dynamic impact of random disturbances on the system of variables. Especially, structural VAR, through the introduction of restrictions, yields some intuitive theoretical economic justifications to the VAR model, thus allowing it to take into consideration some effects of oil discovery on the economy.

2. Methodology

In our case, we conduct two VAR models for the agricultural and manufacturing sectors. The first model (model 1) consists of the volume of oil extraction (ov_t), the real oil price (rop_t), the manufacturing production (m_t) and the inflation rate calculated from the GDP deflator (π_t). The second model (model 2), agricultural production (a_t), and the same explanatory variables used for manufacturing production. Because the co-integration tests for the two models revealed no co-integrating vector among the variables, we conduct a structural VAR model rather than a VECM. Following Bjorland (1998), we identified three other structural shocks in addition to energy booms (ε_t^{ES}). They are real oil price shocks (ε_t^{ROP}), aggregate demand shocks (ε_t^{AD}) and aggregate supply shocks (ε_t^{AS}).

Therefore, we define a vector of stationary variables compounded from the first difference of the cited macroeconomic variables for each model, such that $z_t = (\Delta ov_t, \Delta rop_t, \Delta m_t, \Delta \pi_t)'$, for model 1 is devoted to the manufacturing sector and $y_t = (\Delta ov_t, \Delta rop_t, \Delta a_t, \Delta \pi_t)'$, for model 2, is devoted to the agricultural sector. Indeed, we led stationary tests for the level and first difference variables. The reduced form of VAR is estimated as

$$z_t = B_0 + B_1 z_{t-1} + \ldots + B_p z_{t-p} + e_t \qquad B(L)z_t = B_0 + e_t \tag{1}$$

where B_j (j= 0,1….p) is a matrix of autoregressive coefficients at lag j

B_0 is the identity matrix

e_t, the residual vector, is serially uncorrelated with the covariance matrix Ω.

Following the Wold representation theorem and ignoring the constant term, the VAR can be represented as an invertible distributed lag of serially uncorrelated disturbances:

$$z_t = C(L)e_t \tag{2}$$

with $C(L) = B(L)^{-1}$ and C_0 as the identity matrix.

The elements in e_t are contemporaneously correlated and cannot be interpreted as structural shocks. To have those structural shocks, they must be orthogonalised by imposing restrictions. For this purpose, we must impose enough restrictions to identify the orthogonal (structural) components of the error terms. Therefore, a restricted form of the moving average containing the vector of original disturbances as linear combinations of the Wold innovations can be expressed as

$$z_t = D(L)\varepsilon_t, \tag{3}$$

where ε_t is the vector of the orthogonal structural disturbances, with $cov(\varepsilon_t) = I$, thus ε_t is normalised to have unit variance for convenience.

(2) and (3) imply that $e_t = D_0 \varepsilon_t$, hence,

$$C(L)D_0 = D(L). \tag{4}$$

Therefore, if D_0 is defined, then the MA representation in (3) is also derived. It follows from the normalisation of $cov(\varepsilon_t)$ that $D_0 D_0' = \Omega$. This imposes k(k+1)/2 =10 restrictions on the elements in D_0 (k being the number of variables in the VAR). As the D_0 matrix comprises sixteen elements, we need six more restrictions to orthogonalise the different innovations. These restrictions will, at the same time, allow us to introduce into the model the intuitive economic explanations for the dynamics of the VAR model. Two types of identifying restrictions are considered: short-run and long-run. In our model, we will have one long-run restriction and five short-run restrictions.

As the order of the variable and shocks is important in the structural VAR, we first order the four uncorrelated shocks that we previously defined:

$\varepsilon_t = (\varepsilon_t^{AD} + \varepsilon_t^{AS} + \varepsilon_t^{ES} + \varepsilon_t^{OP})'$. Energy booms will be identified from the equation for oil production and are, thus, interpreted as volume changes. To identify these shocks, we impose the restrictions that oil production depends only on energy booms and real oil price at the first period, in which case, the contemporaneous effects of aggregate demand and aggregate supply disturbances on oil production are zero. Rewriting equation (3) in terms of the equation of oil production, we have:

$$\Delta ov_t = D_{11}(L)\varepsilon_t^{AD} + D_{12}(L)\varepsilon_t^{AS} + D_{13}(L)\varepsilon_t^{ES} + D_{14}(L)\varepsilon_t^{ROP} \tag{5}$$

with $D_{11,0} = D_{12,0} = 0$.

Following Bjorland (1998), we will identify real oil price shocks by assuming that changes in real oil price depend only on real oil price shocks at the first period. This means that aggregate demand and supply shocks, as well as energy booms, will influence the real oil price with a lag, which is reasonable as oil price is a financial spot that reacts quickly to news. Rewriting (3), we have:

$$\Delta rop_t = D_{21}(L)\varepsilon_t^{AD} + D_{22}(L)\varepsilon_t^{AS} + D_{23}(L)\varepsilon_t^{ES} + D_{24}(L)\varepsilon_t^{ROP} \tag{6}$$

with $D_{21,0} = D_{22,0} = D_{23,0} = 0$.

Finally, manufacturing (or agricultural) output will also be impacted by demand and supply shocks. To identify these shocks, we include inflation together with manufacturing (or agricultural) output. Demand shocks are different from supply shocks in that demand shocks are assumed to have no long-run effects on output (cf. Blanchard and Quah, 1989). The long-run effect of the demand shock upon the level of m_t (or a_t) is the sum of the infinite number of lag coefficients, $\sum_{j=0}^{\infty} D_{31,j}$. Writing (4) as $C(1)D_0 = D(1)$, where C(1) and D(1) indicate the long-run matrices of C(L) and D(L), respectively, the long run-restriction implies that $D_{31}(1)$=0 or :

$$C_{31}(1)D_{11,0} + C_{32}(1)D_{21,0} + C_{33}(1)D_{31,0} + C_{34}(1)D_{41,0} = 0 \tag{7}$$

Therefore, from (3) the growth rate of manufacturing (or agricultural) output and the inflation can be described as:

$$\Delta m_t = D_{31}(L)\varepsilon_t^{AD} + D_{32}(L)\varepsilon_t^{AS} + D_{33}(L)\varepsilon_t^{ES} + D_{34}(L)\varepsilon_t^{ROP} \quad (8)$$

$$\Delta \pi_t = D_{41}(L)\varepsilon_t^{AD} + D_{42}(L)\varepsilon_t^{AS} + D_{43}(L)\varepsilon_t^{ES} + D_{44}(L)\varepsilon_t^{ROP} \quad (9)$$

With these six additional restrictions, our structural VAR is identifiable. However, the VAR model results are sensitive to the way in which they are identified, which is why the identifying restrictions should have plausible interpretations. Furthermore, the credibility of the results could be tested using over-identifying restrictions. Therefore, two over-identifying tests will check the respective positive and negative impacts of demand and supply shocks on inflation. Indeed, our last restriction concerned the non-existence of a long-run effect of demand shocks on output, as opposed to the effect of supply shocks. This assumption implies the simultaneous reverse effects of demand and supply on inflation that can be verified by examining the impulse response analysis.

3. Empirical results:

All variables are quarterly data, apart from the GDP deflator, the agricultural and manufacturing outputs. For these variables, we interpolate yearly data into quarterly data by interpolation cubic spline with the last observation matched to the source data[2]. The information criteria can be used to determine the optimal lag length. The lag length should be two (model 1) and should be three (model 2). The data period should be 1985/Q1 to 2008/Q4, after adjustments. The data are collected from World Development Indicators, International Financial Statistics and Geointelligence network.

Figures 1 and 2 depict the cumulative effects of demand shocks, supply shocks, energy booms and oil price shocks at the level of manufacturing production and the level of the GDP deflator, respectively, for model 1. The figures present the response to each shock with a one standard deviation band around the point estimates, reflecting the uncertainty of the estimated coefficients. Demand and supply shocks have a positive impact on manufacturing production, while energy booms and real oil price shocks have no significant impacts. Regarding the response of the GDP deflator, energy booms have a positive but non-significant impact, while real oil price shocks have a positive impact. The responses of GDP deflator to both energy price and volume are consistent with DD, where increases in demand and production in the economy push prices upward. A demand shock permanently increases prices, as does a supply shock; however, for the supply shock, the inferior band encompasses zero in the long run. Therefore, the response to this shock may not be positive, but it may be null or even negative. In all cases, the over-identification of restrictions according to which demand (supply) shocks increase (reduce) prices is not totally supported by model 1.

[2] This method assigns each value in the low frequency series to the last high frequency observation associated with the low frequency period, then places all intermediate points on a natural cubic spline connecting all the points.

Figure 1: Accumulated response to structural one S.D. innovations ±2 S.E. Manufacturing production-mo

1.1 Aggregate demand shock **1.2 Aggregate supply shock** **1.3 Energy booms** **1.4 R**

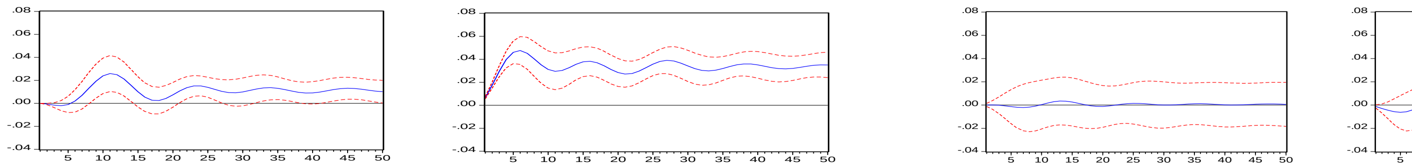


Figure 2: Accumulated response to structural one S.D. innovations ±2 S.E. GDP deflator – model 1

2.1Aggregate demand shock **2.2 Aggregate supply shock** **2.3 Energy booms** **2.4 I**

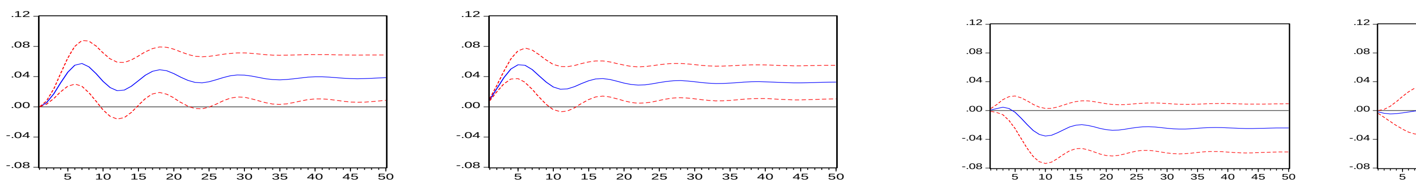


Figure 3: Accumulated response to structural one S.D. innovations ±2 S.E. Agricultural output – model 2

3.1 Aggregate demand shock **3.2 Aggregate supply shock** **3.3 Energy booms** **3.3 I**

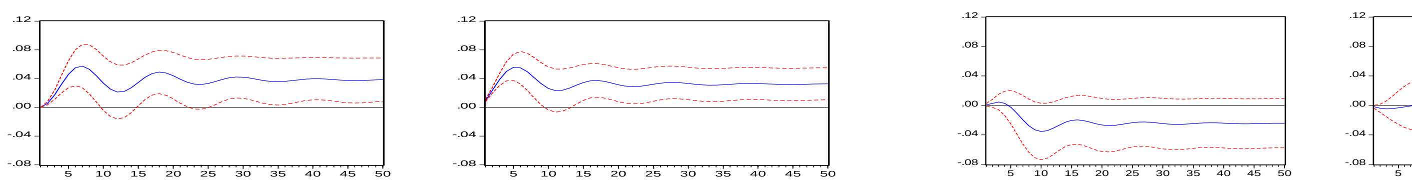
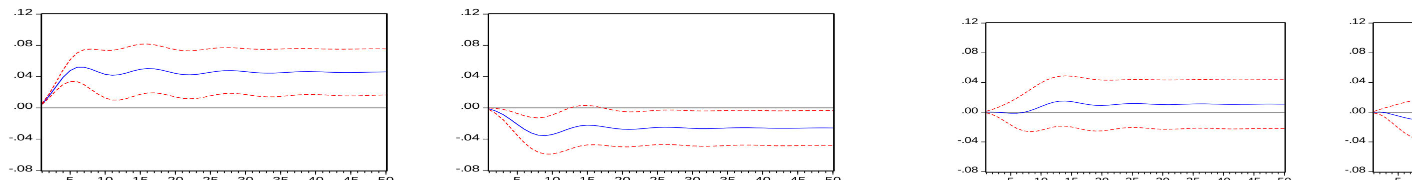


Figure 4: Accumulated response to structural one S.D. innovations ±2 S.E. GDP Deflator – model 2

4.1 Aggregate demand shock **4.2 Aggregate supply shock** **4.3 Energy booms** **4.4 R**



Responses of agricultural output and GDP deflator to the four above mentioned shocks are depicted in figures 3 and 4. Here, the over-identifying restrictions are supported by model 2, as shown in figure 4. Additionally, energy booms are found to have a positive impact on prices after approximately 8 quarters, while real oil price has a negative impact. Again, this is consistent with DD, even if the results may not be significant given that the standard deviation bands encompass the x-axis. Figure 3 indicates that energy booms have a negative impact on agricultural production after 4 quarters, which corroborates, again, the presence of DD in the agricultural sector. However, the higher band of the standard deviation is above the x-axis, implying that output production could continue to increase after one year. Real oil price shocks have no significant impact on agriculture production. Finally, demand and supply shocks have a permanent significant positive impact on agriculture production, as expected.

Table I: Variance decomposition for model 1

Quarters	AD-shock	AS-shock	ES-shock	ROP-shock
Manufacturing				
1	0.00	97.48	0.07	2.45
4	1.67	97.27	0.08	0.97
8	19.61	76.23	0.19	3.96
16	30.45	65.55	0.77	6.23
32	32.58	60.03	1.04	6.35
Inflation				
1	90.60	3.20	0.32	5.88
4	87.73	1.06	0.38	10.82
8	74.23	13.41	1.83	10.53
16	66.47	22.91	1.62	9.00
32	63.21	26.49	1.55	8.75

Table II: Variance decomposition for model 2

Quarters	AD-shock	AS-shock	ES-shock	ROP-shock
Agriculture				
1	0.00	94.86	0.74	4.4
4	0.42	97.32	0.52	1.73
8	0.83	93.46	3.87	1.84
16	2.67	92.01	3.67	1.64
32	3.50	91.10	3.85	1.55
Inflation				
1	75.88	18.54	0.53	5.04
4	84.61	8.72	0.16	6.50
8	78.63	14.96	0.25	6.16
16	72.03	22.18	0.56	5.23
32	66.85	27.30	0.94	4.90

Tables I and II present, respectively, the variance decomposition for manufacturing output and the GDP deflator of model 1 and the agricultural output and the GDP deflator for model 2. As oil volume and real oil price are explained by their own variances, we do not present their variance decomposition. Furthermore, demand shocks are less important than supply shocks in explaining variations in manufacturing output, while the reverse holds for inflation. This may reflect a relatively steep short-run supply schedule in terms of a standard aggregate demand and supply diagram, where wages and prices adjust quickly, while energy booms account for less than 1% of the explained variance in manufacturing. Real oil price shocks, on the contrary, explain 2 to 6% of the variance over the first eight years, which is consistent with our analysis of the impulse response function. Again, energy booms explain approximately 1% of the variation in inflation, while real oil price accounts for approximately 10%.

With respect to model 2, whose results of variance decomposition are displayed in table II, we observe the same pattern for demand and supply shocks, describing the same mechanism for price adjustment. Energy booms are responsible for less than 1% during the first year, but for approximately 4% thereafter, while 4% of the explained variance in agriculture is accounted for by real oil price shocks during the first quarter, though it is less than 2% thereafter. With regard to inflation, energy booms explained less than 1% of the variation, while real oil price accounts for more than 5% at all horizons.

4. Concluding remarks

This paper examines whether Chad, one of the last African countries to have discovered oil, could be affected by RC through DD The interest of the study is enhanced by the fact that Chad is one of the poorest countries in the world, and this oil windfall could be used as a powerful means to alleviate poverty and contribute to economic growth. Our analysis shows that Chad's economy presents symptoms of Dutch disease. Accordingly we find that the manufacturing sector is not negatively affected by energy booms, while the agricultural sector could, in the long run, react negatively to oil production. The variance decomposition analyses corroborate our analyses of an impulse response function. Indeed, the variation of manufacturing output is better explained by real oil price shocks than by energy booms. And variation in the agricultural sector, while explained in the first year by real oil price shocks, is better explained, in the long run, by energy booms.

Nonetheless, to avoid the Natural Resource Curse phenomenon, we make the following policy recommendations. First, the diversification of exports with respect to both goods and trading partners is important. As oil is now its dominant export, Chad's economy is vulnerable to the demand and supply shocks associated with oil. Second, wise spending policies are also indispensable. Revenues received from oil exports, if well managed, can contribute to economic growth. For example, the government should dedicate revenues to the agricultural sector, which used to be the main sector for exports. Indeed, Levy (2007) shows that investments in the road network for food distribution, irrigation infrastructure and improvements to water access in Chad's rural areas allow for poverty reduction and generate substantial economic growth.

References

Benjamin, N.C. , Devarajan S. and Weiner R. J. (1989) "The 'Dutch' Disease in a Developing Country. Oil Reserves in Cameroon", *Journal of Development Economics* 30, 71-92. North-Holland.

Bjorland, H.C. (1998) "The economic effect of North sea oil on the manufacturing sector", *Scottisch Journal of Political Economy*, 45 (5) 553-585.

Blanchard, O. J., Quah, D. (1988) "The dynamic effects of aggregate demand and supply disturbances" NBER Working paper number 2737.

Cerutti, E. and Mansilla, M. (2008) "Bolivia: The Hydrocarbons Boom and the Risk of Dutch Disease", IMF Working Paper, number WP/08/154.

Levy, S. (2007) "Public investment to reverse Dutch Disease: the case of Chad." *Journal of African Economies*, 16 (3), 439-484.

Matsuyama, K. (1992) "Agricultural productivity, comparative advantage and economic growth." *Journal of Economic Theory* 58, 317-334.

Neary, P. and Van Wijnbergen, S. (1986) *Natural resources and the Macroeconomy,* Cambridge, MA: the MIT Press.

Oomes, N. and Kalcheva, K. (2007) "Diagnosing Dutch Disease: Does Russia Have the Symptoms?" IMF Working Paper number WP/07/102.

Sachs, J. D., and Warner, A. M. (1995) "Natural Resource Abundance and Economic Growth", NBER Working Paper Series number 5398.