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## **Is Chad affected by Dutch or Nigerian disease?**

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# **Is Chad Affected by Dutch or Nigerian Disease?**

Sandrine Kablan  
and  
Josef Loening

## **Summary**

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. We associate our findings with structural underemployment and the inefficient use of existing production factors. In this context, increased public expenditures in tradable sectors present the opportunity to make oil revenues an engine of national development.

**JEL classifications: C30, E32, E61, O11, O13.**

**Key words: Natural resource curse, Dutch disease, Chad, Structural VAR.**

## 1. Introduction

Economic history is replete with examples of natural resource-poor countries outperforming natural resource-rich countries. 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. Sala-i-Martin and Subramanian (2003) call this phenomenon the Natural Resource Curse.

In the economic literature, while several studies explain the negative relationships between natural resource exploitation and economic growth, there are four plausible explanations that emerge from the previous research (1) Rent-seeking would not encourage governments of such countries to invest in innovative sectors with growth potential, Gelb (1988) and Auty (1990). (2) The governments of such countries would rather waste rents through profligate or inappropriate consumption. (3) Price volatility of natural resources leads to greater uncertainty, which can reduce factor accumulation through greater risk. (4) More recent studies, from the 1970s and 1980s, suggest that Dutch disease is responsible, i.e., natural resource production promotes de-industrialisation, Neary and Van Wijnbergen (1986) and Matsuyama (1992). Indeed, booms in natural resource sectors do affect the distribution of employment throughout the economy. For example, one typical African country that is afflicted by the natural resource curse is Nigeria. Nigeria is one of the top ten oil exporters in the world; however, its economy was stagnant and failed to alleviate poverty until very recently when reforms were finally undertaken, Budina, Pang, Van Wijnbergen (2006). Sala-i-Martin and Subramanian, 2003, show that rather than Dutch disease, waste

and corruption from oil have been responsible for Nigeria's poor, long-run economic performance. As an illustration, in 1965, when oil revenues per capita were approximately US\$33, the per capita GDP of Nigeria was US\$245. In 2000, when oil revenues were US\$325 per capita, the per capita GDP remained at the 1965 level, US\$245. These statistics suggest that the oil revenues, estimated at US\$350 billion, did nothing to improve the standard of living in Nigeria and, in fact, may have degraded it.

Chad discovered and began exploiting oil in 2003, and ever since, there has been some concern about how and if Chad will benefit from this new source of revenue. Indeed, in 2001 the World Bank agreed to finance the oil exploitation project under the condition that Chad use the oil revenues to finance social programmes and develop its infrastructure. However, some irregularities were recently found, prompting us to analyse Chad and determine if it is a potential natural resource curse country. For the past decade, Chad has been experiencing high volatility in commodities prices, especially those of oil, which may translate into macroeconomic instability. While it may be considered a tax on investment, highly volatile relative prices discourage the irreversible commitments to specific sectors that capital investment implies. Furthermore, Chad, which has been an unstable country since its independence, is still plagued by tension and conflict between the government and the rebels. As a result, its CPIA (Country Policy and Institutional Assessment) index ranking is very low, indicating that it is a very poorly governed country. Combined with its inadequate government, features of Dutch disease have appeared in Chad's economy.

Typical symptoms of Dutch disease 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. In countries affected by Dutch disease, the positive effects of a natural resource boom are diminished by the negative effects of contraction and stagnation in the country's tradable sectors and by an appreciation of the real effective exchange rate. Consistent with these symptoms, Ndjamen, the capital of Chad, ranked third with respect to cost of living, just behind Tokyo, in a recent survey.<sup>1</sup> This suggests that people living in Ndjamen pay higher living costs, defined as consumption, in non-tradable sectors. This paper examines the features that could result in Chad becoming a natural resource curse country, even when the windfall oil revenue it is experiencing could be an opportunity to boost the nation's economic growth, if properly managed. Moreover, if Dutch disease is diagnosed, economic measures could be taken to guide Chad in taking advantage of oil revenues. For example, Chad's government could invest part of the country's oil revenue in the agricultural or manufacturing sectors, thus serving to avoid further decline in the sector. By doing so, Chad could also avoid being the victim of the natural resource curse. The effects of Dutch disease, however, are more challenging to evaluate in Chad because of data limitations and also because the non-oil sectors are underdeveloped, making it difficult to detect their current and anticipated decline. A good diagnosis of Dutch disease would make economic policies more appropriate and help to avoid the problems associated with the resource curse. Indeed, if measures are taken to counter Dutch disease when the economy does not suffer, it could have disastrous consequences. And if measures are not taken when the economy is threatened, the consequences could be equally destructive. The policy recommendations must complement counter-policies to other channels of the natural resource curse and reinforce them. To the

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

best of our knowledge, this is the first paper to address the issue of the natural resource curse in Chad, and as such, this paper is interesting in the sense that Chad is one of the latest low-income countries to have discovered oil. Therefore, there is concern about the effects of this oil windfall on Chad's economic recovery.

In this paper, we consider four channels through which a country may become a natural resource curse country, and we thoroughly analyse the possibility of Dutch disease through its main channels. Because of some specificities to developing countries that are not taken into consideration in the original model of Corden and Neary (1982), we deem it relevant to verify our intuition through an empirical analysis. Indeed, when some hypotheses (perfect substitutability between domestic and imported goods, nonexistence of unemployment and efficient use of production factors) are relaxed, some conclusions of the original model do not hold, making it difficult, through an analysis of Chad's economic data, to draw a conclusion regarding Dutch disease. Therefore, we use a structural VAR model to assess whether the agricultural and manufacturing sectors of Chad are affected by Dutch disease. Introducing structural shocks allows us to take into consideration some specific effects of oil discovery on Chad's economy. Indeed, with only a simple Vector Auto-Regressive (VAR), we were not able to make any substantive conclusions. Our results suggest, however, that there is no evidence of Dutch disease in the manufacturing sector, while evidence of the disease is a bit more obvious in the agricultural sector. We remain cautious in the interpretation of our results, as the data from the manufacturing and agricultural output must be interpolated quarterly due to data limitations.

This paper proceeds as follows. Section 2 provides analyses of Chad's economy as a potential natural resource curse country. Further analyses regarding Dutch disease and its

main transmission channels are presented in section 3. In Section 4, we conduct some empirical tests, and in the analysis, we establish the impulse response functions and the variance decompositions by estimating a structural vector auto-regression (VAR) model. In Section 5, we summarise the findings of this study and propose some policy recommendations.



## 2. Stylised facts: Chad and the natural resource curse

Several studies emphasise the fact that natural resource-rich countries perform far worse than less well-endowed countries. Frankel, 2010, identifies five channels through which the natural resource curse can occur: volatility, institutions, anarchy, the crowding out of manufacturing and Dutch disease. Chad discovered and began exploiting oil in 2003. Since this date, there has been much concern about how Chad can benefit from this new source of revenue. Indeed, in 2001 the World Bank agreed to finance the oil exploitation project under the condition that Chad use the oil revenues to finance social programmes and develop infrastructure. However, some irregularities were recently detected, leading us to analyse Chad as a potential natural resource curse country.

### a) Volatility:

One channel of the natural resource curse is the volatility due to fluctuations in commodities' prices. Commodities' prices fluctuated widely in recent years with a dramatic increase in certain products such as oil, whose price index rose from 47.23 in January 2000 to 188.44 in October 2011. Its standard deviation of 53.47 over the past decade reflects the high volatility of oil prices. This volatility in oil prices is then transmitted to government resources and to the commodities' price level in Chad. Since the discovery of oil, government resources have largely been made up of oil revenues. Thus, public spending as a share of non-oil GDP has increased by 46% between 2003 and 2009, while inflation was 8 to 10% between 2008 and 2009, unlike other CEMAC<sup>2</sup> countries, where it is approximately

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<sup>2</sup> Economic and Monetary Community of Central Africa.

3.5%. These effects create uncertainty in the investment decisions of the public sector as well as private agents, thus ultimately impeding economic growth.

b) Poor institutions:

The literature indicates that entrepreneurial activity, by creating new and better goods or services, destroys rents accruing to those holding licenses, thus restricting trade in already existing goods or services. Lane and Tornell, 1996 and 1999, show that, in an economy with multiple powerful groups, each group has open access to production and higher productivity may, in fact, force a decline in the rate of return on investment and thus on growth. This scenario is probable because, when productivity increases, each group attempts to acquire a greater share of the production by demanding more transfers, which, at term, increases the tax rate and reduces the net return on capital. Thus, the redistribution effect may outweigh the direct effect of increased productivity. Similarly, Baland and Francois, 2000, show that when a significant number of individuals are already engaged in rent seeking behaviours, an increase in productivity drives the economy towards more rent seeking and may actually lead to a decline in the aggregate income. Torvik, 2002, finds that if productivity growth increases profits in rent situations relative to profits in the production sector, the result is lower welfare. Many empirical studies corroborate these facts. Gallagher, 1991, documents the disproportionate rise in rents with increases in income throughout the African continent, while Hilaire, 1992, describes the decline in Trinidad and Tobago's GDP immediately after oil prices quadrupled, an event that constituted 20% of the country's GDP in 1972 through 1974, and further documents a rise in the premium on import licenses for food. Chad could be one of these bad examples. Indeed, Chad, ranked 171 out of 178 countries by

Transparency International, is one of the most corrupt states in the world, and Chad's institutions remain poor, as indicated by its 2.2/6 CPIA index (Country Policy and Institutional Assessment) in 2010. Chad demonstrates very low levels in terms of its management of the four components of CPIA index: economic management, structural policies, policies for social inclusion and public sector management and institutions. Regulation remains inadequate, particularly with regard to creating or closing a business. Moreover, the proportion of budgetary resources allocated to priority sectors remain below the levels suggested by the PRSP (Poverty Reduction Strategy Paper), a fact that particularly disadvantages social sectors and rural development. Even though Chad was accepted in April 2010 as an EITI<sup>3</sup> (extractive industries transparency initiative) candidate, progress remains slow. Thus, most governance indicators show that much remains to be done at this level.

c) Anarchy:

Statistics show that more and more countries around the world have democratised and succeeded in establishing a peaceful environment. This is not true, however, in natural resource-rich countries. The annual rate for democratisation since 1980 is 3.17 for natural resource non-rich countries and 1.13 for resource-rich countries. Chad is a country that has long been affected by political instability. However, recent negotiations between the government and the rebels have somewhat quieted these tensions, though the last parliamentary and presidential elections were marked by unrest and protest. Furthermore, the management of oil revenues reflected a faster increase in government spending than did

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<sup>3</sup> It aims to promote governance by strengthening transparency in the extractive industries. Revenues from the extractive industries should be an important source of economic growth and social development in developing countries.

other resources, a situation due, in part, to the fact that Chad did not create a sovereign fund to manage the volatility of oil resources and ensure the proper use of the funds.

d) Crowding out of the manufacturing sector:

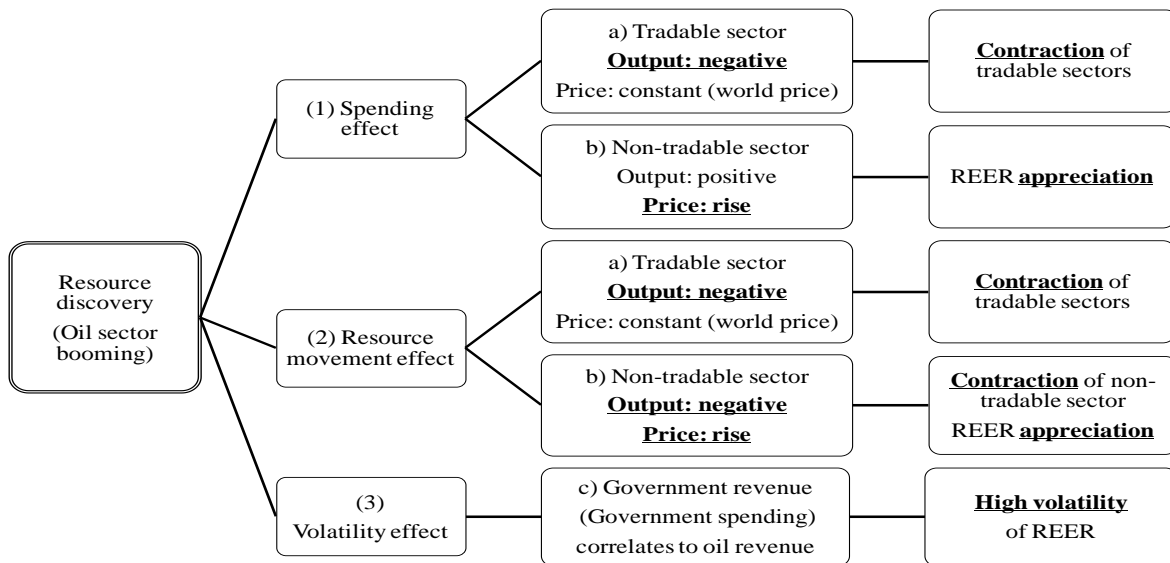
This effect is not really observed in Chad, as many investments, the result of oil revenues or foreign direct investment, have been made in new factories and industries. These investments have helped to provide Chad with new industries such as a refinery, a power plant, and a cement factory, which, in turn, have enhanced Chad's industry sector and freed the country from its dependence on foreign refined oil. However, we propose to better analyse this crowding-out effect of manufacturing along with the phenomenon of Dutch disease.

e) Transmission channels of Dutch disease: a brief overview

Corden and Neary's (1982) original model of Dutch disease considers a small country with full and efficient employment of production factors in the two tradable and non-tradable sectors where there is a mobile production factor transferable between sectors and a perfectly elastic demand for tradable goods. (i) Large resource boom inflows entail an increase in aggregate expenditures for tradable and non-tradable goods, thus influencing the real effective exchange rate (REER). An increased demand for non-tradables, induced by financial inflows, translates into an upward shift in the demand for non-tradables (services and contraction sectors) as well as an increase in their prices. As the price of tradables is fixed, the REER appreciates, which discourages their production. This is **the spending effect**. (ii) In the non-tradable sector, as the marginal product of labour increases as a result,

there is a reallocation of labour from the tradables sectors to the non-tradables sectors. This is **the resource transfer effect**. (iii) Last, REER appreciation induces a disincentive to buy non-tradables. This is **the expenditure-switching effect** (the volatility channel).<sup>4</sup> Further, if the relationships between natural resource exports and government expenditures (or government revenues) are correlated, the movement of a real effective exchange rate will be volatile through the spending effect. Serven (2003) finds that high volatility tends to have negative impacts on investment and economic growth. In sum, the transmission channels and the effects of Dutch disease, presented first by Brahmhatt, Canuto, and Vostroknutova (2010)<sup>5</sup>, can be summarised as follows.<sup>6</sup>

**Figure 1: Transmission Channels and Effects of Dutch Disease**



Note: REER denotes a real effective exchange rate.  
Source: Authors.

<sup>4</sup> We can consider the volatility channel an untraditional channel in the sense that most previous studies mainly focus on the spending effect and the resource movement effect.

<sup>5</sup> Overall explanation of the transmission channels can be found in Brahmhatt, Canuto, and Vostroknutova (2010). Cerutti and Mansilla (2008) and Oomes and Kalcheva (2007) also provide clear explanations of the spending effect and the resource movement effect.

<sup>6</sup> A similar summary can be found in Oomes and Kalcheva (2007).

However, there are many features in the model of Corden and Neary (1982) that do not fit the characteristics of low income countries (LICs). For instance, most LICs suffer from high structural unemployment and inefficient use of existing production factors. As an illustration, Chad is far from full employment and has much idle capital<sup>7</sup>. Again, many importables are domestically produced in LICs, and if one disaggregates the tradables sectors into exportables and importables, the threat of reduction in the tradables sectors is mitigated. Nkusu (2004) notes that in LICs, there is imperfect substitutability between domestically produced manufactured goods and imported goods. Furthermore, domestic manufacturers have the ability to raise prices and increase supply in response to domestic market conditions, while manufacturing firms that use sizable amounts of imported inputs can benefit from a relatively appreciated domestic currency. Because of the complementarity between imported and domestically produced inputs, the demand for domestic inputs can also increase. As a result, input supplier firms, as well as firms using domestic and imported inputs, will expand according to the price elasticities of the supply of inputs and the demand for goods. In the end, elasticity-prices mitigate the REER appreciation, and again, the risk of de-industrialisation is mitigated.

According to the same author (Nkusu), in the two-sector model, the resource effect is a corollary of the spending effect because of the assumption of full employment. However, when this hypothesis is relaxed, the resource effect cannot, by itself, trigger Dutch disease effects. As an illustration, Benjamin, Devarajan and Weiner, 1989, using a computable general equilibrium model for Cameroon, show that when there is imperfect substitutability between domestic and imported goods, some of the manufacturing sector could benefit.

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<sup>7</sup> IMF country report, No 09/67, 2009.

Moreover, whenever resource inflows are used in the socioeconomic sector, the three-sector model of Dutch disease (which differentiates between importables and exportables in the tradables sector) is more relevant, and Dutch disease effects can be reversed. Indeed, an increased use of available resources allows both the tradables and non-tradables sectors to expand, in which case, the trade balance would not necessarily deteriorate. These cause-effect events are demonstrated in Levy's (2007) general equilibrium model as she simulates the positive effects of agricultural policy (road network for food distribution and irrigation infrastructure) on Chad's economy. The results reveal that using oil revenues to improve water access in Chad's rural areas promotes poverty reduction and, at the same time, generates substantial economic growth. A road network not only improves food distribution of agricultural products and market integration, but it is also believed to improve trade and human and physical capital productivity. Thus, if oil revenues are well spent in the key agricultural sectors, the three most common symptoms of Dutch disease (a decline of specific sectors, an increase in the real exchange rate, worsening of poverty and inequality) may not appear. Based on these contrasting models and simulations, Nkusu (2004) and Levy (2007)), and while taking into consideration developing countries' specificities and the good use of oil revenues, we more thoroughly analyse the relationship between Chad and Dutch disease, that is, whether Chad is affected by Dutch disease.

### **3. Chad's economic statistics and Dutch disease channels**

Our methodology is to analyse stylised facts that could reveal the three effects of Dutch disease, though data on Chad's economy are very scarce. We were, nevertheless, able to find data using the BEAC (Banque des Etats de l'Afrique Centrale) and the IMF (International

Monetary Fund) data sources. While Chad's case reveals some patterns of the spending effect, it is difficult given the availability of the data to conclude the extent of resource and volatility effects.

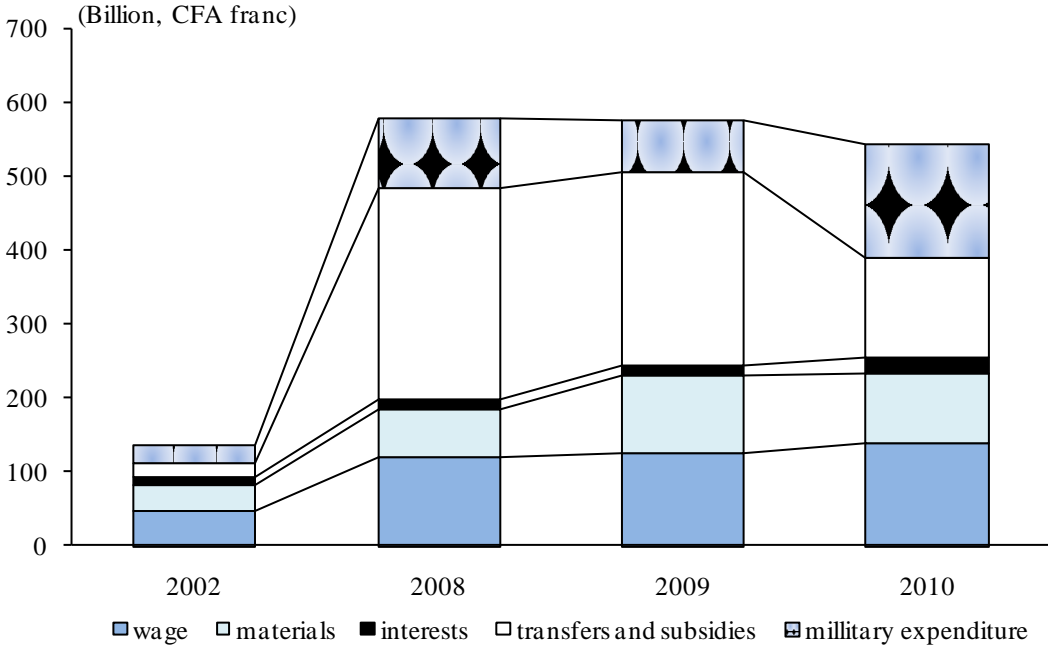
- Spending effect:

Although the data do not allow us to observe the share of spending on non-tradables, data from the table of financial operations of the Chadian government indicate that government spending tripled between 2003 (year in which oil began to be exploited) and 2009 (figure 2). This sharp increase is mainly due to current expenditures, which increased by 332%, and capital expenditures, which increased by 57%. The increased capital expenses mainly served to provide road infrastructure, which placed Chad second behind Cameroon among CEMAC countries. Other investments included those in the social field through the construction of health and education infrastructure. As for current expenditures, the increase is mainly due to the expense of transfers and subsidies (which increased by 1338%), military expenditures (which increased by 203%) and other current expenditures consisting primarily of salaries and materials (which increased by 174%). As noted, these data show a sharp increase in public spending, though the distribution of these expenditures is not necessarily well addressed, as evidenced by the data. The increase in military spending (wages and weapons) is a response to political instability and recurring conflicts that Chad has faced. Furthermore, social spending, which could have been financed by subsidies and transfers, have not yielded significant results. Indeed, Chad remains one of the least developed countries in terms of social development, with a ranking of 175 out of 182 on the Human Development Index of



UNDP (2007). Again, assuming that some of these subsidies and transfers have been allocated to key economic sectors, such as oil and cotton, the results remain disappointing and disconcerting. The cotton sector presents a significant decline in production from 2003 to 2009. For example, cotton seeds decreased from 102,000 tons to 40,000 tons, though there was a peak in 2004 of 207,500 tons. Regardless, increased government expenditures do not result in higher prices for non-tradables<sup>8</sup>.

**Figure 2: Expenditures**



Source: BEAC.  
 Note: The figures in 2009 are estimations, and those in 2010 are the projections.

The two other channels of Dutch disease do not allow us to conclude with certainty whether Chad is a victim of this economic pitfall.

<sup>8</sup> IMF country report No 09/67.

- Resource movement effect:

Increased personal expenditures in the public sector are due to an increase of 47% in the average wage and an increase in the number of employees in the public sector from 57,000 in 2001 to 117,000 in 2008. However, our data do not allow us determine the origin of this workforce. Therefore we cannot draw a conclusion about the existence of a resource movement effect.

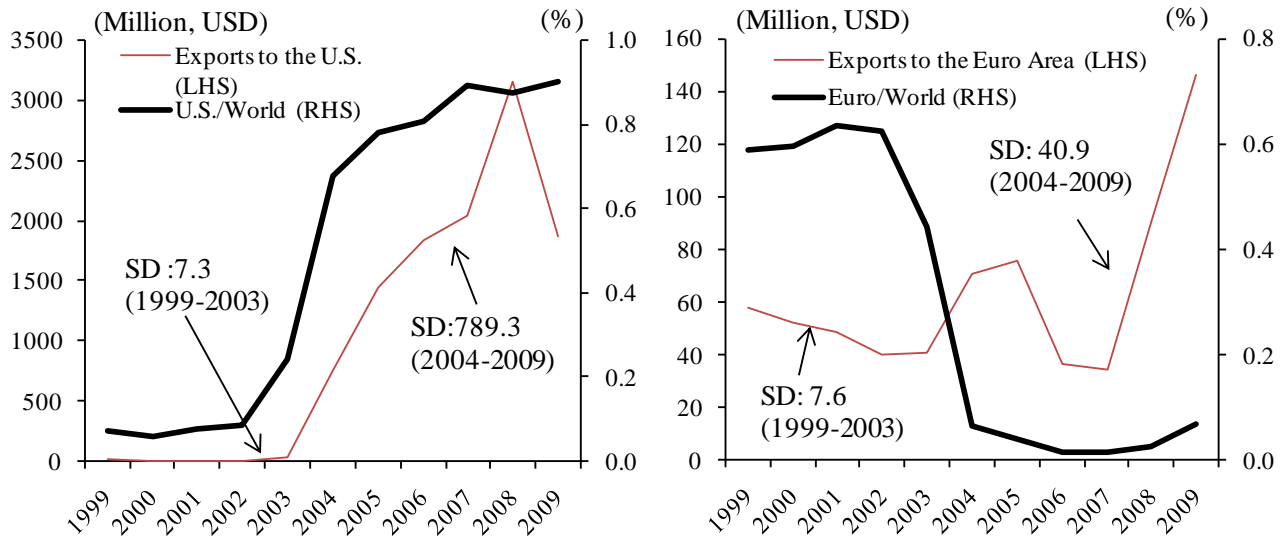
- Exchange rate volatility

Similarly, the anchor of the CFA franc to the euro does not allow us to observe the volatility of the real effective exchange rate. Before the discovery of oil in Chad, Chad's main trading partner for exports had been the euro area (approximately 60 percent in exports). After the discovery of oil, however, Chad increased oil exports to the U.S., which then became Chad's main trading partner (approximately 90 percent of Chad's trading is with the U.S., (figure 3)). Consequently, if the dollar depreciates against the euro, Chad's real effective exchange rate will likely appreciate.<sup>9</sup>

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<sup>9</sup> For example, if we consider that the world consisted only of Chad, the U.S., and the euro area, Chad's real effective exchange rate could be expressed as  $REER = W_{us} \times E_{us} \times (P_{us}/P_{Chad}) + W_{euro} \times E_{euro} \times (P_{euro}/P_{Chad})$ . Here,  $W_{us}$  and  $W_{euro}$  are the weights, that is, the trade flows (both exports and imports) between Chad and the U.S. and Chad and the euro area, respectively.  $E_{us}$  and  $E_{euro}$  are the nominal exchange rates defined as units of domestic currency per unit of foreign currency.  $P_i$  is the price level in country  $i$  measured by the CPI index. By using these relationships, we estimated Chad's real effective exchange rate (REER) in Figure 4.

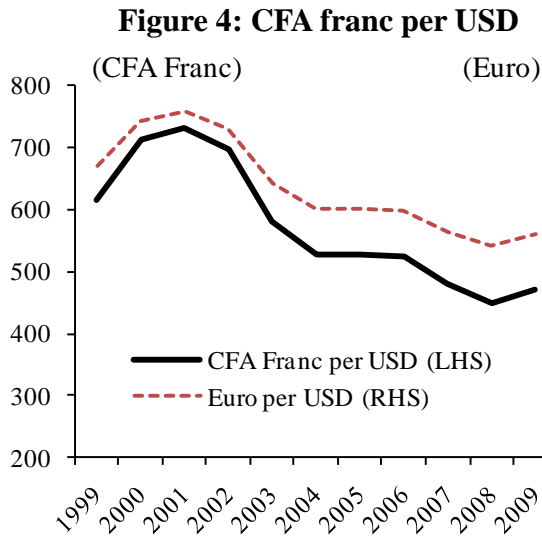
**Figure 3: Exports to the U.S. (left) and to the Euro Area (right)**



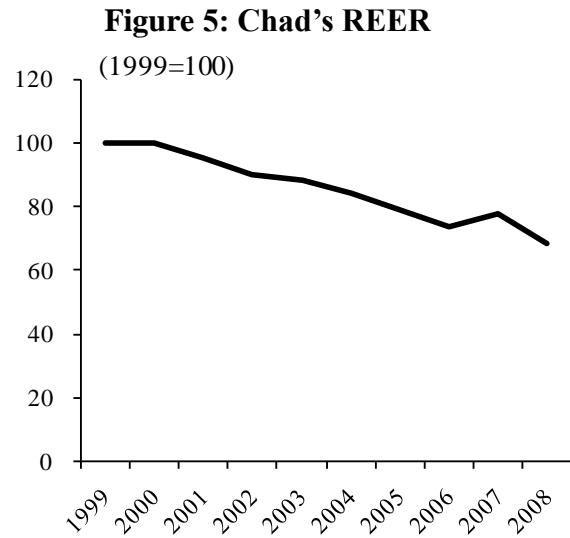
Source: IFS.

Note: SD denotes standard deviation and is calculated by authors. U.S./World and Euro/World denote the ratio of exports to the U.S. and those to the world, and the ratio of exports to the Euro Area and those to the world, respectively.

As an illustration, figure 4 depicts the trend of the CFA franc against the U.S. dollar, indicating that the U.S. dollar is depreciating against the CFA franc. By using the nominal exchange rate, the CPI index, and the trade flows, we estimate Chad's real effective exchange rate. Figure 5 shows, as expected, that the REER is appreciating, as reflected in both the increase of trade flows with the U.S. and the depreciation of the U.S. dollar against the euro.



Source: IFS.



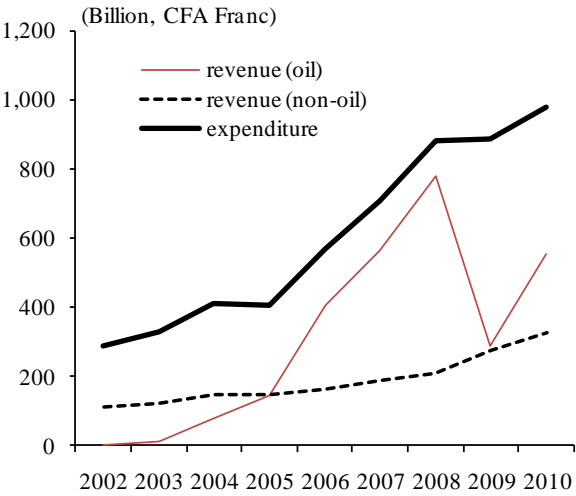
Source: IFS and WDI.  
Note: Authors' calculation

Therefore, the real effective exchange rate is not a meaningful indicator of Dutch disease in Chad's case, because its appreciation since 2004 cannot be interpreted with certainty as an effect of Dutch disease. A thorough analysis would require a close examination of the micro data to calculate Chad's real effective exchange rate. For example, Drelichman (2005) calculates price indices and the real exchange rate of Spain during the 16th and 17th centuries by collecting data for traded and non-traded consumption goods. However, the data limitations with which we are faced with respect to Chad do not allow us to conduct such an analysis.

As previously explained (second section herein), the volatility effect is the movement of a real effective exchange rate due to the volatility of government spending, which, in turn, is due to the volatility of the prices of natural resource exports. As depicted in graph 6, government expenditures and oil revenues are correlated, though the real effective exchange rate appreciated during the same period, as previously illustrated herein. Trade balance is positive from 2003 and increases, as do government expenditures, until 2009, the year in

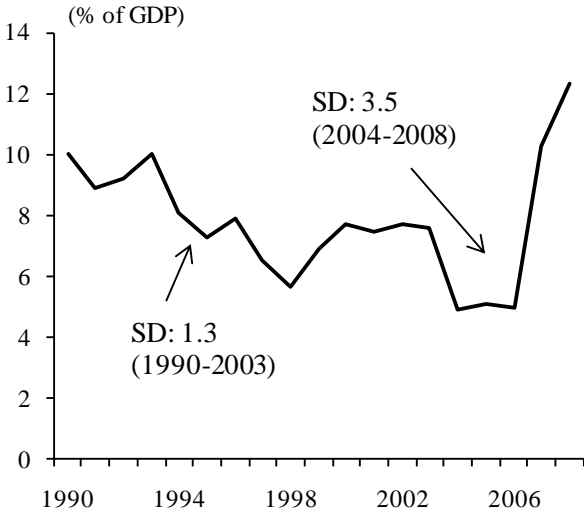
which this balance decreases (although it does remain positive). This decline can be explained by fewer exports to the U.S. (see Figure 10).

**Figure 6: Revenue and Expenditure**



Source: BEAC.  
 Note: The figures for 2009 are estimations and for 2010, they are projections.

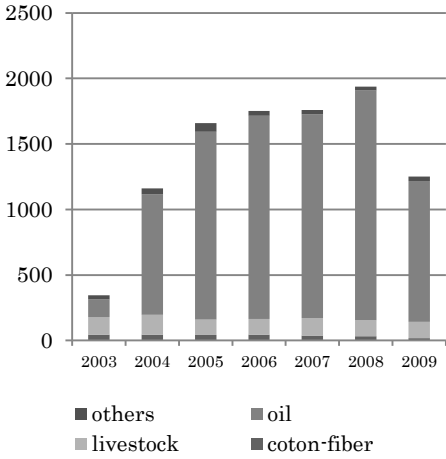
**Figure 7: Government Consumption**



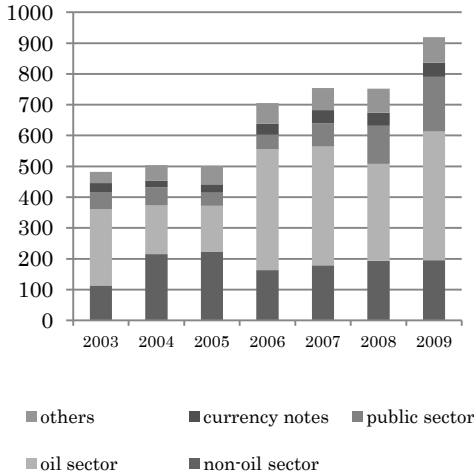
Source: WDI.  
 Note: SD denotes standard deviation and is calculated by authors.

Figure 7 shows that the volatility of government consumption, which has been increasing since 2004. This increase could suggest a risk with respect to an increase in the volatility for the real exchange rate and, therefore, a threat to stable economic growth. Furthermore, upon a thorough examination of the composition of exports and imports (figures 8 and 9), we notice that oil exports rise sharply and represent the bulk of the exports (85%, on average, over the period) at the expense of cotton fibre and other exports, whose export quantities have decreased. Meanwhile, imports have almost doubled from 2003 to 2009, an increase that is attributable to the non-oil sector, the oil sector and the public sector.

**Figure 8: Chad FoB exports in billions CFA F**



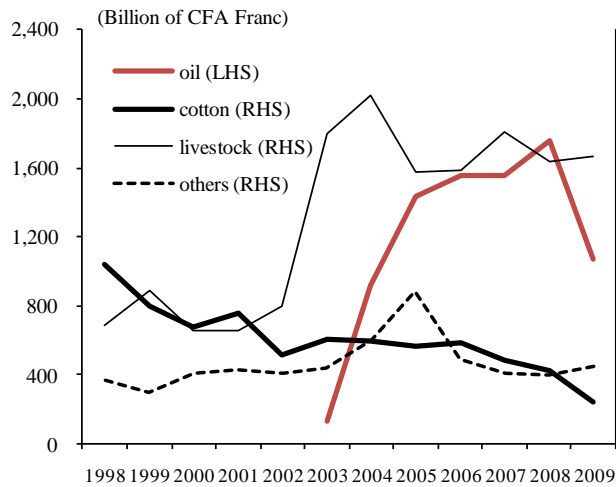
**Figure 9: Chad imports in billions CFA F**



● Contraction and stagnation in tradable sectors (de-industrialisation)

One typical symptom of Dutch disease is contraction and stagnation in the agricultural and manufacturing sectors (tradable sectors) through the spending effect and the resource movement effect. Chad, having discovered oil reserves in 2003, has engaged in oil exportation ever since. Prior to the discovery of oil reserves in Chad, Chad’s main exports were agricultural products such as cotton and livestock; however, after the discovery of the oil reserves, oil quickly became Chad’s dominant export. (Figure 10). Figure 11 shows that oil production has declined gradually since 2004. Figure 12, which depicts the share of the output in the agricultural and manufacturing sectors as a percent of the GDP indicates that the contraction of the agricultural sector is substantial. Therefore, at first glance, Chad seems to be clearly affected by Dutch disease, as a decline of production in agricultural and manufacturing sectors is one of its typical symptoms.

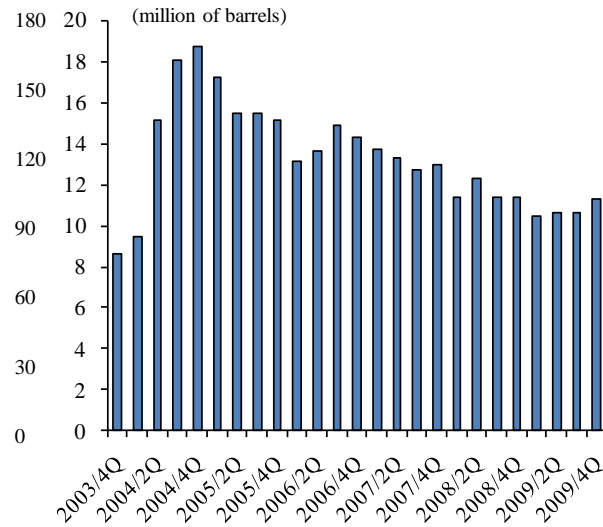
**Figure 10: Exports**



Source: BEAC.

Note: The figures in 2009 are the estimation.

**Figure 11: Oil Production**

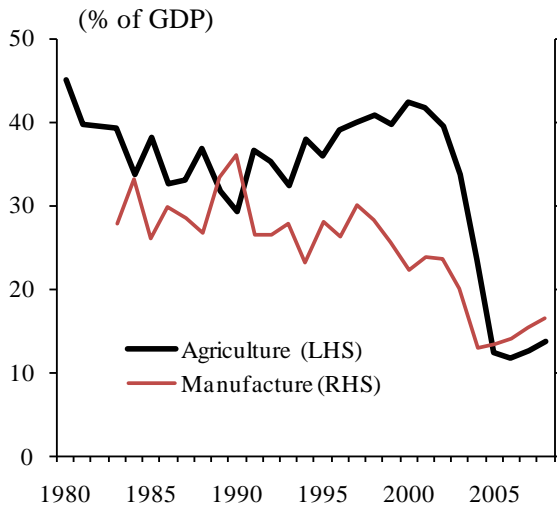


Source: Geointelligence Network, Project update.

Given that Chad’s GDP has increased because of oil exports, we are a bit sceptical in drawing this conclusion. Indeed, figure 13 shows that output in the manufacturing sector is increasing, while the output in the agricultural sector declined severely in 2005 and has been sluggish even since.<sup>10</sup> The aforementioned evidences suggest that the agricultural sector could be affected by Dutch disease 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) and Fardmanesh (1991). For example, Benjamin, Devarajan and Weiner (1989), conclude that the manufacturing sector in Cameroon could expand output, thus assuming imperfect substitutability between domestic and foreign goods.

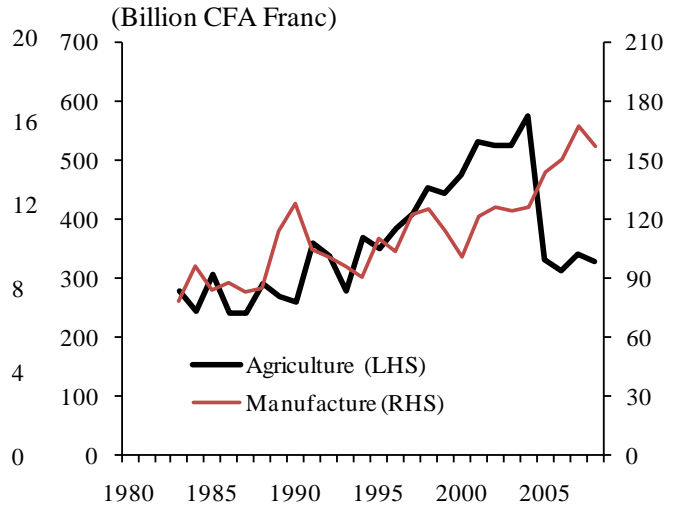
<sup>10</sup> However, it should be noted that we cannot solely rely on the possibility of Dutch disease for the plunge of the output in the agricultural sector. We should also consider other diverse external factors, such as weather, civil war, and enabling environment.

**Figure 12: Share of Output (% of GDP)**



Source: WDI.

**Figure 13: Value Added**



Source: WDI.

Note: Value added (current LCU). By using CPI index (2005=100), we calculate real term basis.

Given the stylised facts, we question whether Chad's economy is actually affected by Dutch disease.

#### **4. Prospecting for Dutch disease in manufacturing and agricultural sectors**

- **Methodology**

In this section, we conduct certain empirical tests. Recent studies such as the IMF (2009), Cerutti and Mansilla (2008) and Oomes and Kalcheva (2007) use an equilibrium real exchange rate method for their empirical analyses, as this method estimates the relationships between a real effective exchange rate and certain influential variables such as terms of trade, productivity differentials, trade openness and government spending. In the analysis of Chad, however, we face a few limitations. First, as mentioned in Section 3, it is difficult to rely on



the real effective exchange rate for the analysis. Second, Chad has relatively poor data, and thus, it is difficult to calculate some of the influential variables mentioned within this text. Therefore, we choose a method that requires a poor theoretical framework: a VAR model. 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. Hutchison (1994) uses a vector error correction model (VECM), which is a restricted VAR for non stationary, co-integrated series, to assess whether there is Dutch disease in the UK, the Netherlands, and Norway. Taking into consideration the energy prices, energy output, money/credit supply, and manufacturing output, he concludes that there is no specific sign for Dutch disease in the manufacturing sector of these countries. In a more recent paper, Bjorland (1998), on the other hand, showed that while Norway presents no evidence of Dutch disease, the UK is subject to Dutch disease in the long run. She concludes that in Norway, energy booms and oil price increases stimulate the economy, which, in turn, leads to increases in manufacturing production. To the contrary, in the UK, energy booms had a small negative impact on manufacturing, thus suggesting that other factors (i.e., oil price shocks, for example) could explain this decline. She was able to perform a refined analysis because of the use of structural VAR. 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.

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

( ). The second model (model 2), agricultural production ( $a_t$ ), is the same that is used for manufacturing production. Appendix 4 shows the co-integration tests for the two models. As there is no co-integrating vector among the variables, we conduct a structural VAR model rather than a VECM. Following Bjorland (1994), we identified three other structural shocks in addition to energy booms ( $\varepsilon_t^{ES}$ ). They are real oil price shocks ( $\varepsilon_t^{ROP}$ ), aggregate demand shocks ( $\varepsilon_t^{AD}$ ) and aggregate supply shocks ( $\varepsilon_t^{AS}$ ).

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, Appendix 2 shows the stationary tests for the level and first difference variables. The reduced form of VAR is estimated as

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

where  $B_j$  ( $j=0,1,\dots,p$ ) 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

$\Omega$ .

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

$$z_t = C(L)e_t \quad (2)$$

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

(2) and (3) imply that  $e_t = D_0\varepsilon_t$ , hence,  $C(L)D_0 = D(L)$ . 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  $D_0D_0' = \Omega$ . 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:

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

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

Oil price shocks in the 1970s are believed to have reduced world manufacturing output, but such shocks have also worked to transfer income from the oil importing countries to the oil exporting countries. Bjorland (1998) introduces into the VAR model the real oil price as opposed to the nominal price, allowing for a focus on both effects. Therefore, 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:

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

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 :

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

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.

- Data description

All variables are quarterly data for the period 1983/Q4 to 2008/Q4. The period depends on the data availability. Specific definitions and sources of the data are provided in Appendix 1. Before the estimation, we must mention a few data limitations.<sup>11</sup> First, we cannot find quarterly data for the GDP deflator or for the agricultural and manufacturing outputs. Therefore, we interpolate yearly data into quarterly data by interpolation cubic spline with the last observation matched to the source data<sup>12</sup>. Second, though Chad discovered oil reserves in 2003, it still lacks ample data for oil production. Therefore, taking these data limitations into consideration, we must be cautious when interpreting the estimation results.

The information criteria can be used to determine the optimal lag length. Appendix 3 suggests that the lag length should be two (model 1) for the combination of manufacturing output, oil volume, real oil price and inflation in first differences, and should be three (model 2) for the combination of the agriculture output and the three other variables also in first difference. The data period should be 1985/Q1 to 2008/Q4, after adjustments.

- Empirical results

Figures 14 and 15 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

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<sup>11</sup> In addition to data limitations, data unreliability is also problem. For example, the IMF (2009) notes that “not only are its external sector data unreliable but Chad also has a substantial amount of unrecorded trade with Nigeria and Cameroon that would not be reflected in such statistics as the REER and the terms of trade.”

<sup>12</sup> 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.

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 Dutch disease, 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.

Responses of agricultural output and GDP deflator to the four above mentioned shocks are depicted in figures 16 and 17. Here, the over-identifying restrictions are supported by model 2, as shown in figure 17 (we had to consider among the endogenous variables, inflation at  $t+1$  instead of  $t$ ). 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 Dutch disease, even if the results may not be significant given that the standard deviation bands encompass the x-axis. Figure 16 indicates that energy booms have a negative impact on agricultural production after 4 quarters, which corroborates, again, the presence of Dutch disease in the agricultural sector. However, the higher band of the

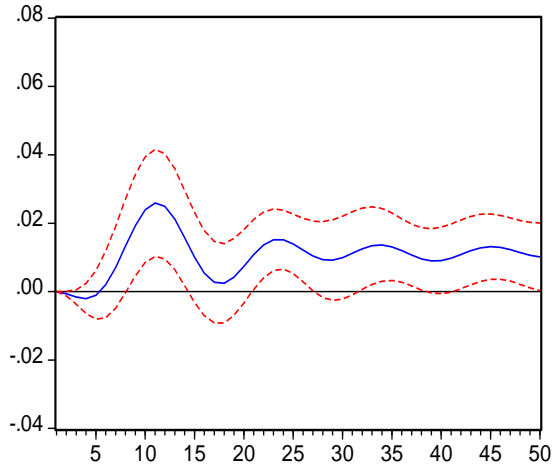
standard deviation is above the x-axis, implying that output production could continue to increase after one year. Real oil price shocks have no significant impact on agriculture production. Finally, demand and supply shocks have a permanent significant positive impact on agriculture production, as expected.



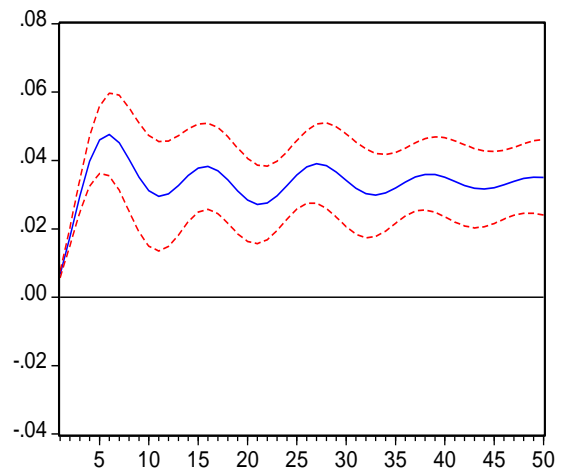
**Figure 14: Accumulated response to structural one S.D. innovations  $\pm 2$  S.E.**

**Manufacturing production-model 1**

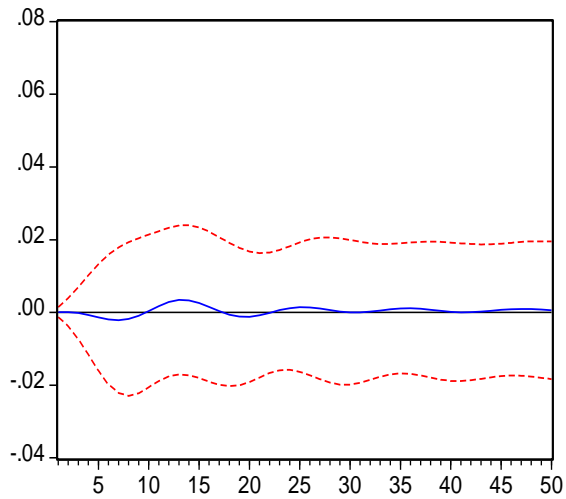
**a) Aggregate demand shock**



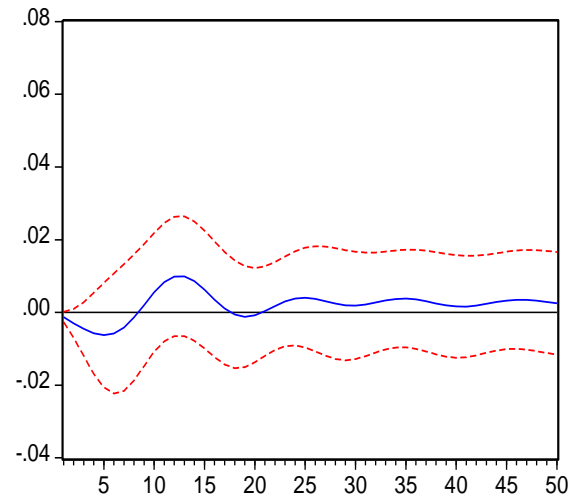
**b) Aggregate supply shock**



**c) Energy booms**



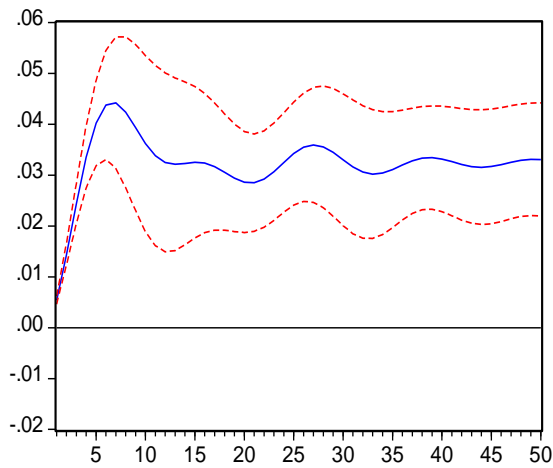
**d) Real oil price shock**



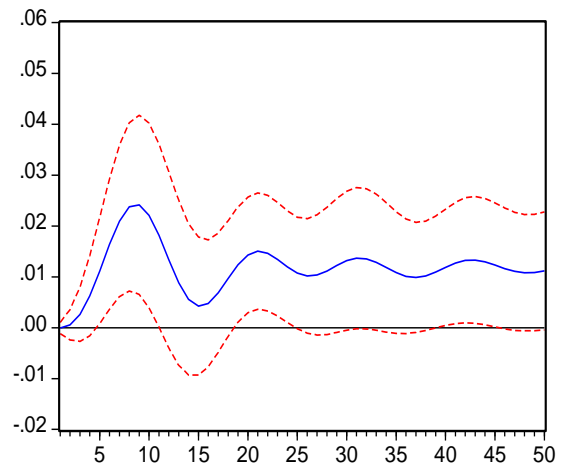
**Figure 15: Accumulated response to structural one S.D. innovations  $\pm 2$  S.E.**

**GDP deflator – model 1**

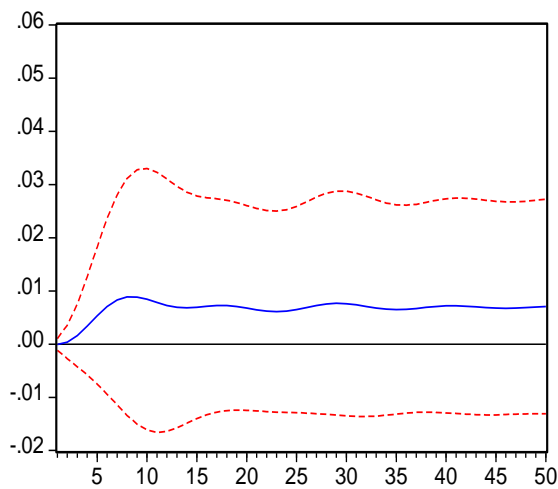
**a) Aggregate demand shock**



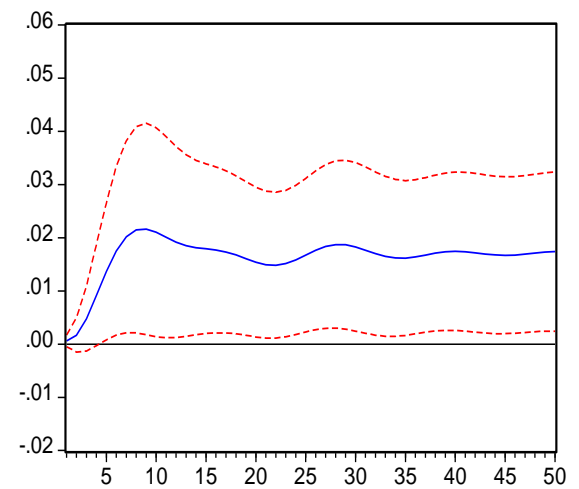
**b) Aggregate supply shock**



**c) Energy booms**



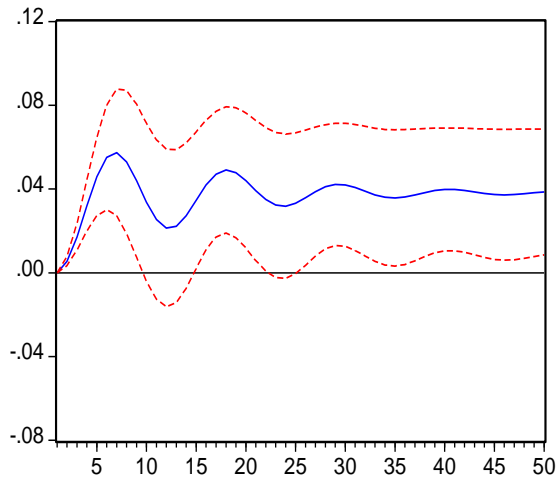
**d) Real oil price shock**



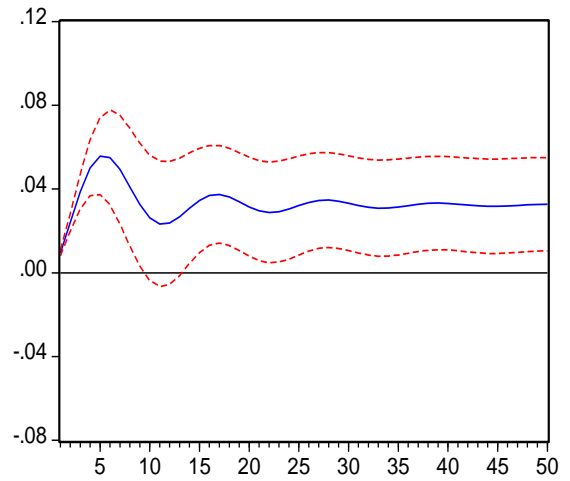
**Figure 16: Accumulated response to structural one S.D. innovations  $\pm 2$  S.E.**

**Agricultural output – model 2**

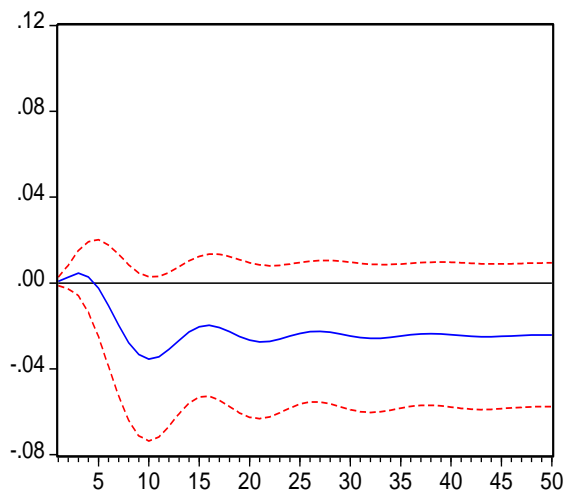
**a) Aggregate demand shock**



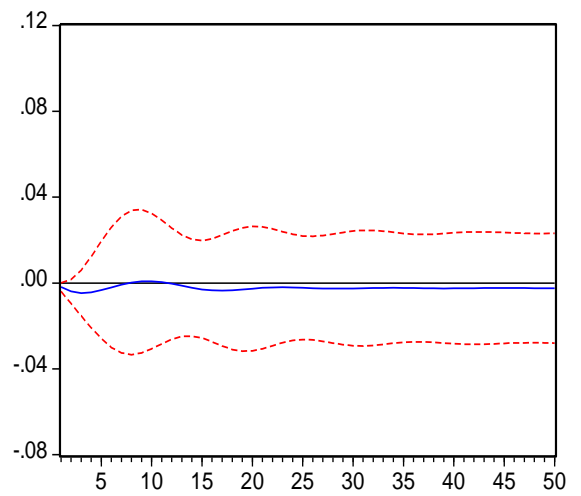
**b) Aggregate supply shock**



**c) Energy booms**



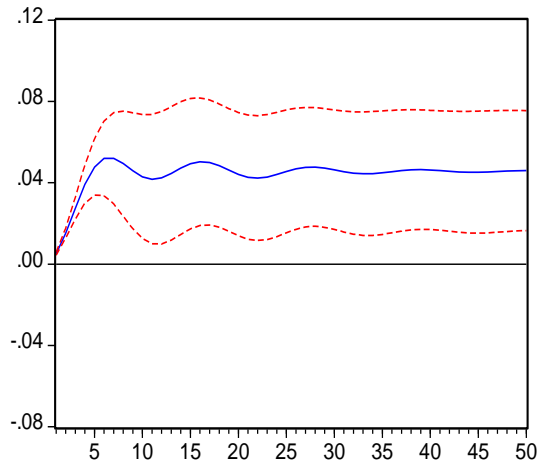
**d) Real oil price shock**



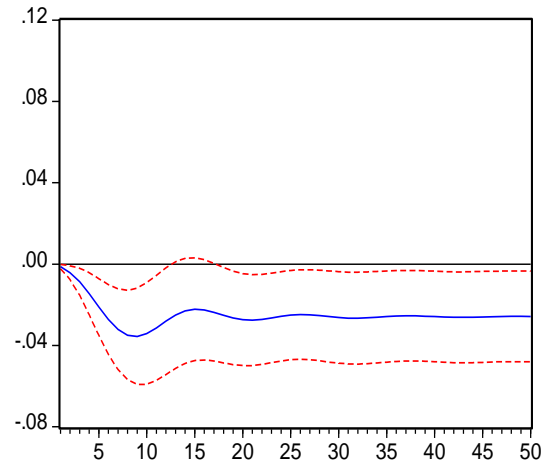
**Figure 17: Accumulated response to structural one S.D. innovations  $\pm 2$  S.E.**

**GDP Deflator – model 2**

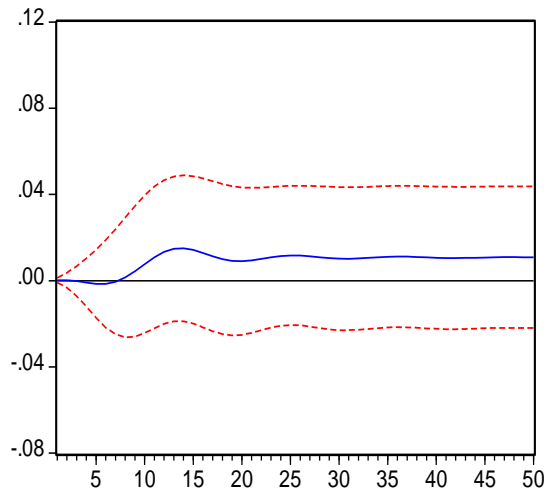
**a) Aggregate demand shock**



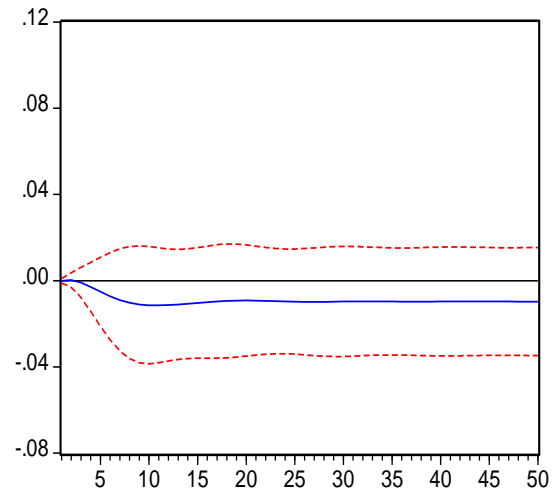
**b) Aggregate supply shock**



**c) Energy booms**



**d) Real oil price shock**



Tables 1 and 2 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 2, 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. As a robustness check, we introduce rainfall as an exogenous variable into the SVAR models. However, the results do not change, probably because the effects of this variable are already captured by agricultural output.

Table 1: 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 2: 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

## 5. Concluding remarks

This paper examines whether Chad, one of the last African countries to have discovered oil, could be affected by the natural resource curse. 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. In addition to the stylised facts for analysing channels of the natural resource curse, we empirically test for Dutch disease. Our methodology is more refined than the traditional methods used to assess Dutch disease, and the results on whether the agricultural sector or the manufacturing sector is affected by Dutch disease allow us to better address policy recommendations applicable to Chad as well as other similar countries.

Indeed, there is considerable literature regarding natural resource-rich countries that performed very poorly economically. In Africa, Nigeria failed during four decades of oil exploitation to make substantial economic gains, thus poverty remains a problem in several Nigerian states, and non-oil economic sectors have stagnated. Our analysis shows that Chad's economy presents several patent features that support the existence of the natural resource curse, such as volatility in government resources, poor institutions, recurrent tensions, and mismanagement of oil resources. More specifically, there are symptoms of Dutch disease. However, as the original model of Corden and Neary (1982) does not take into consideration some specificities of developing countries, we attempt to conduct a more thorough analysis. The descriptive analysis using Chad's economic statistics, suggests that the agricultural sector could be affected by Dutch disease. However, we could not find clear evidence that the manufacturing sector is adversely affected. Furthermore, the features in

Chad's revenue and expenditure systems could be the symptom of Dutch disease, and the volatility effect could have negative impacts on investment and economic growth.

To verify whether there is Dutch disease in Chad's agricultural and manufacturing sectors, we use a structural VAR model and analyse the impulse response functions and variance decompositions. 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.

It should be noted that in the empirical analysis we used interpolated data due to data limitations. Therefore, caution should be exercised when interpreting the results of the study. Another consideration worthy of mention is that there is a possibility that the decline in the agricultural output is due to the decline in the output of the cotton sector (as mentioned in the descriptive analysis), rather than to a decline in oil production. In addition, as mentioned in Section 2, assuming Chad's country-specific circumstances, such as the existence of large number of unemployed workers and idle capital, there is a possibility that Chad could benefit from the oil boom. In fact, the output in the manufacturing sector is increasing, as Figure 13 indicates. Given the data limitations and potential concerns, we should avoid making hard-line policy prescriptions based solely on the interpretations of our findings, as Nkusu (2004) suggests. Further research should be implemented, particularly



in the aforementioned fields.

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. In addition, Chad exports oil mainly to the U.S., and the volatility of these oil exports to the U.S. continue to increase (figure 7), implying that Chad's exports will suffer significantly if the U.S. suffers a severe recession or stops importing from Chad for some reason. Figure 7 and Figure 10 imply that oil revenue and exports to the U.S. seem to be highly correlated, which could increase the volatility of the real effective exchange rate through the spending effect.

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.

Our last policy recommendation is to focus on the improvement and transparency of Chad's government and its institutions, as Chad is ranked 175th in the Corruption

Perception Index (CPI) in 2009.<sup>13</sup> As Sala-i-Martin and Subramanian (2003) note, corruption could be the most influential factor for low economic growth, not Dutch disease. The quality of institutions is, therefore, a pre-requisite for the appropriate use of oil windfalls to ensure economic growth.

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<sup>13</sup> See [http://www.transparency.org/policy\\_research/surveys\\_indices/cpi/2009/cpi\\_2009\\_table](http://www.transparency.org/policy_research/surveys_indices/cpi/2009/cpi_2009_table) in detail. Iraq and Sudan (176th), Myanmar (178th), Afghanistan (179th), and Somalia (180th) are next to Chad.

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### Appendix 1: Data Description

Variable	Definitions and Sources
Agricultural output	<p>Agriculture, value added (current LCU). By using the CPI index (2005=100) as a deflator, we calculate real term basis by dividing the agriculture output &lt;AO&gt; by the CPI index, namely, <math>AO/(CPI/100)</math>.</p> <p>We obtain only annual data and interpolate into quarterly basis (cubic interpolation). We use the log form in the regression.</p> <p>Source: World Development Indicator (WDI).</p>
Manufacturing output	<p>Manufacturing, value added (current LCU). By using CPI index (2005=100) as a deflator, we calculate real term basis by dividing the manufacturing output &lt;MO&gt; by the CPI index, namely, <math>MO/(CPI/100)</math>.</p> <p>We obtain only annual data and interpolate into a quarterly basis (cubic interpolation). We use the log form in the regression.</p> <p>Source: World Development Indicator (WDI).</p>
Oil Price	<p>Petroleum, West Texas Intermediate, U.S. dollars per barrel. Quarterly basis. We use the log form in the regression.</p> <p>Source: International Financial Statistics (IFS).</p> <p>Real oil prices are deducted using <math>(n*e)/cpi</math> : with n: nominal price; e : exchange rate on quarterly basis; cpi: consumer price index on quarterly basis. Source: International Financial Statistics.</p>
Oil Production	<p>Millions of barrels, net volume of shipments from marine terminal. Quarterly basis.</p> <p>Source: Geointelligence Network, Project update.</p>
GDP deflator	<p>We obtain only annual statistics and, therefore, interpolate using the log form to report quarterly data (cubic interpolation).</p> <p>Source: World Development Indicators</p>

## Appendix 2: Unit Root Tests

Variables	Level t-value	First difference t-value
Agricultural output	-1.45	-3.80***
Manufacturing output	-1.73	-3.45**
Real oil price	-1.68	-7.94***
Oil volume	-1.59	-4.30***
GDP deflator	0.44	-4.36***

Note: Sample period: 1983/Q4-2008/Q4. Variables are tested by the Augmented Dickey-Fuller (ADF) test and the number of lags is selected by Schwarz information criterion. The values with \*\*\* and \*\* denote significance at one and five percent levels.

## Appendix 3: Lag Length Criterion

Lag	AIC	
	Model 1	Model 2
0	-6.458048	-5.731075
1	-9.340037	-9.101054
2	-12.53185*	-11.61106
3	-12.49483	-11.79172*
4	-12.32702	-11.70662
5	-12.14140	-11.69979
6	-12.15747	-11.48712
7	-12.01137	-11.47142
8	-11.90247	-11.68974
9	-11.86600	-11.70371

Note: AIC denotes Akaike Information Criterion. \* denotes the optimal lag length.



#### Appendix 4: Johansen Cointegration Tests For Level Variables

Hypothesised number of cointegration relations	Critical Value 5% for Max-eigen statistic	Critical Value 5% for trace statistic	Model 1		Model 2	
			Trace statistic	Max-Eigen statistic	Trace statistic	Max-Eigen statistic
None	28.58808	54.07904	52.04482	26.70350	48.46656	22.24319
At most 1	22.29962	35.19275	25.34132	17.06763	26.22337	17.13465
At most 2	15.89210	20.26184	8.273689	5.567072	9.088721	5.609753
At most 3	9.164546	9.164546	2.706617	2.706617	3.478968	3.478968