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Impact of mining and oil boom on the labour market and economic development in Niger

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Abstract

This paper analyzes the impacts of mining and petroleum sector expansion on economic growth and the labour market through allocation policies. We use a static CGE (computable general equilibrium) model based on PEP 1-1 with some modifications. The results show that the increase in mining and oil revenues does not systematically lead to Dutch disease if the government implements appropriate policies. For example, an agricultural subsidy has beneficial effects on agricultural production and can result in a decrease in food insecurity, while an electricity subsidy helps strengthen the industrial base and creates more jobs through spillover effects.

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Keywords: Mining and oil Resources, CGE model, labour market

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List of abbreviations

ANPE	National Agency for the Promotion of Employment (*Agence National pour la Promotion de l'Emploi*)
BEPC	Primary Graduation Certificate (*Brevet d'Etudes du Premier Cycle*)
CFEPD	Certificat de Fin d'Etudes du Premier Degré
ENBC	National Consumption Budget Survey (*Enquête. Nationale sur le Budget et la Consommation des Ménages*)
FAO	Food and Agriculture Organisation
IMF	International Monetary Fund
IC/BIC	Schedular tax on industry and trade (*Indice Cédulaire sur le Bénéfice Industriel et Commercial*)
IFPRI	International Food Policy Research Institute
INS	National Statistics Institute (*Institut National de la Statistique*)
SAM	Social accounting matrix
CGE	Calculable general equilibrium (model)
PDES	Economic and Social Development Plan
PEP	Partnership for Economic Policy
GDP	Gross domestic product
TIEA	Table of Integrated Economic Accounts (TCEI – *Tableau des Comptes Économiques Intégrés*)
SUT	Supply-Use Table (*TRE – Tableau Ressources Emplois*)
VA	Value added

I. Introduction

In Niger, the volume of available workers has increased rapidly in recent years whereas the possibilities for employment have grown slowly. The National Institute of Statistics (2010a) indicates that the active population is growing at an annual rate of 4.4%, which is much faster than that of the population as a whole (3.3%). Unemployment and underemployment are thus a major problem for Niger. In this context, the interest is to address certain development issues, starting with the mining and petroleum sector in relation to the paradox between natural wealth (uranium, petroleum, gold, coal, etc.) and the poverty of Nigerien populations. Since the 1970s and 80s, mining policies implemented do not seem to have been sufficiently effective to achieve the sought after economic development. The extractive sector remains largely isolated from the rest of the economy. Moreover, these mining policies did not mitigate the risks generally associated with the extractive sector. These risks notably concern vulnerability to swings in international uranium demand, as well as the risk of Dutch disease through real exchange rate appreciation leading to deterioration in the international competitiveness of Niger (IMF 2012). For Niger, these risks mostly arise through fluctuations in exports in mining and an incapacity of the state to convert mining rents into economic and social development outcomes.

However, starting in 2007 and related to new mining reforms, the country entered into a new phase of intensification of extractive activities, generating sizeable revenues for the government. These additional financial revenues should relax the budgetary constraint of the state and favour an increase in public spending. This financial windfall, when it is used for suitable investments, can contribute to driving a sustainable economic growth.

This research is in line with this context. It proposes the use of a calculable general equilibrium model, with options to use mining and petroleum revenues together with economic development policy and promotion of employment in Niger. Section 1 presents the economic and social context of the country in relation to the evolution of the extractive sector. Section 2 reviews literature on theoretical and empirical debates on the impact of rents from natural resources on the economy. Section 3 describes the data used and the theoretical framework of the analysis, and the results and policy recommendations are discussed in section 4.

1.1 The mining and petroleum sector in Niger

Uranium is the main mining resource being exploited. However, as of 2007, Niger has experienced intensification of exploration and exploitation of new petroleum deposits which entered into production in 2011[1]. Niger also has a refinery with a capacity of 20,000 barrels/day. With national consumption at 7000 barrels/day, the remaining 2/3 is exported to neighbouring countries.

This new mining and petroleum context is good for the financial situation of Niger. In 2012, the contribution of the mining and petroleum sector to budget revenues was about 12.9%[2]. As for ore exports, they account for a large share of the total value of exports (75% in 2011 and 62% in 2012).

Table 1: Contribution of mining and petroleum sector to government revenues

	Resource	2007	2008	2009	2010	2011	2012
Exports in billions FCFA	Uranium	136.6	198.2	195.1	228	317.4	338.3
	Petroleum					0.026	109
Contribution to budget revenues (%) excluding aid	Uranium	28.6*	10.0	13.3	14.2	10.4	12.9
	Petroleum						10.8
Share of total exports	Uranium	63.8	62.6	64.0	61.0	74.8	62.5
	Petroleum						20.1
Share of GDP (%)	Total	4.4	6.0	6.4	7.2	7.5	10.8

Source: IMF (2011), Nigerien authorities and authors' calculations
**Budget revenues plus revenues from sale of mining assets totalling* 46 763 797 690 FCFA in this year.

Over 2006-2012, the value of exports of uranium increased fourfold, from 80 to 338 billion FCFA. By volume, it went from 3434 tonnes in 2006 to 4623 tonnes in 2012 (see Annex 2). In terms of the contribution to budget revenues, the uranium sector provided 70.4 billion FCFA in 2012, six (6) times more than 2006 (12.1 billion FCFA). The contribution of petroleum to budget revenues excluding aid is less important[3] at 10.8% in 2012; it accounted for about 20% of total exports.

[1] We find that between 2006 and 2008, 126 uranium and petroleum exploration permits were granted to foreign companies and 125 for gold, precious metals and stones, and base metals (Ministère des mines et de l'energie, 2008).

[2] The contribution of the uranium sector to budgetary revenues of the government is estimated at 53 billion FCFA for budgetary revenues (which totalled 544 billion FCFA excluding aid in 2012).

[3] The variations observed between years can be explained by additional benefits such as bonuses and other advantages.

Furthermore, the adoption of a new mining law in 2006 and a petroleum code in 2007 both provide a framework that is incentivizing for investors and a way for the government to increase its budget revenues. To this end, the 2012 report of the International Monetary Fund states that flows from mining and petroleum resources would reach 258 billion FCFA in 2016, 175 billion from uranium and 82.5 billion for petroleum. Compared to the level of resources in 2012, this represents a 232%[4] increase, 148.6% for uranium and 39.8% for petroleum. Thus, the share of mining and petroleum resources in the government's budget went from 10.4% in 2011 to 26.8% in 2016 (Annex 3).

The increase in budget revenues led to wage adjustments[5] in the public sector and tax reforms to improve the business environment. To combat unemployment and underemployment, the government aims to create 50,000 jobs a year. But, the key question is to know the optimal use of mining and petroleum resources to reach the goal of having a job-creating economic growth. In order to avoid expansion of extractive industries damaging the competitiveness of the Nigerian economy or negatively impacting socio-economic development, it is necessary to inform decision making about potential impediments which may slow progress toward growth and development objectives. Efforts towards a strong, diversified, sustainable and job-creating growth are one of the strategic axes of the Economic and Social Development Plan (PDES[6]).

1.2 The Nigerien labour market

The issues of unemployment and underemployment are a major problem for Nigerien authorities. In 2012, the active population (aged 15 to 64) is estimated at 8 million persons with an activity rate of 61% (the rate from 2008, the most recently known one), for an active population of about 5 million persons. This is about 30% of the total population, estimated at 17 million inhabitants in 2012. Sangaré et al. (2012) estimated the average annual number

[4] Exploitation of mining and petroleum resources totalled 129.4 billion FCFA in 2012, 70.4 billion from uranium and 59 billion from petroleum.
[5] These wages adjustments in 2011 led to 10% wage increases in the public service and a modification of the salary scale in 2010 (highest level from 1000 to 1050).
[6] Policy action framework of the Nigerien government for 2012-2015.

of additional job seekers to be 130,000 between 2005 and 2012. The unemployment rate was estimated at 12% of the population in 2005 (Hamadou Daouda 2010).

In terms of labour market structure, four in five persons work in agriculture where employment is generally poorly or not remunerated. Wage employment in the public, and in private and parapublic, sectors respectively totalled 40,404 and 70,608 persons in 2010 (ANPE 2011)[7]. The supply of qualified labour in each sector is generally insufficient to respond to the needs of organizations looking to fill employment positions. For example, of 21,400 jobs posted with the ANPE in 2009, only 5300 job offers were issued, four times less than the demand (INS 2010a). The weak absorption capacity of job offers can be explained by the small size of the economic fabric of Niger. The country has only 348 public, parapublic or private enterprises. In terms of private enterprise, 262 employ less than 20 employees, 60 have a workforce of between 20 and 99 workers, and only 23 private firms and one parapublic enterprise have a workforce of between 100 and 999 workers. In 2010, 63% of jobs in the private and parapublic sectors were in the tertiary sector and 34% were in the secondary sector.

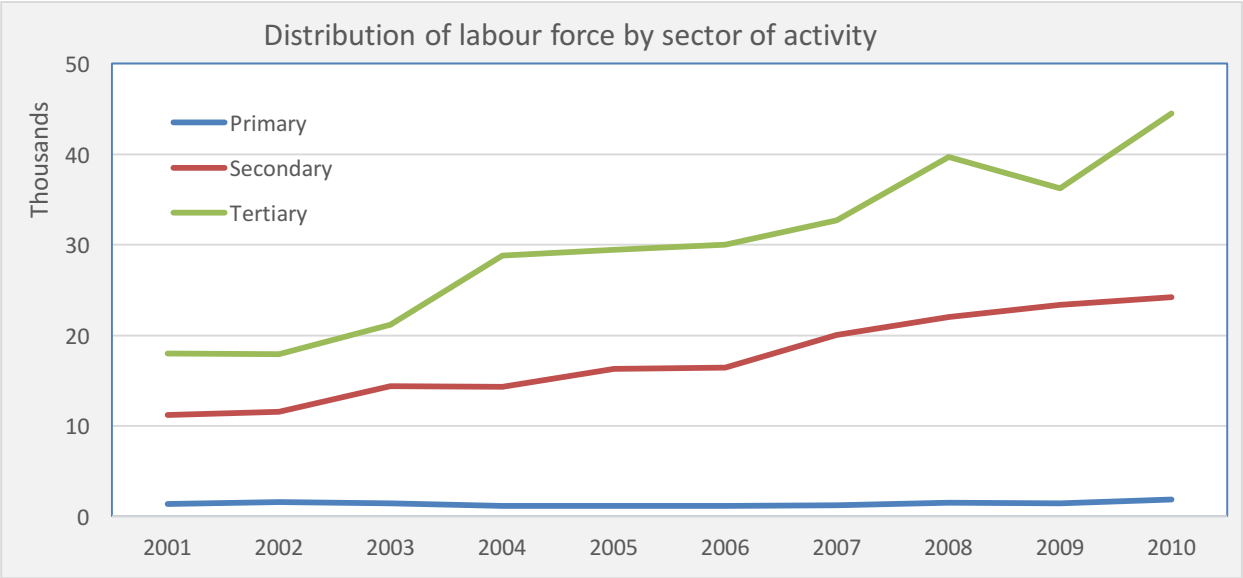
Overall, the propensity of the economy to create formal sector employment is low[8] in Niger. The country remains, outside of the mining and petroleum sector, unattractive for private foreign investment. This situation has promoted the relatively greater expansion of employment in the tertiary sector (Figure 1) and probably also of informal employment[9]. In 2010, informal activities accounted for nearly 80% of the value added of the country and we estimate that nine in 10 among the active are in this sector (INS 2010b).

[7] The ANPE statistics only account for formal registered employment. They do not account for informal employment.

[8] The secondary sector has remained embryonic and the general business climate has not enabled the development of private investments in this sector. The public service has remained the largest provider of employment. In terms of private and parapublic sectors, we observe a nearly constant progression in the number of workers, from 30,600 in 2001 to more than 70,600 in 2010 (cf. Annex 1).

[9] The structure of the economy is such that the primary sector is largely informal while the shares of informality in the secondary and tertiary sectors are respectively estimated at 56% and 57% in 2010.

Figure 1: Changes in the total workforce in private sector and parapublic sector by sector of activity



Source: Authors, using data from the 2006-2010 Statistical yearbook (INS 2011)

On the labour market, the private and parapublic sectors of activity which absorb the most workers are social services, trade services, restaurants and hotels, and services for transportation, warehousing and communications.

According to the survey carried out by Tijdens et al. (2012), the distribution of formal employment is characterized by a predominance of employment in wholesale and retail trade (19%), followed by employment in education (17%) and transportation (14%). The median hourly wage is about 289 FCFA, or 1926 FCFA per day, which was about $4 US daily in 2010. The report confirms that the more employment is informal, the lower wages are. The lowest wages are 105 FCFA per hour, while better paid informal employees may earn as much as 699 FCFA per hour.

1.3 Research questions and objectives

The Economic and Social Development Plan identifies the extractive sector as the main engine of socio-economic development in the country. Moreover, given the priority attributed to employment policies, a study on the impact of natural resources on economic development and employment may prove extremely useful. It is all the more important

considering that this type of research barely is nearly inexistent in Niger. The present study thus contributes to the development of economic policies conducive to structural changes induced by the mining and petroleum boom. More specifically, the study aims to inform public powers on actions to implement, and the sectors to promote in order to promote employment and economic development.

To achieve our objectives, we have chosen the calculable general equilibrium approach because it enables to construct different forecasting scenarios for mining and petroleum rents, and to use it to understand the effects of policy choices for allocation of productive resources in the economy.

Generally speaking, two types of effects may induce a change on the labour market: direct demand effects which flow to production sectors and indirect effects. Labour demand may be also be considered in terms of both unqualified labour and qualified labour because 56.5% of household heads in the mining sector have no diploma at all, 11% have the CFEPD and 15% have as high as the BEPC primary graduation certificate (ENBC 2008). The anticipated job creation results from an expansion of drilling, exploration and exploitation of mineral resources; the workforce in the sector doubled from 2614 to 5209 between 2005 and 2009 according to statistics from the ANPE. Given the new attractiveness of the extractive sector, following investments in this sector, it is expected that labour demand in this sector will rise.

As for indirect effects, they appear through the emergence of activities which are connected upstream and downstream from the mining and petroleum sector. This could be activities to provide services or associated trading activities.

Also, the third transmission channel, no doubt the most important, operates through allocation or reallocation of additional resources needed to develop other sectors of the economy. Other sectors may use labour more intensively and thus a reduction in capital to these sectors negatively impacts job creation. For example, development of the industrial sector (via electricity subsidy) can have positive feedback effects across the entire secondary sector, and thus increase national wealth. Similarly, a subsidy to agriculture can enable

growth of agricultural production and thus reduce the food insecurity of vulnerable populations.

From this research perspective, the underlying reasoning is that development of the mining and petroleum sector generates additional revenues for the government, which enables a number of alternative allocations of resources to stimulate growth and creation of employment. The study thus provides an opportunity, based on a social accounting matrix, to consider the relationship between public policy decisions (e.g., support for agriculture, industrial promotion) and changes in the labour market, and also to deduce the macroeconomic effects. The main research questions addressed are: What is the impact on the labour market due to developing the extractive sector? How will policy measures to allocate public expenditures influence economic development and employment? Which are the most affected household groups? These research questions are appropriate to enable evaluation of pertinence of defined policy actions which are conducive to a harmonious and sustainable development of the country.

II. Literature review

Many scientific works have analyzed links between natural resources and economic development. But, the literature linking the impact of natural resources to the labour market with a calculable general equilibrium (CGE) model are not very explored. The analyses mostly focus on trade liberalization or taxation. In terms of natural resources, very few analyses use a CGE to focus on the impact of prices variations on the economy (McDonald and Van Schoor 2005; Essama-Nssah et al. 2007; Fofana et al. 2007 cited by Maisonnave 2010). Thus, in studying the role of the real exchange rate on the effects of a boom on export supply and import demand, Gregory (1976) emphasizes the fact that opportunities for wages in the industrial sector mean that the expanding sector captures production factors. In the long term this contributes to a weakening of the manufacturing sector due to the resource boom increasing the purchasing power of households through rising wages, which brings about an increase in imports, as well as domestic prices. Similar results were

found by authors such as Sachs and Warner (1995), Gylfason (2001) and Atkinson and Hamilton (2003), also supporting the Dutch disease hypothesis, a.k.a. the resource curse.

Along these lines, Nakoumdé (2007) analyzes the impact of petroleum exploitation on the economy of Chad by use of a calculable general equilibrium model. He shows that it results in a contraction in the manufacturing sector, and the development of a consumption society rather than a production society, with the result of increased dependence on imports, and finally, rural-urban migratory movement.

Using a dynamic calculable general equilibrium model on data from Uganda, Bategeka et al. (2011) analyze the way in which petroleum resources can affect the competitiveness of sectors in traded goods. Their results suggest that there are both winners and losers in different scenarios. And also that the petroleum boom leads to significant currency appreciation in different scenarios; it also shows that demand for non-tradable goods increases, primarily in services. The most important result indicates that investments in agriculture, where most of the population is employed, would lead to major productivity gains and thus significant poverty reduction in rural areas. Similarly, when petroleum resources are used for education and health expenditures, this increases the labour productivity of urban and rural populations. However, the authors estimate that investments in infrastructure can exacerbate Dutch disease effects due to sizeable effects on real exchange rate appreciation and increased demand for non-tradable goods. Such a scenario may very well be balanced by positive externalities in other sectors which benefit from better public investments.

Using a similar approach, Levy (2006) studies the relevance of agricultural policies in Chad to avoid Dutch disease which affects many developing countries with a natural resource boom. She uses a calibrated CGE and studies the impact of use of annual petroleum resources in public investments, notably to finance road and irrigation infrastructure. The model accounts for market integration and intraregional migration processes. The author considers the total supply of labour as fixed, with mobility of workers between three sectors (agricultural, informal and modern) of the economy of Chad using a

migration function à la Harris and Todaro[10]. In each sector, three types of wages are determined: the rural or agricultural wage, the informal wage and the modern wage (industry, commerce, cash cops) which is fixed. The results suggest that improving access to water can reduce the dependence of Chad on food aid and lead to a substantial improvement in the wellbeing of rural households.

This debate is not trivial for Niger. Only public policies for expenditures which are suitable and credible can contribute to directly improving the wellbeing of households and accelerate efforts to reduce poverty, and counter risks generally associated with development of the extractive sector.

The study determines how economic policies enable to ensure that the country draws the best benefit from its resources through an inclusive growth and employment development.

III. Data analyzed and methodology

3.1 The data

3.1.1. Presentation of SAM

The social accounting matrix (SAM) is built based on the 2012 aggregated SAM of the National Institute of Statistics (INS). The disaggregation exercise was done using information provided by the national accounts[11], the supply-use table (SUT) and that from the integrated economic accounts (TIEA) of 2012 and the statistical yearbooks. Other sources such as the 2008 national survey on household budgets and consumption (ENBC) of the INS[12] were

[10] The model of Harris and Todaro (1970) presents a simple general equilibrium model of a dual economy. In this model, the long term equilibrium is characterized by unemployment in the urban sector. The model has been used for many extensions including minimum wage, agglomeration effects, etc.

[11] The national accounts provide the basic information for the national accounting, external trade, and the balance of payment and public finances.

[12] The ENBC survey (National Survey on Household Budget and Consumption) was carried out in 2007/2008. It is a multiple indicators surveys with national scope with a sample size of 4000 households including 2094 in rural areas and 1916 in urban areas. Its main objective was to establish the bases of permanent monitoring and evaluation of the living conditions of households in general, of members of households, and certain indictors of

used to disaggregate the household account.

The 2012 SAM produced from this includes twenty-nine (29) accounts across five (5) categories: factors (2), institutional units (7), sectors of activity (9), goods and services accounts (9), and accumulation accounts (2). It provides information on wages paid to workers, resources allocated by Government to different sectors and trade between these sectors of activity.

Among the sectors of activity, the agricultural sector, which had total production estimated at 1533 billion in 2012, is the largest sector in the economy. This sector includes food crops, grains and cash crops, livestock (about 38,000 head in 2010) and fish production. In terms of value added, the agricultural sectors accounts for 40.8% of total value added. The mining sector includes all extractive activities, the most important of which are uranium, petroleum, gold and coal. According to the data in the SAM, uranium production amounted to 328 billion FCFA and crude oil 128 billion. Extractive activities (42.5%) are the largest within the secondary sector, which accounts for 22% of total value added in the economy. To distribute this value added between extractive subsectors, we resorted to the approach of Wiebelt et al. (2011) and the distribution vector proposed by Nwafor, Diao and Alpuerto (2010) for the 2006 SAM of Nigeria. Much like Nigeria, the Nigerien mining and petroleum sector is isolated from the rest of the economy and only weakly influences labour demand because it is intensive in capital. A large share of the value added is distributed to foreign investors. Government revenues come from direct taxes and the share of production sold on international markets. Overall, the secondary sector is more than 56% informal and includes mining and petroleum industries and manufacturing firms, mostly in metals production and chemicals production.

Finally, services (38.6% of GDP) are distributed between (2) sectors: public and private. The public sector does not produce market goods and involves public services and administration. Private services are comprised of small private units or companies which offer services (transportation, other services).

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satisfaction of basic needs. They also have data on income and expenditures, notably wages, revenues from agricultural activity or others, and consumption expenditures (purchases, auto consumption, aid and gifts) which are essential for the present study.

3.1.2. Analysis of SAM

The distribution of the value added in the SAM is based on the structure of the Nigerien economy as described by the national accounts. It indicates that the secondary sector has a small share of GDP (22%) and employment (23%).

The sectors of activity

In Niger, the 'administration', 'agriculture' and 'construction' sectors turn up as most intensive in their use of labour, while extractive sectors are intensive in capital (Table 2). Moreover, the coefficients of the value added show that the sectors which most intensively use intermediate products are construction, petroleum, other extraction and industry. Overall, the agricultural sector accounts for the largest share of value added (41%), followed by services, whose contribution to the aggregate wages is very large (71%).

Table 2: Some parameters describing the structure of the economy in 2012

Sector	Labour intensity	Capital intensity	Coefficient of VA of production in sector *j*	Contribution of sector to GDP	Contribution of sector to aggregate wages
Agriculture	0.5	0.5	0.86	40.8	5.7
Uranium	0.2	0.8	0.95	10.1	0
Petroleum	0.2	0.8	0.22	2.3	10.9
Other extraction	0.2	0.8	0.60	1.8	0
Industry	0.2	0.8	0.30	3.7	3.9
Electricity	0.5	0.5	0.39	1.2	2.7
Construction	0.4	0.6	0.16	2.7	5.2
Private services	0.2	0.8	0.58	26.0	26.6
Public services	0.6	0.4	0.68	11.4	44.9

Source: Authors' calculations using 2012

The industrial sector, the weak link in the economy, is mainly comprised of extractive industries, considering that other industrial activities are few. These are concentrated around processing of raw materials, in particular agroindustry (23% of industrial activity), chemical products and construction materials. The firms draw most of their income from capital, most of which (87.4%) goes to mining and petroleum firms.

Demand for goods

Domestic demand for goods is comprised of intermediate consumption by firms, final household consumption, public consumption by Government and investment demand. Looking at the structure of the economy, more than 50% of demand for agricultural

products and other extractive products comes from households, while products linked to the petroleum and electricity sectors are most strongly demanded as intermediate consumption. In terms of investments, investment goods are the highest share of demand for goods from industry (47%) and construction (78%).

Table 3: Characteristics of domestic and external demand for goods

Products	Final household consumption	Public consumption	Intermediate consumption of sectors	Margins on production	Gross fixed capital formation	Exports	Imports
AGR	72.3	-	21.5	-	6.3	29.6	9.2
URA	-	-	-	-	-	40.1	-
PTR	-	-	100	-	-	-	-
PPTR	28.5	3.8	67.7	-	0	12.7	2.7
OTH	51.3	0	39.7	-	9	6.3	1.2
IND	34.1	0.6	18.6	0.1	46.6	3.7	55.2
ELEC	7.5	9.7	82.1	0.7	0	-	0.5
CONST	-	22.4	-	-	77.6	-	0.6
SER	42.6	4.2	49.7	0.3	3.3	7.6	30.5
ADM	24.9	50.2	13.9	0.2	10.8	-	0

Source: Authors' calculations using 2012 SAM

In terms of external trade, extractive products comprise the majority (52.8%) of exported goods, while more than 85% of imports are of industrial products and services. In nominal terms, exports are half the size of exports, which is the same as saying that there is a trade deficit.

The institutional units

The institutional units are represented as households, firms, the government and the rest of the world. The information on sources of household income is provided by the 2007/2008 ENBC survey[13]. The socioeconomic group of the household is considered as the main explanatory factor for income. Four categories of households are defined using household head as a proxy for the household: (i) farmers; (ii) public sector employees; (iii) modern private sector employees; and (iv) private informal sector employees[14].

Farmers include all individuals who mainly work land, as well as those occupied with

[13] The underlying assumption here is that the structure of the economy remained unchanged between 2006 and 2012.

[14] It should be noted that the informal sector here includes all non-agricultural unregistered activities. The informal nature is defined by the absence of an accounting approach that is compatible with the existing regulatory regime. Most often, this includes small production units or individual enterprise offering services.

livestock, forest exploitation or fishing. This sector employs the largest share of the population (65% according to ENBC 2008), but is more than 95% informal. Public sector employees include all whose main employer is the government or the parapublic sector. Together with private formal employment, it accounts for a very high share of secure and protected formal employment where the flexibility of hours enables to perform a second job. The employment in this categorization is mostly in the services sectors (25.5%) and agriculture (20%).

Finally, informally employed households (32% of the active population) include all households performing economic activities on their own accounts or with an insecure precarious employment. The activities concerned are in particular in agriculture (68.7%) and commerce and trade (nearly 50%). Table 4 shows that informal employees capture the largest share of total income followed by public employees. Their annual income totalled 66 billion FCFA.

Table 4: Income distribution of the active population by socio-economic group

	Farmers	Public employees	Private employees	Informal	Total
Number of persons	4694647	121215	60195	538971	5415028
Total annual income (billions FCFA)	39.8	61.1	7.3	66.0	174.2

Source: Authors using data from 2008 ENBC

Household income mostly comes from remuneration to factors: labour (65%) and capital (34%) and transfers. Households in the formal sector and informal sector capture 95% of total wage remuneration to the labour force[15] (the other 5% goes taxes to government and transfers to the rest of the world) and 73% of capital remuneration. This can be explained by the predominance of individual and family enterprises in the economy.

Two accounts for firms are specified to discern between mining and petroleum firms and other firms. These two economic entities face different fiscal charges. For mining and petroleum firms, legislation (cf. Annex 5) defines two types of taxes: indirect taxes, the most important of which is the mining royalty of 5.5% of the market value of what is extracted (12.5% of the market price for liquid hydrocarbons and 5% of the market price for gas), and

[15] In fact, in Niger as is the case in other African countries, agricultural households are not paid for their labour, and the system to account for this does not fully capture the contours of this remuneration.

direct taxes. These last include a schedular tax on profits in industry and trade (IC/BIC) at a 40.5% rate (45% in the case of petroleum) on companies in the exploitation phase and income received as dividends by Government[16] or taxes on dividends (16%). Export taxes are nearly non-existent across all firms (0.5% of the value of exports). In considering the structure of expenditures, mining and petroleum firms allocate more than 65% of their resources to investment, as compared to other firms whose pre-tax profits go more to private transfers.

Table 5: Allocation of pre-tax profits by firms

	Firms	Mining firms
Private transfers	47.3	20.9
Direct taxes	21.9	13.9
Investment	30.9	65.2
Total	100	100

Source: Data from 2012 SAM

Overall, taxes on production and taxes on income and profits respectively total 19.5% and 24.3% of fiscal receipts; taxes on imports account for a further 56.2%. In the model, Government transactions are described in six (6) accounts. Its sources of revenues are tax receipts (75.2%), income from capital (18.1%) and transfers from the rest of the world (6.7%) through international aid and interest.

Finally, the SAM that was produced specifies an accumulation account which accounts for savings of institutional agents (resource supply) and gross fixed capital formation (resource use).

3.2 The analytical framework

The analytical tool in this study is based on the PEP 1-1 model (Decaluwé et al. 2013). It is a static model, representative of a small multisectoral country that does not impact world prices. Some modifications were introduced to take into account the mechanisms of transmission of the mining and petroleum boom in the economy and labour market.

[16] For example, the Nigerien state holds 40% of the capital of the Zinder refinery but the company benefits from a 10-year tax exemption as per the applicable tax regime for major projects.

The choice of a CGE as the analytical framework is motivated by its usefulness, as compared to other macroeconomic models, to explicitly represent the potential transmission channels of shocks (Marouani 2002). This type of model describes the mechanisms of resource allocations, including the presence of rigidities of certain variables in the economy. In this research, it enables to work with assumptions about the effects of growth in the capital stock or prices in the mining sector and to determine the effect on the economy.

The basic assumptions of the model are as follows. Total production in the sectors is obtained using fixed proportions of value added and intermediate consumption as is represented in most standard CGE models. The function which determines the level of value added is Cobb-Douglas type and combines composite labour and capital. Producers minimize their production cost of value added and optimal demand for labour is obtained based on cost minimization. We assume that capital is fixed between sectors, reflecting agreement with Levy (2008) that it is difficult in the medium term in Africa to convert capital being used in one sector towards another sector following a policy shock. From the demand side, production is optimal on domestic and external markets following a Cobb-Douglas type technology.

The households draw most of their income from remuneration to production factors and from transfers from Government, the rest of the world and other households. Their total consumption is a fixed share of disposable income. The distribution between different types of goods depends on income and price elasticities. Goods consumed are composite goods, and the relative share of goods imported compared to domestic goods depends on their relative price.

As for Government, most of its resources are from fiscal receipts and transfers from the rest of the world which are exogenous. Government produces non-market services, consumes different goods and pays public servants. Savings of Government is residual and corresponds to the income available after deducting public expenditures and transfers towards Nigerien households. Government distributes public consumption using a Leontief-type fixed proportions technology. We introduce a change to the PEP 1-1 model which

considers public consumption of each good as being a fixed proportion of the volume of public spending, which enables to isolate the price effect:

$$CG_i = ig_i * (G/PIXGVT)$$

where CG_i represents public consumption by product, ig_i the Leontief coefficient and $(G/PIXGVT)$ real public expenditures.

Other changes introduced to the PEP 1-1 model concern the specification of demand for capital, which is generally considered as a fixed share of labour supply, and also introduction of a variable representing the government subsidy to industrial production (TIS(j)).

$$KD_j^k = \frac{{}_j^k * KS_k}{r_j^k}$$

$$TIS_i = ttis_i * \left(PC^{elec} * DI_j^{elec}\right)$$

In terms of external trade, we accept the assumption of a small open country, with world export and import prices thus being exogenous to the model. Domestic demand for each good is a composite of imported and domestic goods. The distribution of demand for this composite good is determined by a constant elasticity of supply (CES) function. The demand for imports and domestic demand are derived using a CES function (Armington assumption, 1969). The trade-off between demand for domestic goods and imports thus depends on the relative prices of these goods and the preferences of consumers.

As for export demand, it is presumed infinite in the mining and petroleum sector and finite in other sectors. Otherwise said, to export more, Nigerien producers must be more competitive, which is not the case of mining and petroleum producers. Mining and petroleum producers are the main exporters of goods, and agricultural products follow. The trade-off between selling production on domestic or external markets is a function of the elasticity of transformation of goods and relative prices. Also, foreign savings and exchange rates are exogenous variables in the model, as are nominal public consumption of Government and transfers.

Finally, the parameters of the LES demand function are drawn from Rampulla et al.

(2007). They are calibrated between 0.47 and 0.9 for income elasticities and -1.5 for the Frisch parameter. These values are chosen to reflect differences between products consumed and the living conditions of households. For example, for all households considered together, agricultural products have a low income elasticity (0.47) compared to others.

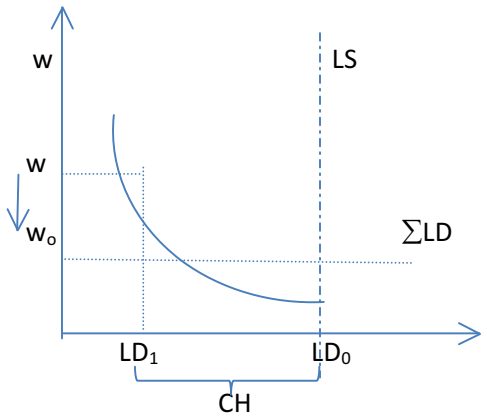
3.3 Modelling the labour market

In order to capture the impact of shocks on employment, the labour market is segmented into four types of labour: agricultural, public, mining and non-mining private work. Agricultural work is only accessible to farmers and mining work to individuals working in the extractive sectors (uranium, petroleum or others). Private employment includes all individuals linked to the industrial, construction, electricity and private services sectors, while public employment includes employees in the public administration.

On all markets, wages are assumed fixed such that equilibrium is determined by the volume of employment. This assumption is introduced to be consistent with the characteristics[17] of the Nigerien labour market, but in particular to show the existence of a surplus of unemployed workers, educated or otherwise, waiting to join the labour market. In Niger, the unemployment rate is evaluated at about 16% in 2005 and underemployment is also very high. Theoretically, that suggests that at the wage rate (w) prevailing on markets, the sum of labour demand (LD_1) is not equal to the labour supply (LS) and the residual is the number of unemployed ($CH= LS-LD_1$).

[17] The modern market in Niger and that of public servants are characterized by high wage rigidity due to regulations and collective agreements.

Figure 2: Labour supply and demand



Source: Authors

Wage rigidity prevents the decline of the wage rate from *w* to w_o, the level at full employment.

The households receive transfers from the Government and the rest of the world and income from factors (labour and capital). These sources of income go to consumption of goods and services, taxation and savings. Household demand is represented by a linear expenditure system (LES). These functions are derived by maximizing a Stone-Geary utility function.

IV. Results of effects of mining and petroleum boom, associated with some economic policy measures

Two groups of simulations are implemented in this study. The first highlights the effects of mining and petroleum development and the second includes a set of scenarios of how the additional resources are used, i.e., different policy options for public expenditures.

In the first group, three scenarios are specified. The first considers the reference scenario as representing a situation in which the stock of capital in the mining or petroleum sector increases. This scenario is followed by two others which account for the situation of prices on the world market.

The scenarios are implemented separately for uranium and petroleum due to their structural differences. Uranium is extracted from underground and sold in raw form on the international market, since there is no domestic processing capacity. This is not the case for

petroleum where refining capacity exists, in the east of the country (Zinder). The petroleum sector impacts the rest of the economy through intermediate consumption, employment and capital income.

The three scenarios for use of mining and petroleum resources analyze alternative options for conceivable policies that the government could take. The weakness of the industrial sector and the weak development potential of the agricultural sector which drives the economy justify the need to create conditions to develop these two sectors. The Economic and Social Development Plan (PDES)[18] highlights, among other things, that these two sectors are priority areas for intervention. Niger experiences problems with food security, which can be explained by the rudimentary nature of cultivation practices, reduced access to equipment and inputs and in particular the high dependence of agriculture on climactic variations. The challenge for the government is to find the ways and means to increase agricultural production and to ensure food self-sufficiency. Several reports from the Food and Agriculture Organisation (FAO) and the International Food Policy Research Institute (IFPRI) confirm the urgency of increasing agricultural production in Sub-Saharan Africa. The problematic involves various vulnerabilities in Niger where the use of fertilizers and phytosanitary products is limited.

We thus consider a situation where the government subsidizes the agricultural sector via taxes (subsidy totalling 500 times the amount of taxes levied on agriculture in the period up to 2017, or 2.5% of agricultural value added) and another where the government instead decides to support the industrial sector by subsidizing electricity (3% of electricity consumption in the sector). The two scenarios are compared to a reference scenario which reflects an increase in public expenditures at the initially unchanged structure. The subsidies to agriculture that we assume are those envisaged under the 3N initiative and include provisions for farmers to have lower cost access to agricultural inputs (pesticides) and equipment (tractors, small tools). As for the electricity subsidy, it is proportional to the

[18] This plan highlights opportunities and perspectives relating to structural transformation of the economy which may lead to rational and sustainable exploitation of extractive resources, in accordance with Article 153 of the Constitution, which pronounces the choice of the government to prioritize reinvesting mining and petroleum rents into diversification of the economy. This amounts to financing structuring investments in agriculture and livestock, in support of the 3N initiative with a view to food security.

consumption in the industrial sector (3%), which can help to reduce production costs in industry and thus increase their competitiveness.

The interest to analyze different policy options lies in the possibilities to emphasize the most efficient choices and their effects on sectoral and aggregate economic variables. In the analyses, we mostly focus on variables linked to employment, government revenues and household income.

4.1 The effects of an expansion in the stock of capital in the mining and petroleum sector on economic variables and employment

We analyze these effects by assuming a context of increasing capital stocks in the extractive sector. The growth assumed here (82% for uranium and 62% for petroleum, totalling 2509.6 billion FCFA) corresponds with the expected change in foreign direct investment[19] over the 2012-2017 period according to the estimates of the Central Bank of West African States. These estimates are based on major future investment projects, for example the upcoming exploitation of the Imourarem mine with a capacity of 5000 tonnes of uranium per year and construction of a pipeline linking the Agadem oil field (in the east of the country) with Chad, where an already existing pipeline will take the Nigerien oil to the Cameroonian coast.

In the reference scenario we assume that the capital stock increases by 82% in uranium and 62% in petroleum. The simulation results show that this shock has a direct effect of accelerating production in the extractive sector by inducing an increase in labour demand (82% in uranium and 59.7% in petroleum). The effect is less pronounced in petroleum due to substitution of capital for workers[20]. Given that uranium is not sold on the domestic market, only a change in petroleum production will affect domestic prices. These

[19] In 2012, public and private gross fixed capital formation respectively grew by 15% and 20% in part due to purchases of equipment on the part of Areva and also infrastructure works undertaken by the government in the rural sector, roads and social sectors.

[20] For example, construction of the pipeline will facilitate transportation of petroleum by sidestepping road transportations activities.

fall by 27%, which is not only beneficial for households, but also for domestic producers. On the external market, exports of extractive products rise.

Regarding the indirect effects, they stem from the increase in aggregate demand which follows increased household income. As we might expect, the household group which draws the most benefit are formal private sector households (+15.3% and +7.8% respectively for uranium and petroleum scenarios) which benefit from dividends from mining and petroleum firms. As for the shock in uranium production, we should also mention agricultural households (14.3%) and informal households (11.3%) through income from factors, while in the case of petroleum, the largest positive effects are for public households (9.2%).

On the market for goods, the increase in aggregate demand causes upwards pressure on domestic prices, thus affecting the competitiveness of domestic products on both domestic and external markets. The largest increases are in the agricultural and industrial sectors, and for the case of petroleum are in the electricity and services sectors. The additional demand is satisfied more by imports which rise (66% and 11% respectively for the agricultural and industrial sectors), while exports decline in all non-extractive sectors. This result thus confirms the thesis of Carbonnier (2007) according to which the increase in uranium exports leads to a loss of competitiveness in other sectors, leading to bankruptcies and job losses.

Domestically, the increase in production enables to create more employment in all sectors where production increases, with the changes ranging between 1.8% and 19.5% for the uranium shock and between 0.5% and 35.6% for petroleum. The observed effects are the combination of a price effect and a volume effect due to growth of production induced by the increase in the volume of consumption. The shock on uranium has stronger positive impacts on the agricultural, services and construction sectors (and on electricity, construction, services and administration for the case of petroleum). The decline in labour demand (-11.7%) observed in the industrial sector is due to two effects: the first results from the loss of competitiveness that the sector faces as mentioned above, which leads to a decline in production (-3.6%) and thus a decline in labour demand. The second effect results from a reallocation of demand for labour toward sectors which generate more productivity,

mainly construction, services and public administration. These sectors are in fact those most linked to mining and petroleum development. In the case of petroleum, the low price of oil benefits the industrial sector, thereby improving its competitiveness on the market. At all levels, the increase in employees is covered by the surplus of workers waiting to be hired.

Overall, the increase in the capital stock in the extractive sector increases government revenues (12.5% for uranium case and 6.4% for petroleum case) and GDP is 22.5% higher (6% for petroleum), which increases employment in all sectors other than industry.

In the scenarios that follow we build from the first simulation with two simulations representing shocks to world prices: world prices rise by 10% in one and decline by 2% in the other, still in a context of an expanded capital stock. We find that the increase in world prices exacerbates the effects on economic variables. The variations in labour demand are larger in the sector which experiences the shock, but there are also effects in other sectors through indirect effects. The returns for the Government revenues are also larger (14.8% and 6.7%). However, this situation could be quickly reversed if world export prices are not favourable. The simulation results show that while a 10% increase in international uranium prices leads to 7.6% higher GDP (from +22.8% to +30.4% instead), a small change in prices in the opposite direction (-2%) causes the economic growth to be 1.5 percentage points lower (22.8% to 21.3%). This result highlights the role of international prices in policy decisions in the extractive sector.

4.2 The effects of policy choices in terms of use of resources generated by the mining and petroleum sector on economic variables and employment

The goal of this analysis is to investigate the effects of policy decisions relating to the use of additional mining and petroleum resources. We consider two alternative options that we compare with a base simulation in which the Government distributes the additional resources among all the sectors.

The simulations implemented here are closer to economic reality because the resources generated by governments are not generally stocked but instead are used. In the

model, government savings are fixed, while government spending is endogenous. Public consumption is calibrated as a fixed proportion of overall public spending, which enables to isolate the price effect on the investment. The shock considered is an 82% increase in the capital stock in uranium production.

The results show that the use of additional resources by the Government would have the effect of increasing the volume of public consumption (15.2%) while public savings remains constant. The increase in public consumption compared to the first simulation has the direct effect of boosting the demand for goods, especially in sectors where this consumption is larger (construction, services and public administration). On the labour market, we observe a reallocation of labour demand towards expanding sectors, especially the public sector. The incomes of public households increase strongly (+13.1%) to the detriment of the industrial (-7%) and construction (-3%) sectors. The total effect is approximately 20% higher employment by 2017. This 13.1% increase in incomes of public households has spillover effects on other sectors through the consumption of goods. The final effect is a 25.1% increase in GDP (a 2.3 percent increase compared to the first simulation) and an increase in incomes of agricultural sector and formal private sector households through increased labour demand (electricity, agriculture and services sectors). Moreover, the decline in labour demand in the industrial sector is larger (-18.3%).

The two other simulations that follow highlight other policy options which enable use of resources generated by natural resources. These involve measures indicated under the 3N initiative (Nigeriens nourishing Nigeriens) as the mechanisms to support agricultural production through facilities and advantages offered to producers through a policy to support the industrial sector by reducing charges for their electricity consumption. The shocks defined are a) a subsidy to agricultural production which is 500 times larger than taxes on agriculture up to 2017, and b) an electricity subsidy corresponding to 3% of electricity consumed in the sector. We suppose that public and private enterprises can reduce their production cost when the Government introduces an electricity subsidy proportional to their level of consumption. Implementation of these two policy measures modifies the effects observed in the preceding scenario.

In the case of a subsidy to agricultural producers, which is about 2.5% of agricultural

value added, the effects of increased aggregate demand are more pronounced in the agricultural sector. The outcome is an approximately 10% increase in production in this sector. This leads to positive gains for agricultural households whose incomes rise by 18%.

The fact that production in the industrial sector declines can be explained by reduced labour demand (-20.8%) due to reallocation towards the expanding sector. On the labour market, labour demand becomes larger in the agricultural (+4.9%) and administration (+4.8%) sectors, while it decline in industry (-10.3%) and construction (-7.2%). The net effect on employment is an overall increase of 20.7% as opposed to 16.9% in the first simulation. As we might expect, the households which benefit the most are agricultural households and public households. However, at the macroeconomic level, the overall effect on GDP is only slightly higher than in the situation where the Government blindly injects additional resources across the economy (2.2% as opposed to 2%).

The situation is different in the case of an action to promote the industrial sector, with GDP being about 7% higher. Also, the spillover effects on other sectors are larger. Labour demand increases in almost all sectors, especially industry, electricity, services and administration. The net total effect is employment creation in the range of 26%. This result can be explained by positive effects of the decline in prices of industrial products. The benefits to producers enable them to increase their supply and thus reduce the price of goods. The public expenditures of the Government are higher (+19.3%) and all household groups gain, especially formal private and public sector households.

V. Conclusions and policy implications

The simulations implemented in the present research enable to draw several lessons.

1. Any decision to expand the stock of capital in the mining and petroleum sector should be compared against an analysis of world export prices. The preceding analyses show that the positive effects flowing from such an expansion can be negated if world export prices are not favourable.

2. It is possible to stimulate the economy with adequate internal economic policies. The results of the study confirm the thesis according to which expansion of the extractive sector does not necessarily lead to Dutch disease if the government implements policies that are needed in the appropriate sectors.
3. The 3% of consumption subsidy to electricity used in the electricity sector generates a positive impact on labour demand in all sectors and GDP growth in general.
4. In an absence of targeted policies, public households are by far the most favoured, while in the case of the subsidy to electricity consumption in the industrial sector, all household groups benefit.

The results obtained are pertinent and may help with policy decisions by the Nigerien government. The subsidy to agricultural producers and the electricity subsidy contribute to relative growth in labour demand. The subsidy to agricultural inputs and equipment is already in place under the 3N initiative, but merits further diffusion. In time, this will contribute to reducing food insecurity of vulnerable populations.

Finally, we should be explicit that the simulations considered here are not exhaustive. Other pertinent analyses covering the effects of allocating mining and petroleum resources into infrastructure are conceivable in the Nigerien context. But since they are more suitably studied in a dynamic context, that will provide direction for future research. A dynamic CGE will enable us to account for the sequence of impacts of a given policy and also to understand the speed of adjustments.

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Annexes

Annex 1

Private and parapublic sectors – Total wage bills by sector of economic activity

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Agriculture, hunting, sylviculture and fishing	1 400	1 623	1 438	1 154	1 166	1 170	1 268	1 506	1456	1855
Extractive industries	**2 381**	**2 157**	**2 285**	**2 545**	**2 661**	**2 674**	**4 281**	**4 860**	**5109**	**5209**
Manufacturing industries	2 702	2 546	3 069	3 962	3 431	3 434	4 273	5 235	5400	5324
Electricity, water and gas	2 890	2 583	3 789	3 566	5 883	5 885	6 442	6 486	3863	6995
Building and public works	3 239	4 284	5 232	4 215	4 321	4 423	5 068	5 453	8979	6711
Commerce, restaurants, hotels	4 895	4 621	5 904	6 690	6 724	7 212	8 039	8 740	4056	9744
Transports, warehousing, communications	4 844	5 243	5 338	6 853	6 598	6 614	7 924	9 289	7355	10112
Banks, insurance, real estate, business services	1 518	1 594	2 198	2 845	3 228	3 232	3 254	3 989	3551	4783
Social services	6 763	6 489	7 707	12 425	12 894	12930	13461	17 656	21284	19875
Total	30 632	34 194	36 962	44 255	46 906	47 574	54 010	63 214	61053	70608

Source: National Agency for the Promotion of Employment (ANPE)

Annex 2

Production and exports of uranium, Niger (2000-2012)

Year	Production (tonnes)	Exports (tonnes)	Exports (billions FCFA)	In % of total export receipts	In % of budget receipts	In % GDP at current prices
2000	2898	2950	64.0	45.9	58.1	5.4
2005	3093	3400	78.5	47.7	41.5	4.5
2006	3434	3160	79.6	55.3	32.2	4.2
2007	3153	3415	136.6	63.8	44.2	6.6
2008	3072	3181	201.0	63.5	45.5	8.4
2009	3245	3200	195.1	63.6	53.6	7.8
2010	3939	3939	227.9	61.0	59.1	9.0
2011	4264	4499	317.5	74.8	61.7	10.5
2012	4623	4623	338.3	62.5	62.2	9.8

Source: 2010a Statistical yearbook, National Institute of Statistics; 2013 national accounts

Annex 3

Contribution of mining and petroleum sector to forecasted government revenues (billions FCFA)

	2012	2013	2014	2015	2016	2017
Natural resources revenues	129.4	162.6	188.4	237.3	257.7	
Uranium	70.4					
Petroleum	59.0	71.5	72.5	73.6	82.5	
Total revenues	654.1	693.0	771.0	870.0	963.2	
% of natural resources in government budget	19.8	23.4	24.4	27.2	26.8	
Foreign direct investment (FDI) in billions FCFA (a)	428.4	315.3	442.4	329.7	495.3	498.5

Source: IMF 2012 and Nigerien authorities. (a) BCEAO. Data from conversions done with IMF Services and data directly compiled in mbp format, using the new BPT application.

Annex 4: Other important statistics

Contribution of uranium sector to national economy

	Contribution to budget revenues		Contributions to exports		Contribution of mining and petroleum sector to GDP	
	Millions FCFA	**%**	**Millions FCFA**	**%**	**Millions FCFA**	**%**
2006	12369	5.00		69	40440	2.1
2007	88475	28.61		78.76	90775	4.42
2008	44016	9.96	198164	62.6	144399	5.97
2009	48517	13.37	195121	64.0	162627	6.38
2010	54811	14.21	227964	61.0	203462	7.2
2011	53264	10.4	317464	74.8	226029	7.5
2012	70176	12.9	338250	62.5	372830	10.8

Source: Authors' calculations from data in the Statistical yearbook

Distribution of value added in the petroleum sector

	Crude oil	Refined oil
Intermediate inputs	7.77	78.62
		Value-added
Labour	0.25	0.25
Capital	91.98	21.13
Total	100	100

Source: Nwafor, Diao and Alpuerto (2010)

Annex 5: Mining and petroleum legislation in Niger

In Niger, the legal and regulatory framework of the mining and petroleum sector is governed by three texts of fundamental laws:

- Law n°2006-26 of 09 August 2006 on modification of order n°93-16 of 02 March 1993 about the mining law complemented by order n°99-48 of 5 November 1999 and its implementing decree n°2006-265/PRN of 18 August 2006;
- Law n°2008-30 of 03 July 2008 grants special advantages for investment in major mining projects and its application decree n°2009-06/PRN of 05 January 2009;
- and Law n°2007-01 of 31 January 2007 on the *Code Pétrolier* and its application decree n°2007-082/PRN/MME of 28 March 2007).

These laws clearly enunciate the process by which exploration titles and mining rights are attributed and clarify the responsibilities of companies and the government concerning mining titles, and including tax obligations, environmental protection and safeguarding the health and safety of workers. The revised mining Law in 2006 introduced specifications related to the governance of extractive industries, sharing of the rent between central authorities and local communities, and integrating mining operations into the socio-economic environment. Among these specifications, we can mention the clause requiring 15% of mining receipts to go to development of communities in regions concerned by extraction activities and the reduced duration of validity of a research permit from 20 years to 5 years.

Note that with regard to the specifications, the attribution of an exploitation permit by the government gives it a right to a free share in the mining exploitation project up to 10% of capital, but its stake cannot exceed 40%. All operators are also subject to an annual royalty at a rate of 5.5% of the market value of the extracted production in the case of uranium and 12.5% and 5% respectively for the market price of liquid hydrocarbons and the market price of gas. Mining and petroleum royalties are the largest component in indirect taxes. In addition to this tax, mining and petroleum companies have to submit a share of dividends and other distributions to shareholders to a 16% rate and there is also the tax on commercial and industrial profits (BIC) at a 40.5% rate (45% in the case of petroleum) for

companies in the exploitation phase, except in the case of holders of exploitation permits where an exemption period is agreed to.

However, in the exploration phase as well as in the exploitation phase, holders of mining or petroleum titles benefit from non-negligible tax and tariff advantages. These include, among others: (i) exemption from payment of tariffs and taxes for entry of materials and equipment needed for research and exploitation activities if there is not availability on equivalent conditions in Niger, (ii) exemption from schedular taxes on profits in industry and trade, during the five (5) first years for a large mine and the two (2) first years for a small mine, after the first year of trade shipments and (iii) exemption of tariffs and taxes on exit including a statistical fee. This last specification is not applicable in the case of petroleum where a single exit tax (*droit unique de sortie*) is required of the concessionary, equal to 1% of the market price for liquid hydrocarbons and 0.5% of the market price for gas.

Annex 6: Simulation results

			Uranium (82%)			Petroleum (62%)			Uranium			Petroleum	
			Sim1	Sim2	Sim3	Sim1	Sim2	Sim3	Sim4	Sim5 (500*ttip)	Sim 6 (3%)	Sim5	Sim6
Effects on production													
Labour demand (LD)	agr	Agriculture	17.9	25.5	16.3	3.3	4.3	3.0	19.5	23.7	20.4	-18.8	4.9
	ura	Uranium	82.0	95.2	79.3	0.0	0.0	0.0	82.0	82.0	82.0	17.7	0.0
	ptr	Crude oil	1.7	1.9	1.7	-1.6	6.9	-4.4	1.8	1.5	2.9	95.5	-0.5
	pptr	Petroleum products	1.9	2.1	1.9	-4.8	3.7	-7.7	2.0	1.7	3.2	101.3	-3.8
	autr	Other extraction	2.4	2.8	2.3	0.5	0.5	0.5	2.1	2.2	3.0	34.8	1.3
	ind	Industry	-11.7	-20.5	-9.8	4.3	3.1	4.7	-18.3	-20.8	174.3	251.5	208.5
	elec	Electricity	2.6	2.4	2.7	35.6	35.8	35.5	7.2	4.4	12.6	103.9	44.5
	const	Construction	12.8	14.7	12.4	12.4	12.3	12.4	8.5	4.7	9.1	83.6	10.6
	ser	Services	9.8	8.8	10.0	22.4	22.2	22.5	11.5	9.1	17.8	184.3	30.6
	adm	Administration	5.4	5.8	5.4	9.2	9.3	9.2	19.2	10.5	22.9	84.5	20.9
Production (XS)	agr	Agriculture	8.5	10.8	7.2	1.6	2.0	1.4	8.5	10.1	8.8	-10.2	2.3
	ura	Uranium	82.0	84.3	81.5	0.0	0.0	0.0	82.0	82.0	82.0	2.9	0.0
	ptr	Crude oil	0.0	0.0	0.0	59.7	60.3	59.5	0.0	0.0	0.0	62.4	59.8
	pptr	Petroleum products	0.0	0.0	0.0	59.7	60.3	59.5	0.0	0.0	0.0	62.4	59.8
	autr	Other extraction	0.4	0.5	0.4	0.1	0.1	0.1	0.4	0.4	0.5	5.2	0.2
	ind	Industry	-3.6	-4.1	-1.9	0.8	0.6	0.9	-3.6	-4.2	24.5	32.6	28.2
	elec	Electricity	3.2	1.1	1.2	15.1	15.2	15.1	3.2	1.9	5.5	40.8	18.7
	const	Construction	3.2	5.4	4.6	4.6	4.5	4.6	3.2	1.8	3.4	25.9	3.9
	ser	Services	2.1	1.6	1.8	4.0	4.0	4.0	2.1	1.7	3.2	27.1	5.4
	adm	Administration	10.6	3.2	3.0	5.2	5.2	5.1	10.6	5.9	12.6	44.5	11.5
Effects on trade													
Exports (EX)	agr	Agriculture	-10.5	-14.5	-9.6	-2.1	-2.7	-2.0	-11.3	-12.0	-11.8	34.2	-3.1
	ura	Uranium	82.0	84.3	81.5	0.0	0.0	0.0	82.0	82.0	82.0	2.9	0.0
	pptr	Petroleum products	-6.6	-7.1	-6.4	128.3	130.9	127.4	-7.6	-6.4	-9.3	103.5	125.4
	autr	Other extraction	-2.7	-3.1	-2.7	-1.4	-1.5	-1.4	-2.8	-2.6	-3.5	-2.3	-2.2
	ind	Industry	-5.9	-8.0	-5.5	-2.0	-2.2	-1.9	-6.2	-6.6	18.7	22.0	23.0
	ser	Services	-3.4	-3.7	-3.3	-2.6	-2.7	-2.6	-3.9	-3.5	-4.9	10.3	-3.9
Imports (IM)	agr	Agriculture	66.3	102.4	59.4	10.9	14.1	9.9	73.5	83.5	77.5	-71.0	16.1
	pptr	Petroleum products	13.1	14.3	12.9	-32.4	-31.3	-32.8	15.3	12.9	19.3	-0.1	-29.5
	autr	Other extraction	14.4	16.4	14.0	6.8	7.0	6.7	14.3	13.8	18.4	34.9	10.9
	ind	Industry	10.9	12.4	10.6	7.0	7.2	6.9	8.3	8.1	4.6	12.1	2.1
	elec	Electricity	5.4	5.4	5.3	25.2	25.6	25.1	9.9	6.9	15.1	5.5	33.4
	const	Construction	13.5	15.1	13.1	2.5	2.8	2.4	11.7	8.5	13.4	-8.7	3.0
	ser	Services	11.5	11.9	11.4	14.9	15	14.8	13.4	11.5	18.6	34.6	21.5
Effects on households													
Household income	hagr	Agr. households	14.3	18.8	13.4	3.3	3.9	3.1	16.2	18.0	17.0	-4.7	5.0
	hspu	Public employees	5.4	5.8	5.4	9.2	9.3	9.2	19.2	10.5	22.9	84.5	20.9
	hspr	Private employees	15.3	16.4	15.1	7.8	7.8	7.8	17.3	15.4	24.6	62.5	17.0

	hinf	Informal households	11.3	11.4	11.3	3.9	3.8	3.9		11.3	11.0	13.7	19.0	6.4
Household consumption	hagr	Agr. households	14.3	18.8	13.4	3.3	3.9	3.1		16.2	18.0	17.0	-4.7	5.0
	hspu	Public employees	5.4	5.8	5.4	9.2	9.3	9.2		19.2	10.5	22.9	84.5	20.9
	hspr	Private employees	15.3	16.4	15.1	7.8	7.8	7.8		17.3	15.4	24.6	62.5	17.0
	hinf	Informal households	11.3	11.4	11.3	3.9	3.8	3.9		11.3	11.0	13.7	19.0	6.4
Effects on economy														
GDP		Gross production	22.8	30.4	21.3	6	6.8	5.7		25.1	25.5	31.1	34.5	13.3
GI		Government income	12.5	14.8	12	6.4	6.7	6.3		12.5	6.3	14.1	13.1	8.2
G		Public expenditures	2.5	2.7	2.4	1.1	1.1	1.0		19.4	9.3	22.2	23.3	13.2
Effects on prices														
Price (P)	agr	Agriculture	20.4	29.7	18.4	3.7	4.8	3.4		22.3	24.5	23.3	-36.0	5.5
	ura	Uranium	0.0	10.0	-2.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	ptr	Crude oil	3.1	3.4	3.1	-10.5	-9.5	-10.8		3.7	3.1	4.4	-10.3	-9.9
	pptr	Petroleum products	3.5	3.8	3.4	-16.4	-15.0	-16.8		4.0	3.4	5.1	-10.7	-15.8
	autr	Other extraction	3.0	3.4	3.0	1.5	1.5	1.5		3.0	2.9	3.9	5.0	2.4
	ind	Industry	6.2	7.9	5.8	2.7	3.0	2.7		5.8	6.0	-8.7	-8.7	-11.1
	elec	Electricity	2.0	2.1	2.0	4.3	4.4	4.2		3.2	2.4	4.4	-13.4	6.0
	const	Construction	4.1	4.5	4.0	-1.0	-0.8	-1.1		4.0	3.3	4.7	-14.8	-0.5
	ser	Service	4.4	4.7	4.3	4.7	4.8	4.7		5.1	4.4	6.8	2.2	6.9
	adm	Administration	1.6	1.8	1.6	2.0	2.0	2.0		3.6	2.4	4.0	-13.2	3.5

Source: Authors

*Sim1: 82% increase in capital stock in uranium and 62% in petroleum ; Sim2 : Sim1 + 10% increase in world prices for uranium and petroleum ; Sim3 : Sim1 + 10% decline in world prices for uranium and 2% for petroleum; Sim4: Sim1 + use of additional resources following a policy of no changed structure; Sim5: Sim1 + agriculture subsidy policy; Sim6: Sim4 + policy of electricity subsidy in the industrial sector (3% of electricity consumption).

For the first group of simulations, the percentages in the table represent changes with respect to the initial situation without an impact, and the 2nd group of simulations are compared to the 1st group.

Equations

PRODUCTION

1. $VA_j = \ _j XST_j$
2. $CI_j = io_j XST_j$
3. $VA_j = \ _j B_j^{VA}\left[\left(\ _j^{VA} LDC_j \ \ ^{VA}_j\right) + \left(1 \quad _j^{VA}\right) KDC_j \ \ ^{VA}_j\right]^{-\frac{1}{LD}_j}$
4. $LDC_j = \ \frac{^{VA}_j}{1 \quad ^{VA}_j} \frac{RC_j}{WC_j} \quad ^{VA}_j \ KDC_j$
5. $LDC_j = B_j^{LD} \quad _l \quad ^{LD}_{l,j} LD_{l,j} \ ^{LD}_j \quad ^{-\frac{1}{LD}}_j$
6. $LD_{l,j} = \ \frac{^{LD}_{l,j} WC_j}{WTI_{l,j}} \quad ^{LD}_j \left(B_j^{LD}\right) \ ^{LD}_j \ ^{1} LDC_j$
7. $KDC_j = B_j^{KD} \quad _k \quad ^{KD}_{k,j} KD_{k,j} \ ^{KD}_j \quad ^{-\frac{1}{KD}}_j$
8. $KD_{k,j} = \ \frac{^{KD}_{k,j} RC_j}{RTI_{k,j}} \quad ^{KD}_j \left(B_j^{KD}\right) \ ^{KD}_j \ ^{1} KDC_j$
9. $DI_{i,j} = aij_{i,j} CI_j$

INCOME AND SAVINGS

Households

10. $Yh_h = YHL_h + YHK_h + YHTR_h$
11. $YHL_h = \quad _l \quad ^{WL}_{h,l} \ W_l \quad _j \quad LD_{l,j} + ldrow_l$
12. $YHK_h = \quad _k \quad ^{RK}_{h,k} \quad _j \quad R_{k,j} KD_{k,j}$
13. $YHTR_h = \quad _{ag} \quad TR_{h,ag}$
14. $YDH_h = YH_h \quad TDH_h \quad TR_{gvt,h}$
15. $CTH_h = YDH_h \quad SH_h \quad _{agng} \quad TR_{agng,h}$
16. $SH_h = PIXCON \quad sh0_h + sh1_h YDH_h$

Firms

17. $YF_f = YFK_f + YFTR_f$
18. $YFK_f = \quad _k \quad ^{RK}_{f,k} \quad _j \quad R_{k,j} KD_{k,j}$
19. $YFTR_f = \quad _{ag} \quad TR_{f,ag}$
20. $YDF_f = YF_f \quad TDF_f$
21. $SF_f = YDF_f \quad _{ag} \quad TR_{ag,f}$

Government

22. $YG = YGK + TDHT + YTDFT + TDPRODN + TPRCST + YGTR$
23. $YGK = \quad _k \quad ^{RK}_{gvt,k} \quad _j \quad R_{k,j} KD_{k,j}$
24. $TDHT_f = \quad _h \quad TDH_h$
25. $TDFT_f = \quad _f \quad TDF_h$

26. $TDPRODN = TIWT + TIKT + TIPT$
27. $TIWT = \sum_{l,j} TIW_{l,j}$
28. $TIKT = \sum_{k,j} TIK_{k,j}$
29. $TIPT = \sum_{j} TIP_{j}$
30. $TPRCTS = TICT + TIMT + TIXT$
31. $TICT = \sum_{i} TIC_{i}$
32. $TIMT = \sum_{i} TIM_{i}$
33. $TIXT = \sum_{i} TIX_{i}$
34. $YGTR = \sum_{agng} TR_{gvt,agng}$
35. $TDH_{h} = PIXCON\ \ ttdh0_{h} + ttdh1_{h} YH_{h}$
36. $TDF_{f} = PIXCON\ \ ttdf0_{f} + ttdh1_{f} YFK_{f}$
37. $TIW_{l,j} = ttiw_{l,j} W_{l} LD_{l,j}$
38. $TIK_{k,j} = ttik_{k,j} R_{k,j} KD_{k,j}$
39. $TIP_{j} = ttip_{j} PP_{j} XST_{j}$
40. $TIC_{i} = ttic_{i}\ \ PL_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i}\ \ DD_{i} + (1 + ttim_{i}) PWM_{i} e + \sum_{ij} PC_{ij} tmrg_{ij,i}\ \ IM_{i}$
41. $TIM_{i} = ttim_{i} PWM_{i} eIM_{i}$
42. $TIX_{i} = ttix_{i}\ \ PE_{i} + \sum_{ij} PC_{ij} tmrg^{X}_{ij,i}\ \ * \sum_{j} EX^{i}_{j}$
43. $SG = YG \sum_{agng} TR_{agng,gvt}\ \ G$

Rest of world

44. $YROW = e \sum_{i} PWM_{i} IM_{i} + \sum_{k} {}^{RK}_{row,k} \sum_{j} R_{k,j} KD_{k,j} + \sum_{l} {}^{WL}_{row,l} * w_{l} * \sum_{j} LD^{l}_{j} + ldrow_{l} + \sum_{agd} TR_{row,agd}$
45. $SROW = YROW \sum_{i} PE^{FOB}_{i} EXD_{i} \sum_{agd} TR_{agd,row} \sum_{l} ldrow_{l}$
46. $SROW = CAB$

Transfers

47. $TR_{agng,h} = {}^{TR}_{agng,h} YDH_{h}$
48. $TR_{gvt,h} = PIXCON\ \ tr0_{h} + tr1_{h} YH_{h}$
49. $TR_{ag,f} = {}^{TR}_{ag,f} YDF_{f}$
50. $TR_{agng,gvt} = PIXCON\ \ TR^{0}_{agng,gvt}$
51. $TR_{agd,row} = PIXCON\ \ TR^{0}_{agd,row}$

Demand

52. $PC_{i} C_{i,h} = PC_{i} C^{MIN}_{i,h} + {}^{LES}_{i,h}\ \ CTH_{h} \sum_{ij} PC_{ij} C^{MIN}_{ij,h}$
53. $GFCF = IT \sum_{i} PC_{i} VSTK_{i}$
54. $PC_{i} INV_{i} = {}^{INV}_{i} GFCF$
55. $PC_{i} CG_{i} = {}^{GVT}_{i} G$
56. $DIT_{i} = \sum_{i} DI_{i,j}$

57. $$MRGN_i = \sum_{ij} tmrg_{i,ij} DD_{ij} + \sum_{ij} tmrg_{i,ij} IM_{ij} + \sum_{j} \sum_{ij} tmrg^{X}_{i,ij} EX^{j}_{ij}$$

SUPPLY OF PRODUCTS AND INTERNATIONAL TRADE

58. $$XST_j = B^{XT}_j \left(\sum_i {}^{XT}_{j,i} XS^{\rho^{XT}_j}_{j,i} \right)^{\frac{1}{\rho^{XT}_j}}$$

59. $$XS_{j,i} = \frac{XST_j}{\left(B^{XT}_j\right)^{1+\rho^{XT}_j}} \left(\frac{P_{j,i}}{{}^{XT}_{j,i} PT_j} \right)^{\rho^{XT}_j}$$

60. $$XS_{j,i} = B^{X}_{j,i} \left[{}^{X}_{j,i} EX_{j,i}^{\rho^{X}_{j,i}} + (1 - {}^{X}_{j,i}) DS_{j,i}^{\rho^{X}_{j,i}} \right]^{\frac{1}{\rho^{X}_j}}$$

61. $$EX_{j,i} = \left(\frac{1 - {}^{X}_{j,i}}{{}^{X}_{j,i}} \frac{PE_i}{PL_i} \right)^{\rho^{X}_{j,i}} DS_{j,i}$$

62. $$EXD_{i2} = EXD^{O}_{i2} \left(\frac{ePWX_{i2}}{PE^{FOB}_{i2}} \right)^{\rho^{XD}_{i2}}$$

63. $$Q_i = B^{M}_i \left[{}^{M}_i IM_i^{\rho^{M}_i} + (1 - {}^{M}_i) DD_i^{\rho^{M}_i} \right]^{\frac{1}{\rho^{M}_i}}$$

64. $$IM_i = \left(\frac{{}^{M}_i}{1 - {}^{M}_i} \frac{PD_i}{PM_i} \right)^{\rho^{M}_i} DD_i$$

PRICES

Production

65. $$PP_j = \frac{PVA_j VA_j + PCI_j CI_j}{XST_j}$$

66. $$PT_j = (1 + ttip_j) PP_j$$

67. $$PCI_j = \frac{\sum_i PC_i DI_{i,j}}{CI_j}$$

68. $$PVA_j = \frac{WC_j LDC_j + RC_j KDC_j}{VA_j}$$

69. $$WC_j = \frac{\sum_l WTI_{l,i} LD_{l,j}}{LDC_j}$$

70. $$WTI_{l,j} = W_l (1 + ttiw_{l,j})$$

71. $$RTI_{k,j} = R_{k,j} (1 + ttik_{k,j})$$

72. $$R_{k,j} = RK_k$$

International trade

73. $$P^{j}_i = PT_j$$

74. $$P_{j,i} = \frac{PE_i EX_{j,i} + PL_i DS_{j,i}}{XS_{j,i}}$$

75. $$PE^{FOB}_{i2} = (1 + ttix_{i2}) \left(PE_{i2} + \sum_{ij} PC_{ij} tmrg^{X}_{ij,i2} \right) / e$$

76. $$PWX_{i3} = (1 + ttix_{i3}) \left(PE_{i3} + \sum_{ij} PC_{ij} tmrg^{X}_{ij,i3} \right)$$

77. $$PD_i = (1 + ttic_i) \left(PL_i + \sum_{ij} PC_{ij} tmrg_{ij,i} \right)$$

78. $$PM_i = (1 + ttic_i) (1 + ttim_i) ePWM_i + \sum_{ij} PC_{ij} tmrg_{ij,i}$$

79. $$PC_i = \frac{PM_i IM_i + PD_i DD_i}{Q_i}$$

Price indices

80. $$PIXGDP = \sqrt{\frac{\sum_j \left(PVA_j + \frac{TIP_j}{VA_j}\right) VA_j^O}{\sum_j \left(PVA_j^O VA_j^O + TIP_j^O\right)} \frac{\sum_j \left(PVA_j VA_j + TIP_j\right)}{\sum_j \left(PVA_j^O + \frac{TIP_j^O}{VAO_j^O}\right) VA_j}}$$

81. $$PIXCON = \frac{\sum_i PC_i \sum_h C_{i,h}^0}{\sum_{ij} PC_{ii}^0 \sum_h C_{ij,h}^0}$$

82. $$PIXINV = \prod_i \left(\frac{PC_i}{PC_i^0}\right)^{INV_i}$$

83. $$PIXGVT = \prod_i \left(\frac{PC_i}{PC_i^0}\right)^{GVT_i}$$

EQUILIBRIUM

84. $$Q_{i1} = \sum_h C_{i1,h} + CG_{i1} + INV_{i1} + VSTK_{i1} + DIT_{i1} + MRGN_{i1}$$

85. $$\sum_j \left(LD_{l,j}\right) + ldrow_l = LS_l$$

86. $$\sum_j KD_{k,j} = KS_k$$

87. $$IT = \sum_h SH_h + \sum_f SF_f + SG + SROW$$

88. $$\sum_j DS_{j,i} = DD_i$$

89. $$\sum_{n\min} EX_{n\min,i} = EXD_l$$

GROSS DOMESTIC PRODUCT

90. $$GDP^{BP} = \sum_j PVA_j VA_j + TIPT$$

91. $$GDP^{MP} = GDP^{BP} + TPRCTS$$

92. $$GDP^{IP} = \sum_{l,j} W_l LD_{l,j} + \sum_{k,j} R_{k,j} KD_{k,j} + TPRODN + TPRCTS$$

93. $$GDP^{FD} = \sum_i PC_i \sum_h C_{i,h} + CG_i + INV_i + VSTK_i + \sum_i PWX_i * e * EX_i^j \quad e \sum_i PWM_i IM_i$$

REAL SECTOR

94. $$CTH_h^{REAL} = \frac{CTH_h}{PIXCON}$$

95. $$G^{REAL} = \frac{G}{PIXGVT}$$

96. $$GDP^{BP\_REAL} = \frac{GDP^{BP}}{PIXGDP}$$

97. $$GDP^{MP\_REAL} = \frac{GDP^{MP}}{PIXCON}$$

98. $$GFCF^{REAL} = \frac{GFCF}{PIXINV}$$