Exploring Natural Resources in Mozambique: will it be a blessing or a curse?

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Abstract (Ingles)
Mozambique has considerable quantities of natural resources, of which the major part is yet to be explored. The Government of Mozambique is determined to extract and export its natural resource potential as fast as possible, supposing that this will positively contribute to economic growth and poverty reduction. However, many resource rich countries are among the poorest nations in the world, in spite of decennia-long exploration of their natural wealth. This so-called 'paradox of plenty' or 'resource curse' raises the question whether the foreseen exploration of natural resources in Mozambique will pose a serious threat rather than a blessing to its economic development. In this paper we first estimate the potential resource wealth of Mozambique in comparison to other countries. Next, we briefly review the growing body of literature on the existence and determinants of a natural resource curse. Then we evaluate the risk of a resource curse to occur in Mozambique in the (near) future. Finally, we try to come up with suggestions to avert a Mozambican resource curse.

Key words: Resource Curse, Natural Resource Wealth, Economic Growth, Development, Political Economy, Institutions, Transparency

Abstracto (Português)

Moçambique possui quantidades consideráveis de recursos naturais, dos quais a maior parte ainda não foi efectivamente explorada. O Governo de Moçambique está determinado a extrair e exportar os seus recursos naturais o mais rápido possível, supondo que estes irão contribuir positivamente para o crescimento económico e redução da pobreza. Contudo, muitos países ricos em recursos naturais encontram-se entre as nações mais pobres do mundo, apesar dos longos anos de exploração das suas riquezas naturais. Este aspecto, conhecido por "paradoxo da abundância" ou "maldição dos recursos" (*resource curse*) faz com que se levantem questões sobre em que circunstâncias a prevista exploração dos recursos naturais em Moçambique pode constituir mais uma séria ameaça do que uma bênção para seu desenvolvimento económico. Neste *paper*, começamos por estimar o potencial da riqueza em recursos naturais de Moçambique em comparação com os outros países. A seguir uma breve revista a literatura existente e em desenvolvimento sobre os determinantes da "maldição dos recursos naturais" e daí avaliamos o risco deste fenómeno ocorrer em Moçambique num futuro próximo. Finalmente tentamos derivar algumas sugestões de modo a se evitar a ocorrência de uma "maldição dos recursos naturais" em Moçambique.

Palavras-chave: Maldição dos Recursos, Riqueza em Recursos Naturais, Crescimento Económico, Desenvolvimento, Política Económica, Instituições, Transparência

1. Introduction

Mozambique possesses considerable quantities of natural resources. Contrary to many (African) countries, however, Mozambique is still predominantly virgin soil: most natural resources are yet to be explored, including natural gas, coal, mineral sands, hydropower and most likely oil as well. The Government of Mozambique is determined to extract and export its natural resource potential as fast as possible, supposing that this will positively contribute to economic growth and poverty reduction. Intuition suggests that resource wealth is a gift that may generate economic dynamics and a flow of income to finance investment programs and policies to fight poverty and stimulate economic development. And indeed illuminating examples exists: countries like Australia, Canada, Norway and Botswana have been able to use their rich natural resources to embark on a sustainable high growth path. At the same time, the majority of resource rich countries have not been able to replicate this scenario. In Nigeria, for example, GDP per capita (in PPP terms) has decreased from US$ 1,113 in 1970 to US$ 1,084 in 2000 and poverty incidence has increased from 36% to 70%, in spite of roughly 350 billion US$ oil revenues over the same period (Sala-i-Martin e Subramanian, 2003). And Nigeria is not an isolated example: Angola, Sudan, Sierra Leone, Liberia and Congo, among others, are all gifted with considerable resource wealth (oil, diamonds, coltan, rubber, copper, among others) while decennia-long exploration of this natural abundance has not lifted these countries from the lowest ranks in the Human Development Index list. Likewise way, the member countries of the oil cartel OPEC, with their abundance of this natural resource, have not been able to realize sustainable economic growth: the GDP of the OPEC as a whole decreased on average with 1.3% per year between 1965 and 1998 (Gylfason, 2001a; Karl, 1997; Papyrakis e Gerlagh, 2004). This phenomenon is known as the "paradox of plenty" or "resource curse".

To illustrate the resource curse, Figure 1 shows the simple relationship between natural resource wealth in 1975 (measured as the export of natural resources as % of GDP) and economic growth (over the period 1975-2005) for a cross-country sample of 90 countries (Source: Worldbank Development Indicators). From the Figure it can be seen that the simple relationship between long run GDP growth and resource wealth is negative, with an estimated coefficient of -0.058.

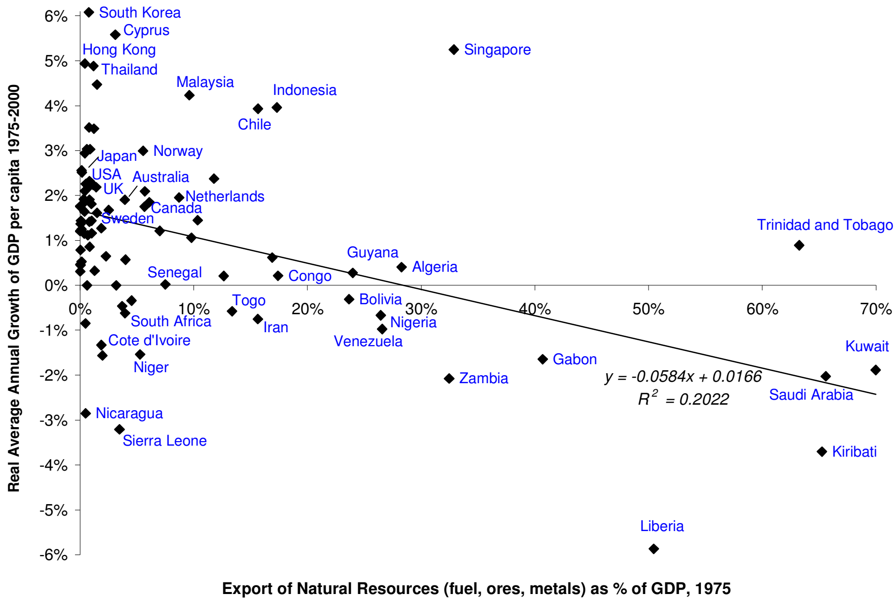

Figure 1. The relationship between Natural Resource Wealth and Economic Growth

In other words: countries with more natural resources exhibit a lower average GDP growth rate. However, as mentioned before, there are positive exceptions to this negative global trend, like, for example, Singapore, Chile and Norway. Since GDP growth is a relatively poor indicator to measure welfare or well-being, in Figure 2 we plot the simple relationship between natural resource wealth (again measured as the export of natural resources as % of GDP) and the Human Development Index (in 2000) for a cross-country sample of 85 countries.

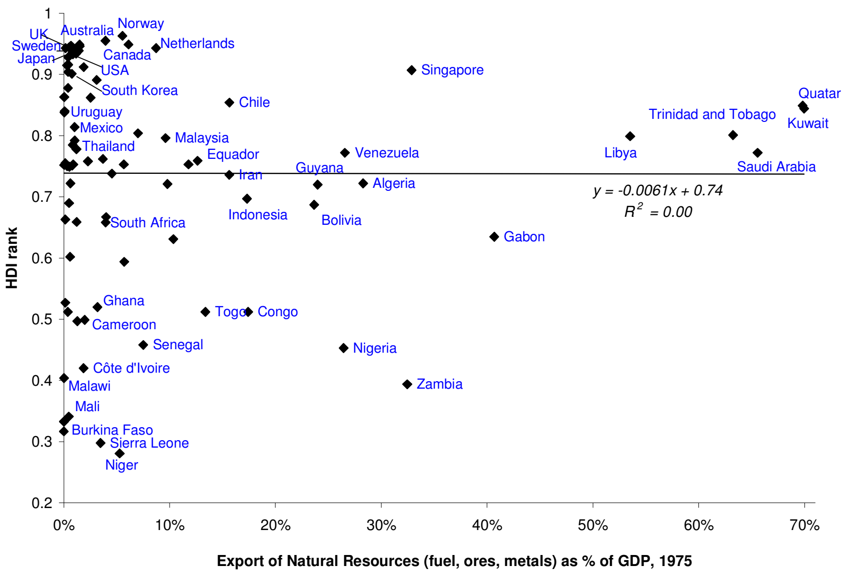

Figure 2. The relationship between Natural Resource Wealth and HDI ranking

The Human Development Index measures well-being across countries as a composite index of GDP per capita, life expectancy at birth and the adult literacy rate. From Figure 2 it can be seen that there is no significant relationship between resource wealth in 1975 and well-being in 2000; the estimated coefficient is 0.006. Some resource rich countries, like for example Gabon, Zambia, Congo and Nigeria, have not been able to end absolute poverty during 25 years of natural resource exploration, while the majority of the most developed nations, like for example Sweden and Japan, are poor in terms of natural resources. Also within the subsample sub-saharan Africa, the established resource rich nations have generally performed no better than other African countries. In other words, the relative well-being of the population in different countries in 2000, cannot be traced back to natural resource wealth. In sum, at first sight it is not obvious that resource wealth brings welfare, it is rather the opposite: often resource wealth goes along with low economic growth and low levels of well-being.

It can be concluded that natural resources can be turned into a blessing of a country as well as into a curse. The obvious question then is: will exploration of natural resources prove to be a blessing to Mozambique's development or is it more likely to pose a serious threat? And what can we do to ensure that future resource exploration in Mozambique will help to embark on a Norwegian- rather than Nigerian-type of development path? In this paper we first estimate the potential resource wealth of Mozambique (section 2) in comparison with other countries. Next, we briefly review the growing body of literature on the existence and determinants of a natural resource curse (section 3). In contrast with most contributions to the literature on the resource curse we do not evaluate the past, but evaluate the risk of a resource curse to occur in Mozambique in the future (section 4) – using the insights gained from the (cross-) country comparisons reported in the literature. Of course this change in perspective is motivated by the very fact that Mozambique does not have a past of large scale resource extraction, while plans to do so exist and are already implemented. Finally, we try to come up with suggestions to avert a Mozambican resource curse (section 5). A final section resumes and concludes.

2. Natural Resources in Mozambique

Natural resources are given by nature, not created by man, and can be divided into renewable and non-renewable resources. A further differentiation exists between point and diffuse resources, depending on whether or not the resource is concentrated and can be explored within in a limited area (Auty, 2001). Le Billon (2001) added to this classification the decisive factor whether the distance between the resource and the central government is small or large, i.e. whether the resource can be easily controlled or not. It is to be noted that certain types of natural resources, like oil, natural gas, minerals, etc. including their exploration and rents are in general concentrated while natural resources like agricultural products are in generally more dispersed and their rents transferred throughout the whole economy.

When we talk about Natural Resources in this paper we do *not* take into account the exploration of agricultural, fisheries and forestry resources but limit ourselves to ores, metals and fuels, including electricity.[1] Although one may argue that strictly spoken electricity is not a natural resource since it is a man-made product, we will treat electricity in this paper as an integral part of Mozambique's resource wealth. It is to be noted that by far most existing and future electricity generation in Mozambique is based in hydro, the exploration of which requires investments that in essence not much differ from the investments needed to extract and process natural gas, coal, mineral sands and oil.

The principal natural resources of Mozambique are: coal, natural gas, hydro, mineral sands and probably also oil. Hydro is a renewable resource that serves to generate electricity, while in the near future also part of the natural gas and coal reserves in Mozambique will be used as (non-renewable) sources of electricity generation. Table 1 provides an overview of the principal sources of resource wealth in Mozambique, based on information we collected through the Ministry of Energy, the Ministry of Mineral Resources, and a variety of other sources including the Unites States Geological Survey (USGS) Minerals Yearbook, the journal African Mining Review and websites of the involved companies. Concerning electricity, the Table shows that hydro by far is and will be the main source for electricity generation, with an estimated potential of 12,500 MW. Currently, just over 2,000 MW of this potential is being explored, almost exclusively through the Cahora Bassa hydro dam. In the near future, new hydro dams are planned, including the Mphanda Nkuwa dam (1,300 MW), which will raise total exploration of

[1] We also exclude gold and various types of mineral stones which, although available in Mozambique, are found in very small quantities and are to a large extent explored in an informal (illegal) way.

hydro potential to around 3,700 MW. In addition, it is expected that in 2010 a 700 MW natural gas-fired electricity plant will become operational, fuelled by gas from the Pande/Temane fields in Inhambane province. Furthermore, the planned large-scale exploration of the Moatize coal mine (to start in 2009/10) has given rise to the possibility of constructing a coal-fired power station with a capacity of 1,500 MW, of which we expect 1,000 MW to become operational in 2012 while the remaining 500 MW will probably be available as of 2015.

Table 1. Natural Resource in Mozambiaue – Potential/Reserves

		Reserves Potential	Actual *2006*	To be realised *2007/8*	*? 2009*
Electricity	**MW**	**14,700**	**2,185**	**2,265**	**5,885**
Hydro	**MW**	**12,500**	**2,185**	**2,265**	**3,685**
HCB		2,150	2,150	2,150	2,150
Mavuzi & Chicamba		90	35	90	90
Massingir		25		25	25
Lúrio		120			120 *(2012?)*
Mphanda Nkuwa		1,300			1,300 *(2014)*
Rio Zambeze (outros)		6,800			
Outros		2,015			
Thermal - Natural Gas	**MW**	**700**			**700**
Inhambane		700			700 *(2010)*
Thermal - Coal	**MW**	**1,500**			**1,500**
Moatize		1,500			1,500 *(2012/15)*
Natural Gas	**TJ**	**5,334,000**			
Pande/Temane		5,334,000			
Mineral Coal	**1000 ton**	**6,000,000**			
Moatize		2,400,000			
Mucanha-Vuzi		3,600,000			
Minerals (Heavy Sands)	**1000 ton**	**456,220**			
Moma		299,000			
Contained Ilmenite		273,000			
Zircon		20,400			
Rutile		5,600			
Chibuto*		157,220			
Titaniferous (titanium) slag		100,000			
Zircon		6,250			
Rutile		1,220			
High-purity pig iron		49,110			
Leucoxene		640			
Oil (crude)	**1000 ton**	?			

** based on: annual exploration x 100 years*

Regarding natural gas, total reserves of the Pande/Temane fields in the Inhambane province are estimated to consist of more than 5 million TJ. Total coal reserves are estimated to be at least 6 billion ton, including the Moatize and Mucanha-Vuzi coal mines in Tete province.

In addition, large deposits of Mineral Sands have been identified in Moma in the Zambezi province and near Chibuto in the province of Gaza. The most recent figures indicate a reserve of 299 million ton of mineral sands in Moma, mainly consisting of contained ilmenite as well as zircon and rutil. The Chibuto (Corridor) heavy sands mine represents one of the world's largest deposits of heavy minerals and has a lifespan of well over a hundred years. Our figures indicate a reserve of at least 157 million ton, but this is probably (much) more. Reserves include mainly titanium slag, as well as zircon and rutile, leucoxene and high purity pig-iron. Mineral ilmenite (iron titanium oxide) is smelted into titanium slag and then sold to the pigment industry, rutile can be used directly by pigment manufacturers and titanium metal producers, zircon is used in the ceramics industry, while high purity iron is a by-product of ilmenite smelting.

On top of this, Mozambique probably has yet unproven reserves of oil. Recently, a number of (foreign) companies were licensed to investigate the supposedly considerable potential of oil reserves in Mozambique, both on-shore as well as off-shore (Mozambique and Rovuma-basins). See Figure A4.1 in Annex 4 for an overview. Unfortunately, since the investigation is in its initial phase no useful data yet exists on the potential oil reserves of Mozambique.

So far, the major part of Mozambique's natural resources is under-explored, but this situation is rapidly changing. Table 2 summarizes the existing and foreseen production of electricity, natural gas, coal and minerals. From the Table it can be seen that total electricity production is expected to increase from about 15,000 GWh/year currently to over 41,000 GWh during the next 7 years. The major part of electricity is and will be generated from hydro, followed by coal and natural gas. Large scale natural gas production started in 2004 with the exploration of the Pande/Temane gas fields in the Inhambane province by the South African company Sasol, and is expected to grow steadily over the next years to circa 145 thousand TJ per year. Coal production used to be small-scale and became marginal during the civil war. This situation is, however, going to change since the Brazilian Company Vale do Rio Doce (CVRD) won a bid in 2004 to develop

Table 2. Natural Resources in Mozambiaue – Annual Production

	Annual	Actual *2006*	To be realised *2007/8*	*? 2009*
Electricity	**GWh**	**14,732**	**15,873**	**41,242**
Hydro	**GWh**	**14,732**	**15,873**	**25,824**
HCB		14,502	15,067	15,067
Mavuzi & Chicamba		230	631	631
Massingir			175	175
Lúrio				841 *(2012?)*
Mphanda Nkuwa				9,110 *(2014)*
Rio Zambeze (outros)				
Outros				
Thermal - Natural Gas	**GWh**			**4,906**
Inhambane				4,906 *(2010)*
Thermal - Coal	**GWh**			**10,512**
Moatize				10,512 *(2012/15)*
Natural Gas	**TJ**	**102,494**	**123,494**	**144,494**
Pande/Temane		102,494	123,494	144,494
Mineral Coal	**1000 ton**	**5**	**5**	**15,000**
Moatize		5	5	15,000
Minerals (Heavy Sands)	**1000 ton**		**1,466**	**2,888**
Moma			877	1,316 *(2010)*
Ilmenite			800	1,200
Zircon			56	84
Rutile			21	32
Chibuto			589	1,572 *(2017)*
Titaniferous (titanium) slag			375	1,000
Zircon			22	63
Rutile			5	12
High-purity pig iron			184	491
Leucoxene			3	6
Oil (crude)	**1000 ton**			**?**

the Moatize coalfield in Tete province, with an expected coal production of 15 million ton per year, starting in 2009/10. The Moma heavy sands mine, explored by Kenmare Resources, began its operations in 2007 and is expected to gradually increase its annual production from 900 thousand ton to over 1,300 thousand ton. The start of the exploration of the Chibuto heavy sands deposits has been delayed due to difficulties with power supply. After having redesigned the project, the company Corridor Sands is now expected to start production by the end of 2008 at a level of circa 590 ton per year, with production gradually increasing to over 1,500 thousand tone per year by 2017.

Most natural resources explored in Mozambique are exported. With respect to the coal from the Moatize mine, we expect 15% to be marketed in Mozambique, including consumption by the electricity plant, while the remainder will be exported for consumption by steel plants in Brazil (USGS, 2005).

Table 3. Natural Resources in Mozambique – Annual Exports

	Annual	Quantity				Price of Exports		
		2006	*2007/8*	*≥ 2009*		*2006*	*2007/8*	*≥ 2009*
Electricity	**GWh**	**10,877**	**11,300**	**27,366**	**US$c/kWh**			
Hydro	**GWh**	**10,877**	**11,300**	**15,102**	**US$c/kWh**	**1.66**	**1.83**	**2.48**
HCB		10,877	11,300	10,547		1.66	1.83	2.21
Mavuzi & Chicamba		0	0	0				
Massingir			0	0				
Lúrio				0				
Mphanda Nkuwa				4,555				2.75
Rio Zambeze (outros)								
Outros								
Thermal - Natural Gas	**GWh**			**2,803**	**US$c/kWh**			**3.20**
Inhambane				2,803				3.20
Thermal - Coal	**GWh**			**9,461**	**US$c/kWh**			**3.50**
Moatize				9,461				3.50
Natural Gas	**TJ**	**101,162**	**119,789**	**137,269**	**US$/TJ**			
Pande/Temane		101,162	119,789	137,269		1,200	1,200	1,200
Mineral Coal	**1000 ton**	**4.9**	**4.9**	**13,500**	**US$/Ton**			
Moatize		4.9	4.9	13,500		30	32	35
Minerals (Heavy Sands)	**1000 ton**		**1,466**	**2,888**	**US$/Ton**		**136**	**142**
Moma			877	1,316				
Ilmenite			800	1,200		85	87	92
Zircon			56	84		700	714	743
Rutile			21	32		450	457	471
Chibuto			589	1,572			**398**	**408**
Titaniferous (titanium) slag			375	1,000		425	429	438
Zircon			22	63		700	714	743
Rutile			5	12		450	457	471
High-purity pig iron			184	491		300	303	309
Leucoxene			3	6		500	505	515
Oil (crude)	**1000 ton**			**?**	**US$/Barril**			**50-70?**

The vast majority of natural gas is and will be exported to South Africa, although domestic consumption tends to increase due to the realization in 2005 of a new pipeline to the Beleluane industrial park near Maputo and because of the natural gas-fired electricity plant to be constructed. Also in terms of electricity, almost all production is exported, mainly to South Africa but also to Zimbabwe and in the near future to Malawi. Table 3 summarizes natural resource export figures for Mozambique, both in terms of quantity as well its (average) prices. The prices are best estimates based on (projections of) world market prices as well as existing long-term contracts.

Using the (projected) export quantities and prices as shown in Table 3 we calculated the total (projected) value of natural resource exports from Mozambique for the period 2006-2020 and combined this with historical data for the period 2000-2005 from the SADC Trade Database (SADC, 2007). In addition we estimated the total value of exports until 2020 by assuming that non-natural resource exports will grow with 10% annually.[2] The results are shown in Figure 3, including the value of aluminum exports (by Mozal). The Figure shows a spectacular growth of export from about 365 million US$ in 2000 to almost 6,500 million US$ by 2020. Of the latter, circa 1,800 million consists of non-natural resource (related) exports (under the assumption of a 10% annual growth rate). A large part of the primary exports consists of aluminum (products), the growth of which is to be explained by expansion of production capacity of the Mozal factory (Mozal 3, in 2009/10).[3] In addition, electricity, mineral sands and coal will be major elements of Mozambique's export, while the share of natural gas is relatively small as compared to the other natural resources.

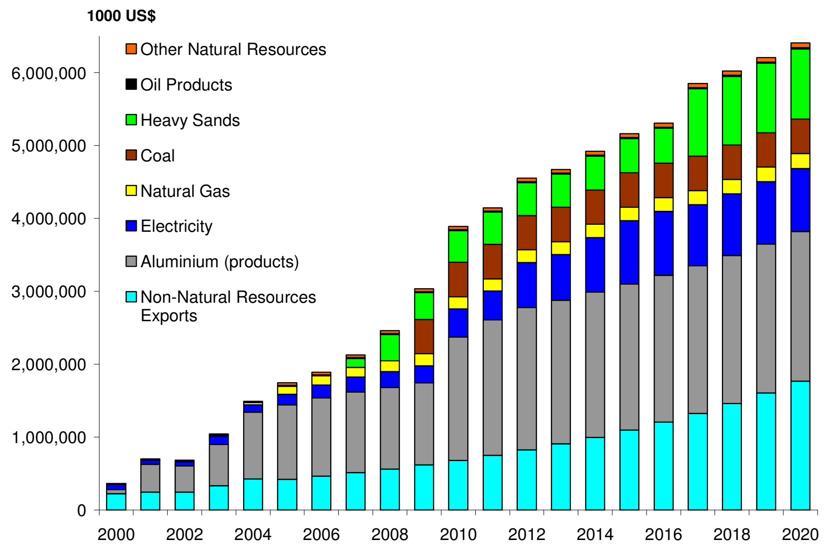

Figure 3 Exports Mozambique

[2] This is in line with the projections of the Quadro Macro of the Ministry of Planning and Development (until 2010).
[3] We assume a doubling of production capacity in 2010, as well as the following annual growth figures: 2007 (3%), 2008-2009 (1%), 2011 (10%), 2012, (5%), 2013-2014 (1%), 2015-2020 (0.5%).

To further illustrate the importance of natural resource (related) exports in Mozambique, we plot in Figure 4 primary exports (fuel, ores and metal) as % of total exports for the period 2000-2020. The Figure shows that the share of primary exports will fluctuate around 70-80%. Again, it can be seen that aluminum (products) produced by Mozal constitutes a major part of this. Without aluminum, the share of natural resource (related) exports in total exports will be around 40-50%.

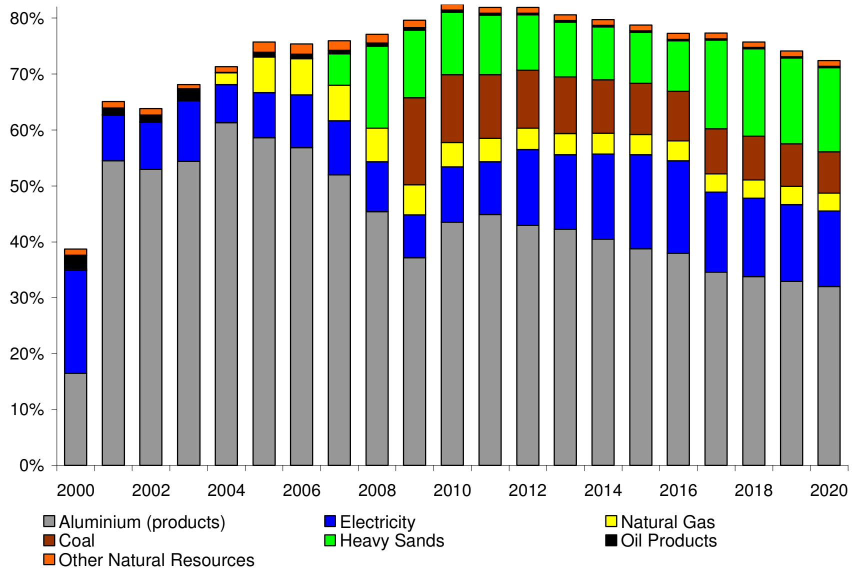

Figure 4 Natural Resources as % of Exports

As noted before, no data yet exists on the potential oil reserves of Mozambique because investigation of potential reserves is still in its initial phase. However, we decided instead to do a kind of thought experiment to see what happens to natural resource exports if Mozambique becomes an oil producing country like one of the existing oil producing nations. To facilitate this exercise, Figure 5 plots the oil production of small and medium sized oil producing countries in 2004, assuming that we may exclude the possibility that Mozambique will become an oil producer of the size of Saudi-Arabia or Iran. Using this information we may analyse the situation if Mozambican oil production turns out to be *very small* like Tunisia, a bit bigger but still *small* like Chad or Gabon, *medium* like Brazil or Libya or *big* like Norway.

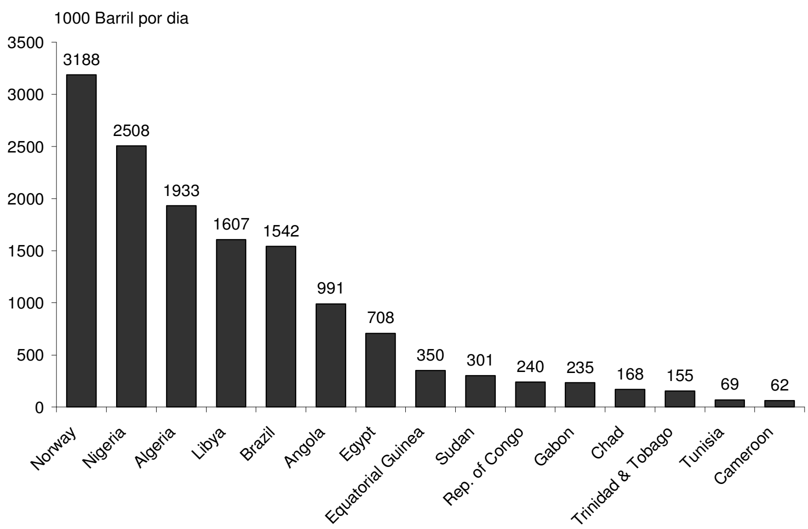

Figure 5. Oil production various countries

In our experiment we define *very small* as 75,000 Barrels/day, *small* as 200,000 Barrels/day, *medium* as 1,500,000 Barrels/day and *big* as 3,00,000 Barrels/day, while for the sake of the argument we assume oil production to start at full-scale in 2015.[4] In Figure 6 we then project total exports of Mozambique like before, but now including aforementioned 4 scenarios regarding oil production, supposedly as of 2015, assuming a constant oil price of 50US$/Barrel. From the Figure it can be seen that if Mozambique will become a (very) small oil producer like Tunisia, Chad or Gabon (75,000-200,000 Barrels/day), and given an oil price of 50US$/barrel, exports may increase to circa 10 billion US$ in 2020 as compared to 6.5 billion US$ without oil. However, if Mozambique turns into a medium-size oil producing nation like Brasil or Lybia (1,500,000 Barrels/day) or even a large oil producing nation like Norway (3,00,000 Barrels/day), and given an oil price of 50US$/barrel, total export value may explode to over 30 or 60 billion US$, respectively.

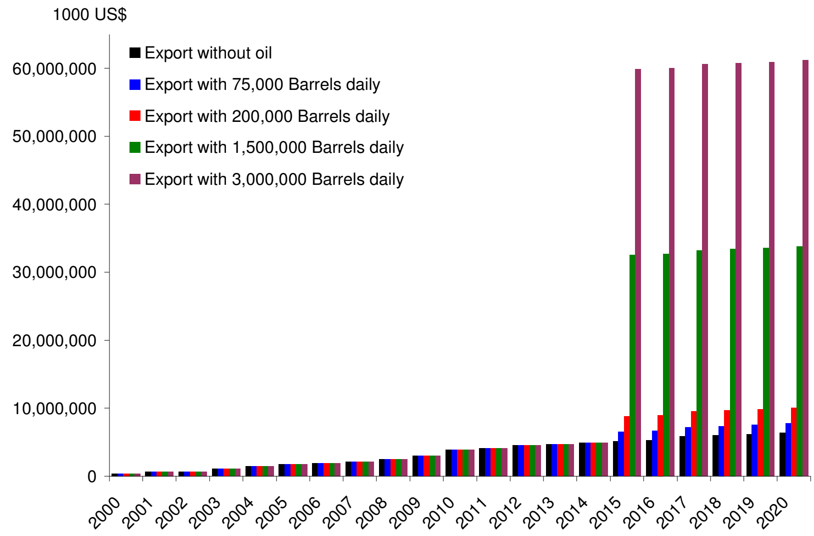

Figure 6. Exports Mozambique including oil

Regarding the share of primary exports in total exports, this will grow to over 90% in case Mozambique becomes a medium or large-size oil producing country, as illustrated in Figure 7.

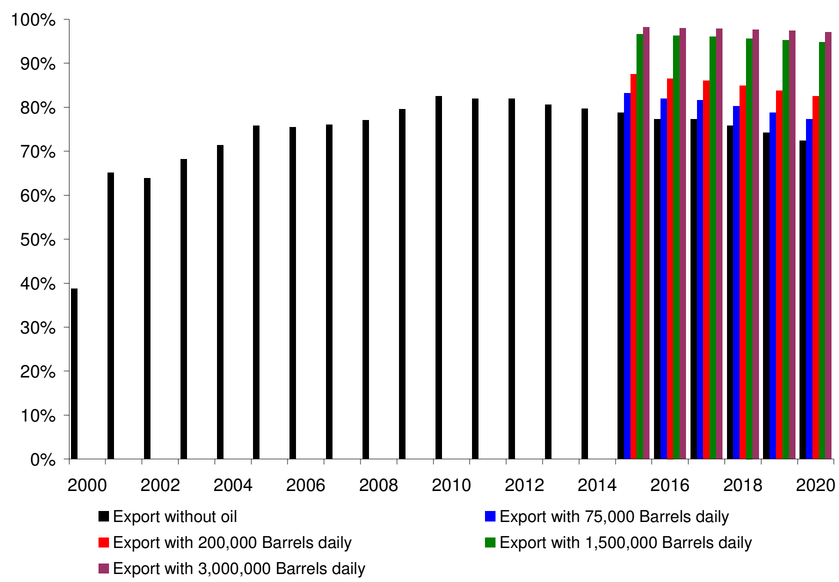

Figure 7. Natural Resources as % of Exports, including oil

[4] Note that the investigation period started in 2007 with a maximum of 6 years, to be followed by exploration.

To put these numbers in an international perspective, Table 4 lists a couple of key indicators for Mozambique in comparison with a selected list of countries, including resource rich and resource poor countries. Since natural resource exploration in Mozambique is still in its infancy, we compare Mozambique in 2010 and 2015 with the situation in other countries in 2000.

Table 4. Primary Exports Mozambique in International Perspective.

	Fuel + ores and metals exports (% of GDP)	Fuel + ores and metals exports (% of exports)	Fuel exports (% of exports)	Ores and metals exports (% of exports)	HDI rank (1 - 177)	GDP per capita (US$)	GDP per capita, PPP (US$)
					2000	*2000*	*2000*
Nigeria	49.7%	99.6%	99.6%	0.0%	158	332	878
Congo, Rep.*	48.7%	88.0%	87.6%	0.3%	142	934	961
Gabon	42.5%	85.0%	83.3%	1.7%	123	3,920	6,127
Mozambique 2010	**40.4%**	**82.5%**	**14.6%**	**67.9%**	**168**	**208**	**874**
Mozambique 2015, with Oil at 200,000 Barrel/day	**38.2%**	**87.6%**	**53.5%**	**34.0%**	**168**	**208**	**874**
Trinidad and Tobago	34.3%	65.4%	65.3%	0.1%	57	6,326	8,951
Norway	25.2%	70.0%	63.9%	6.1%	1	39,322	35,132
Mozambique 2010, without Aluminium	**19.1%**	**39.0%**	**14.6%**	**24.4%**	**168**	**208**	**874**
Zambia	13.1%	63.9%	1.6%	62.3%	166	328	777
Chile	11.8%	46.5%	1.1%	45.3%	37	4,964	9,197
Malaysia	11.6%	10.7%	9.6%	1.0%	61	3,881	8,952
Canada	6.8%	17.5%	13.2%	4.4%	5	23,198	27,880
Australia	6.3%	38.5%	21.9%	16.6%	3	20,285	26,181
South Africa	4.9%	21.0%	10.1%	10.8%	120	2,910	9,434
Botswana	3.6%	7.1%	0.1%	7.0%	131	3,135	7,525
Sweden	2.1%	5.6%	2.9%	2.7%	6	27,012	24,526
Germany	1.2%	3.9%	1.5%	2.5%	20	22,750	26,075
United States	0.3%	3.8%	1.9%	1.9%	10	34,599	34,114
Burkina Faso	0.3%	3.3%	3.2%	0.0%	175	231	1,013
Japan	0.2%	1.6%	0.4%	1.3%	11	37,409	25,974
Malawi	0.1%	0.4%	0.2%	0.2%	165	166	599
Mali	0.1%	0.3%	0.0%	0.3%	174	223	792
Angola	0.0%	6.9%	3.0%	3.9%	160	715	1,952

* Natural Resource Data are of 1995

From the Table it can be seen that in 2010 primary exports (fuel, ores and metal) in Mozambique are expected to amount to circa 40% of GDP (assuming an annual GDP growth rate of 7.5%). As discussed before, the share of primary exports in total exports is expected to be around 80% in 2010. Natural Resource exports consist mainly of ores and metals due to the important role of aluminum in Mozambican export, while the fuel component consists mainly of electricity and natural gas. In terms of these numbers, Mozambique can be defined as a resource rich country that can be compared to countries like the Republic of Congo, Gabon, Trinidad and Tobago, Norway and Zambia. Without aluminum, primary exports drop to circa 19% of GDP, and to around 40% of total exports. These numbers are more in line with those of Chile and Malysia.

By way of illustration, the right hand side of Table 4 lists the HDI ranking as well as GDP per capita for the selected countries in 2000. Although these numbers are expected to have improved by 2010 for Mozambique due to economic development, the figures may serve to illustrate that the Mozambican economy and trade structure is likely to be very natural resource intensive by 2010 while in terms of GDP/capita and HDI Mozambique still belongs to the poorest nations in the world. This draws a clear comparison between Mozambique and countries like Congo, Zambia and Gabon rather than Norway.

So far, we have measured resource dependence (in Mozambique) by the share of primary exports in total exports and as % of GDP. A somewhat different way to measure natural resource dependence is to calculate the value of resource stocks relative to the total wealth of a country. To conclude this section, we estimate this stock value of (nonrenewable) natural resources in Mozambique according to the methodology used by the Worldbank in its study 'Where is the Wealth of Nations?' (Worldbank 2006). The study provides monetary estimates of the range of assets – produced, natural, and intangible – for a range of 120 countries. A key message of the Worldbank study is that natural capital is an important share of total wealth, greater than the share of produced capital. This suggests that managing natural resources must be a key part of development strategies. The composition of natural wealth in poor countries emphasizes the major role of agricultural land, but subsoil assets and timber and non-timber forest resources make up another quarter of total natural wealth. For Mozambique no estimates for subsoil assets were provided, due to lack of data and the (nearly) non-existence of subsoil assets exploration in 2000. We aim to fill this gap by applying the Worldbank methodology to our data and using 2010 as a base year.

The approach used is based on the well-established economic principle that asset values should be measured as the present discounted value of economic profits over the life of the resource. This value, for a particular country and resource, is given by the following expression:

$$V_t = \frac{\sum_{i=t}^{t+T-1} \pi_i q_i}{(1+r)^{(i-t)}} \qquad (1)$$

where π_i q_i is the economic profit or total rent at time i (π_i denoting unit rent and q_i denoting production), r is the social discount rate, and T is the lifetime of the resource. However, this approach is rarely used for the practical estimation of natural asset values since it requires the knowledge of actual future rents. Instead, simplifications of (1) that implicitly predict future rents based on more or less restrictive assumptions (such as constant total rents, optimality in the extraction path) are used. The simplification used here assumes that the unit rents grow at rate g:

$\frac{\dot{\pi}}{\pi} = g = \frac{r}{1+(\varepsilon-1)(1+r)^{(T)}}$ where ε = 1.15 is the curvature of the cost function, assumed to be isoelastic (as in Vincent, 1996). Then, the effective discount rate r* is defined as $r^* = \frac{r-g}{1+g}$ and the value of the resource stock can be expressed as:

$$V_t = \pi_t qt\left(1+\frac{1}{r^*}\right)\left(1-\frac{1}{(1+r^*)^T}\right) \quad (2)$$

This expression is used to value the resource stocks, extending for a period of 20 years.[5] Furthermore we follow the Worldbank in assuming a social discount rate of 4%.

To reflect uncertainty regarding future prices of non-renewable resource rents, we calculated the value of resource stock using three scenarios: Low, Medium and High, which differ with respect to the assumed prices. The supposed price ranges are taken from the values listed in Table 3. The results of our calculations for Mozambique based on equation (2) are shown in Table 5 (for more details we refer to Annex 1).

Table 5. Estimates of Value of Subsoil Assets Mozambique

		Low	Medium	High	Medium including Oil - 200,000 Barrel/day	Medium including Oil - 1,500,000 Barrel/day
Natural Gas	US$/capita	117	175	234	175	175
Coal	US$/capita	242	303	364	303	303
Heavy Sands	US$/capita	452	462	473	462	462
Oil	US$/capita*				1,892	14,192
TOTAL	US$/capita	812	941	1,070	2,833	15,132

* Using 2015 population number (UN projections, medium variant)

From Table 5 it can be seen that the total value of Mozambique's natural resources rents for a period of 20 years is close to 1,000 US$ per capita.[6] The Table shows that the major part of this wealth consists of mineral sands and coal, while the value of natural gas is relatively small. If we include a supposed oil production in our calculation, total value increases significantly to circa 3,000 US$/capita in case of an oil production of 200,000 Barrels/day (small, like Chad or Gabon) and to circa 15,000 US$/capita in case of an oil production of 1,500,000 Barrels/day (medium, like Brazil or Libya). In Figure 8 we plot the values of resource rents in Mozambique together with the Worldbank estimates of other sources of wealth in Mozambique. From the Figure it can be seen that with 941 US$/capita, the subsoil assets amount to circa 18% of total estimated value

[5] From a purely pragmatic point of view, the choice of a longer exhaustion time would demand increasing the time horizon for the predictions of total rents (to feed equation [1]). On the other hand, rents obtained further in the future have less weight since they are more heavily discounted.

[6] Of course, electricity based on hydro is a renewable source and as such the methodology is strictly spoken not applicable to hydroelectricity. Furthermore, electricity in general is not a subsoil asset; hence, for matters of consistency we excluded electricity from our calculations.

for Mozambique. The largest share of total wealth consists of intangible capital, which includes an amalgam of human capital, governance, and other factors that are difficult to value explicitly. Apart from subsoil assets, Mozambique also has a considerable value of Timber and Non-Timber forest resources (together around 14% of total wealth).

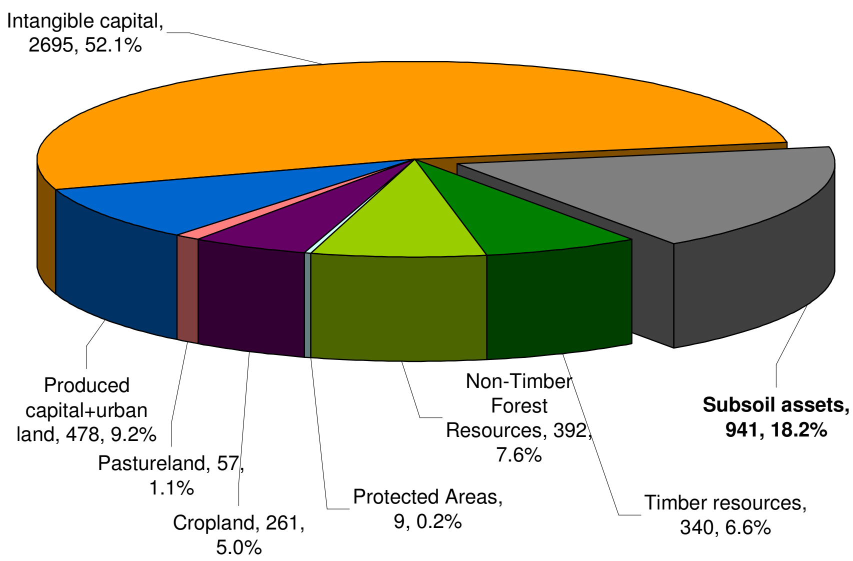

Figure 8. Wealth Stock Estimates for Mozambique

If we assume that Mozambique turns into a small oil producing nation (like Chad or Gabon) the share of subsoil assets in total wealth in Mozambique will increase to circa 40%; in case Mozambique becomes a medium-size oil producer (like Brazil or Libya) this number will be around 78%.

In Figure 9 we compare the share of subsoil assets in total wealth in Mozambique with a selected number of other countries according to the Worldbank estimates.

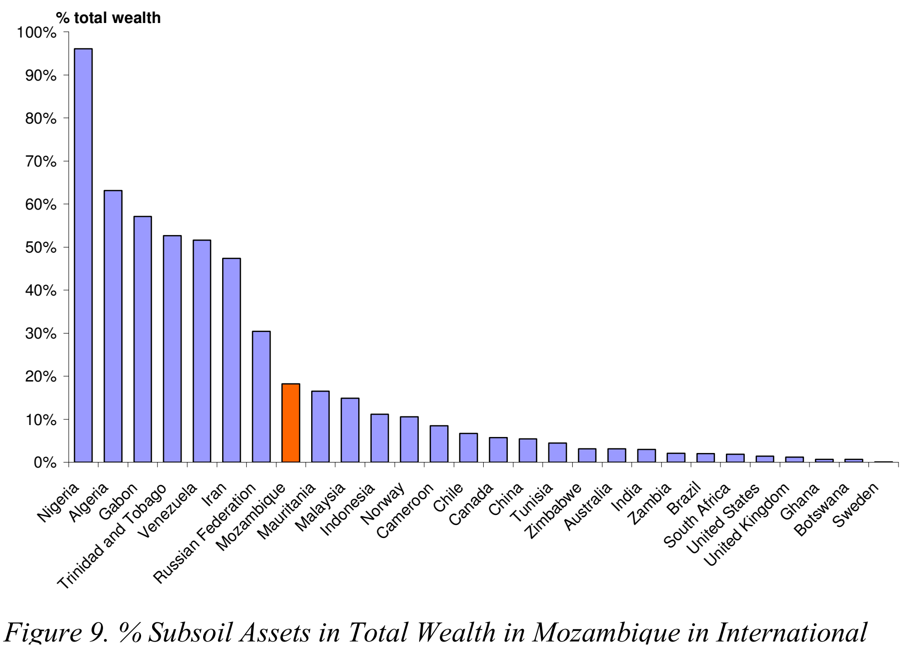

Figure 9. % Subsoil Assets in Total Wealth in Mozambique in International

The Figure shows that even without oil exploration the share of subsoil assets in total wealth in Mozambique (18%) is to be considered high in international perspective. In case Mozambique becomes an oil producing country, its share of subsoil assets in total wealth (40%, 78%) is comparable to that of oil producing countries like Venezuela, Algeria, or Gabon. Once again, this underlines the value of proper management of natural resources as part of a development strategy in Mozambique.

3. The determinants of a Resource Curse

In essence the resource curse refers to the inverse relationship between high natural resource dependency and economic growth. The notion that natural resources are often a curse rather than a blessing has received considerable attention in the economic literature ever since the influential study of Sachs and Warner (1995), which showed that after controlling for other important factors, the economic growth rates of countries in the 1970s and 1980s were strongly and negatively related to their natural resource dependence, as shown before in Figure 1. This result has been confirmed by a series of studies (see for example, Gylfason 2001, Sala-i-Martin and Subramanian 2003, Mehlum et al., 2005). The key question of course is as to what determines this apparently strong negative relationship between natural resource wealth and low levels of human development and economic growth? Is there a direct link between resources and welfare, or is there an indirect link that operates through other factors? Following Papyrakis (2006) we can distinguish in the literature four principle explanations for the resource curse: 1. Dutch disease, 2. Investments, 3. Economic Policy, 4. Institutions. We briefly discuss these explanations below.

3.1 Dutch disease

Originally the Dutch disease phenomenon referred to the situation in the Netherlands during the 1960s when the discovery and export of natural gas in this country caused adverse impacts on its manufacturing sector through an appreciation of the currency. Natural resource exploration and its revenues[7] cause a demand shock that may lead to inflationary pressure at home as well as an overvaluation of the currency due to increased demand from abroad (Corden, 1984; Neary and Van Wijnbergen, 1986). As a result, prices of non-natural resource goods increase, in that way

[7] Resource reveneus or rents, refer to actual income from the exploration and export of natural resources.

turning the non-natural resource sector less competitive and also hampering diversification of the economy (Fardmanesh, 1991). Since the size of exports and the degree of openness of an economy are important determinants of economic growth (Frankel and Romer, 1999), natural resources wealth might in this way – paradoxically – have a negative impact on economic development. More in detail, the Dutch disease consists of three principal mechanisms:

- The *spending effect,* which refers to an increasing demand for non-tradeable goods and services, pushing up their prices. The discovery of considerable quantities of natural resources is often associated with large direct foreign investments (FDI), particularly in developing countries like Mozambique, and a sharp increase of export revenues. The implied inflow of foreign currencies causes an appreciation of the domestic currency, turning the non-natural resource sectors less competitive. At the same time, this causes increasing demand for goods and services, invoking increased prices and wages.
- The *movement effect*, which refers to a reallocation of production factors (capital, labour) from other sectors (manufacturing) towards the primary sector due to its increased marginal productivity (Corden and Nery, 1982). If new reserves of oil, natural gas, or coal are discovered in an economy that finds itself close to its maximum production level, the extra demand for production factors to extract the discovered resources may cause scarcity of these resources in other sectors. As a result, the wage premium in the primary sector – motivated by its high marginal productivity – causes a crowding-out effect regarding other activities in the economy.
- The s*pillover-loss effect*, refers to natural resource exploration undermining the positive externalities (spillovers) generated by other sectors including the development of know-how, innovations in the area of technology and management and all kinds of skills of the labour force. In general these effects are principally generated by the manufacturing sector due to its exposure to international competition, with considerable positive effects on the productivity of the economy as a whole (Matsuyama, 1992; Krugman, 1987). In contrast, the primary sector generates in general little positive externalities for the rest of the economy, due to its capital intensity and very specific activity implying in general very little forward and backward linkages to the rest of the economy, particularly in developing countries. Hence, a contraction of the manufacturing sector (see above) in favour of the primary sector might lead to a decrease in positive spillovers and thus in a slow down of productivity increase at the level of the economy as a whole.

The Dutch disease becomes an even more serious problem when non-renewable resources (like natural gas, coal, mineral sands, etc.) are getting exhausted at a certain point in time. If the other sectors of the economy have suffered for many years from Dutch disease phenomena, a country will face great difficulties to restore its competitiveness once the natural resource wealth is reaching its end. Given the fact that the majority of Mozambique's natural resources are non-renewable, the large share of natural resources in total export and the relative volatility of natural resource prices (particularly in case of oil), Mozambique faces the risk to suffer from a Dutch disease.

3.2 Investments

The important role of investments in promoting economic development has been well documented in the economic literature (see, for example, Barro, 1991; Grier and Tullock, 1989; Kormendi and Meguire, 1985; Sachs and Warner, 1997). Recent empirical research has identified the effect of *crowding out* on investments and thus on economic growth, caused by natural resource abundance, with circa 40% of the negative impact of mining on economic growth to be attributed to a fall in investments (Papyrakis and Gerlagh, 2004). The world market prices for primary products tend to be more volatile than the prices of other goods and services, which makes an economy based on primary products vulnerable to frequent booms as well as recessions. These fluctuations in economic conjuncture often cause exchange rate volatility and (consequently) increased risks and uncertainty for investors (Herbertsson et al., 1999). This fact is reflected in a strong negative correlation between resource abundance and the level of FDI (Gylfason, 2001b).

Additionally, natural resource wealth diminishes the sense of necessity of savings and investment because resource revenues feed the illusion that current and future wealth and prosperity do not depend much on capital accumulation (Papyrakis and Gerlagh, 2004). Furthermore, resource rents may reduce the need for financial intermediation and consequently of the development of financial institutions that usually promote investments in the long run. On top of this, as noted before, Dutch disease effects may invoke contraction of the manufacturing sector thereby further contributing to reduced capital accumulation. Frequently, governments of resource abundant countries spent their revenues on unproductive investments and consumption, including expenses for military and security or all kinds of prestige projects with little or no sustainable positive impact on the economy (Ascher, 1999).

3.3 Policy failures

Natural resource wealth creates frequently a false sense of euphoria and confidence that undermines careful planning and prudent economic policies by the government (Gylfason, 2001a). Resource revenues may contribute to myopic behavior and irrational expectations at the side of governments, leading to accumulation of debt with resource stocks as collateral. This makes countries vulnerable in the sense that resource price volatility at the world market might easily lead to a heavy debt burden (in case prices fall). Moreover, easily obtained wealth often stimulates unproductive behavior and undermines willingness to make great efforts; this is not only true for individuals but also for governments. Hence, natural resource wealth often encourages bureaucracy, inefficiency and corruption and disencourages innovation and efficiency improvements. (Papyrakis and Gerlagh, 2004). Moreover, governments often tend to use resource revenues for subsidies and transfers supporting uncompetitive industries instead of promoting diversification and competitiveness (Auty, 1994). Also investments in education are often neglected in resource abundant countries, which can be explained by the fact that the primary sector is principally in need of low-skilled labour (Gylfason, 2001a), and also by the lack of sense of urgency to invest in human capital in the face of increased income from resources. This however makes it increasingly difficult for the economy to diversify its activities, because the non-resource sectors often do require skilled labour. Finally, since the resource revenues are collected by the government, the decisions about its spending are often in the hands of a few, which – against the background of weak democracies in many resource abundant countries – often implies lack of control, thereby contributing to further weakening of a country's institutions.

3.4 Institutions

Institutions are the "the rules of the game in a society" (North, 1990). The economic growth literature leaves no doubt about the strong positive role good institutions play in bringing about on economic development (see, for example, Acemoglu et al., 2001; Knack e Keefer, 1995; Mauro, 1995; Murphy et al., 1993; Easterly & Levine, 1993). The institutional quality of a country reflects the quality of laws and their enforcement, efficiency of the bureaucracy, level of corruption, political stability, democratic values and transparency. To illustrate the relevance of institutions as a potential indirect link between resource wealth and economic performance, following Mehlum et al (2005), we show in Figure 10a and 10b again the relationship between natural resource wealth in 1975 (measured as the export of natural resources as % of GDP) and economic growth (over the period 1975-2005), like in Figure 1, but now we have split the sample in two subsamples, according to the quality of institutions.[8] To define the quality of institutions we make use of the Worldbank Aggregate Governance Indicators (Kaufmann et al., 2006), which are measured in units ranging from -2.5 to 2.5, with higher values corresponding to better governance outcomes.[9] We took the average score of each country across the 6 governance indicators in 2000 and define a value of 0.5 or higher as good institutions and a value below 0.5 as bad institutions. From Figure 10 it can be seen that the negative relationship between long run GDP growth and resource wealth as shown in Figure 1 holds for countries with bad institutions, indicating a resource curse, while the result is the opposite for countries with good institutions: they show a positive relationship between long run GDP growth and resource wealth.

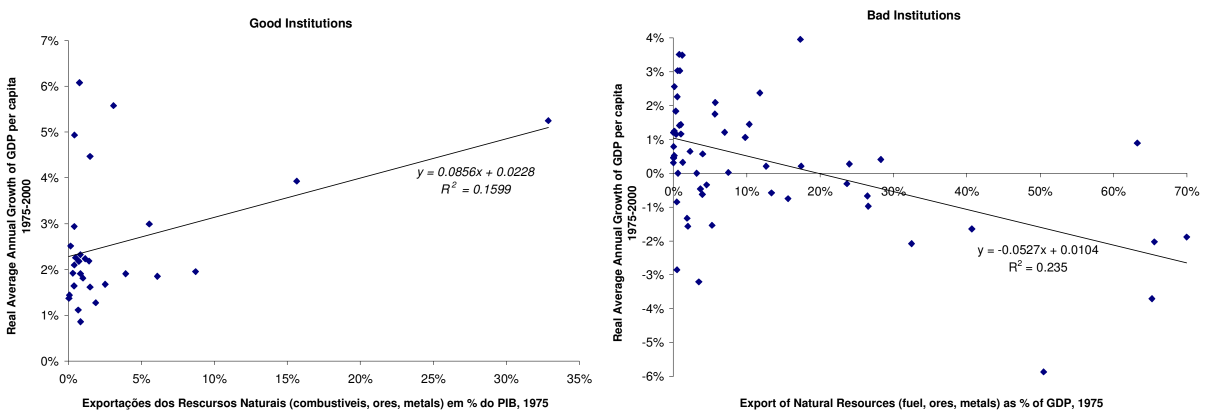

Figure 10. The relationship between Natural Resource Wealth and Economic Growth under Good and Bad Institutions

Although Sachs and Warner (1995) in their seminal study of the resource curse pointed to the Dutch disease as the principal determinant of the observed resource curse, the more recent literature shows a strong consensus in identifying institutional quality as the key mechanism establishing a causal relationship between natural resource wealth and economic development (see, for example, Auty, 2001; Bulte et al., 2003; Karl, 1997; Ross, 1999, 2001; Mehlum et al.,

[8] Note that Mehlum et al. (2005) show somewhat different subsamples of countries with the resource curse vanishing for countries with good institutions, rather than inversing as in our case.

[9] The governance indicators reflect the statistical compilation of responses on the quality of governance given by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries, as reported by a number of survey institutes, think tanks, non-governmental organizations, and international organizations.

2005, 2006; Sala-i-Martin and Subramanian, 2003; Torvik 2002). According to this literature, the impact of natural resources on economic development depends critically on the quality of institutions: natural resource rich countries with a positive growth record (like Botswana, Australia, Canada, Norway, USA, etc.) have escaped a resource curse due to the high quality of their institutions. With weak (*grabber friendly*) institutions natural resources do often not bring prosperity because their revenues are applied for unproductive activities, whereas in the presence of strong (*producer friendly*) institutions the natural resource abundance is likely to stimulate growth and development through productive investment in physical and human capital (Mehlum et al., 2005).

Most of the authors who stress the role of institutions as the fundamental link between natural resource abundance and economic performance, argue that natural resource exploration actively undermines the institutional quality of a country. As a result countries with weak institutions that start to explore their natural resources suffer from a double resource curse: weak institutions that impede economic development are further weakened by natural resource exploration as a result of which economic development is even more hampered. The underlying mechanism is to be found in the inclination of individuals to engage in rent-seeking rather than productive activities once resource wealth is emerging (see Baland and Francois 2000; Tornell and Lane, 1999; Torvik, 2002), which often includes preventing the establishment of proper institutions or active undermining of existing institutions.[10]

As noted before, rent-seeking behaviour has much to do with the nature of the resource wealth: point-resources – like oil, natural gas, minerals etc. – that allow for limiting access make a country particularly vulnerable for rent seeking with all its negative consequences for economic growth. One of these consequences is lack of competition and the accumulation of much wealth by a few. The higher the potential resource rents the stronger rent-seeking activities will be (Auty 2001). It is important to realize that rent-seeking as such is in principle not an illegal activity. However, often the existence of resource rents invokes illegal activities by individuals in search for personal wealth, which undermines government administrations and their institutions (Leite e Weidmann, 1999). In many cases, even in established market economies, the management of natural resources is often not guided by open and transparent competition and licensing of concessions but rather by politically networked interests that lead to

[10] Ross (2001) showed that in various South Asian countries the boom in forestry exploration caused the political elite to undermine the institution responsible for the management of state forests. Karl (1997) illustrates the same scenario regarding the management of oil in Venezuela.

negotiations between companies and senior government officials outside the control of democratic institutions and the public in general.

Another aspect of institutional quality as a determinant of the resource curse refers to the way resource revenues are spent in the economy. In general, a significant part of these resource revenues are captured by the government who regularly use these funds to satisfy specific interests of specific groups in the society, particular those that consitute and support their power base. This often not only implies that these revenues are invested in projects with limited return for the economy as a whole, but it also may invoke feelings of injustice and disputes between various groups within a society. Evidence exists that this undermines democratic processes and political stability. The latter is further enhanced by the fact that natural resources are often geographically concentrated, as a result of which discrimination across various interest groups easily translates into ethnic or regional tensions that ultimately may result in armed conflicts and civil wars (Collier e Hoeffler, 1998, 2000). Among other examples (like Sudan, Nigeria, or Congo), this mechanism has played an important role in Angola where a 30-year civil war has to a large extent been inspired and sustained by abundance of natural resources like oil and diamantes. It is needless to say that this strongly undermines economic development.

In sum, the ways in which the resource revenues are channeled to productive investments promoting economic growth or are captured by elites for personal enrichment depends very much on the quality of institutions, which in turn are itself also influenced by natural resource wealth. Hence, in this view the quality of the institutions determines whether the exploration of natural resources will be a blessing or a curse for a country.

4. Evaluating the Risk of a Resource Curse in Mozambique

The international literature on the natural resource curse is dominated by empirical cross-country analyses, with relatively little attention paid to case studies of specific countries (for an exception, see for example Sala-i-Martin and Subramanian 2003). In this section we do not offer another regression analysis on the existence and determinants of a resource curse, but instead evaluate the risks of a natural curse to occur in Mozambique in the (near) future. Of course this change in perspective is motivated by the very fact that Mozambique does not have a past of large scale resource extraction, while plans to do so exist and are already being implemented. By implication, our study controls for the variation in economic, demographic, and political factors typically present in cross-country studies.

The determinant of a resource curse as discussed in the previous section can essentially be aggregated into two areas: problems of economic nature (Dutch disease, including lack of planning and prudent economic policies, reduction of investments and debt accumulation) and problems of institutional nature (lack of transparency, corruption, rent-seeking, nepotism, waste of money, tribalism, weakening of democracy, etc.). Below we analyze the risk of a resource curse to happen in Mozambique by discussing subsequently these 2 major mechanisms behind a resource curse.

4.1 Problems of Economic Nature

The Dutch disease explanation for the existence of a resource curse points to the contraction of non-resources tradeable sectors as a result of a boom in the natural resource sector. The contraction reflects decreasing competitiveness of the other tradeable sector caused by real currency appreciation due to a substantial inflow of foreign exchange, which in turn has an upward effect on prices and wages. This so-called *spending effect* may be accompanied by a *movement effect* or *resource allocation effect* if factors of production are re-allocated towards the natural resource sector motivated by increased demand and higher wages. To assess the risk of these effects for Mozambique we show in Table 6 an estimate of the impact of the natural resource sector on the Balance of Payment until 2020[11], together with data on the exchange rate as well inflation.[12] From the Table it can be seen that so far there are no indications for a Dutch disease in Mozambique. The real exchange rate shows a trend of small depreciation rather than appreciation, while inflation figures also show a modest reduction over time. Except for their respective periods of construction, the different natural resource (related) projects in Mozambique will have a considerable positive effect on the Balance of Payment, reaching an estimated 1.3 billion US$ by 2020. It is to be noted that the balance of payment effect is much smaller than the direct effect on the balance of trade (around 3.4 billion US$) because of substantial amounts of profit repatriation and debt service. Assuming a constant GDP growth rate

[11] Calculated as the direct trade balance effect (export – import) minus expected debt service and profit repatriation. Our calculations took as a starting point the information provided by Andersson (2001), which we updated and revised where necessary, while adding our own calculations for those projects not included in his paper. For example, our calculations reflect higher aluminum prices than assumed by Andersson, a completely revised calculation for HCB due to the transfer of its ownership in 2007, as well as new information on the heavy sands mine of Moma, and the exploration of coal and the thermal production of electricity.

[12] Projections are from the Quadro Macro model of the Ministry of Planning and Development.

of 7.5%, the total balance of payment effect of the natural resource (related) sector is expected to amount to 7-8% of GDP in the long run, with a peak of 13% around 2012.

Table 6. Dutch Disease and Natural Resource Exploration

	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020
Balance of Payment Effect											
Aluminium (Mozal)	-318	-575	151	226	247	-467	437	451	460	470	480
Electricity	8	10	19	40	151	225	321	331	337	343	350
HCB	8	10	19	40	151	169	174	178	181	185	189
Mphanda Nkuwa	0	0	0	0	0	0	0	6	9	11	14
Thermal Central Inhambane	0	0	0	0	0	56	56	56	56	56	56
Thermal Central Moatize	0	0	0	0	0	0	91	91	91	91	91
Natural Gas (Sasol)	0	19	19	19	21	24	25	26	27	28	29
Mineral Coal (Moatize)	0	0	0	0	0	232	232	232	232	232	232
Heavy Sands	0	0	0	0	74	158	176	180	183	186	279
Corridor	0	0	0	0	12	33	49	50	51	52	143
Moma	0	0	0	0	62	125	127	130	132	134	136
TOTAL	**-310**	**-546**	**189**	**286**	**494**	**173**	**1,192**	**1,220**	**1,240**	**1,260**	**1,370**
BoP Effect in % of GDP	-8.6%	-12.2%	3.7%	4.8%	7.2%	2.2%	13.0%	11.5%	10.1%	8.9%	8.4%
Exchange Rate (MT/US$)	15.7	23.7	22.6	25.8	27.6	29.2					
Inflation Rate	12.7%	16.8%	12.6%	8.1%							

Obviously, these numbers will increase considerably once we include the revenues from oil exploration and export. However, lack of information does prevent us from making any meaningful estimate of the total balance of payment effect of oil exports. In sum, the aforementioned numbers are not yet a cause for great concern, but prudent spending of natural resource earnings remains a prerequisite for avoiding the risk of a Dutch disease to occur. This will be especially true in case Mozambique will start to export considerable quantities of oil (products).[13]

In addition, we consider the risk of a movement or resource allocation effect to happen in Mozambique as fairly small, given the relatively small number of jobs offered by the natural resource (related) projects in comparison with the total labour supply. It is to be noted that the main non-natural resource export sectors in Mozambique are the fisheries and agricultural sector, rather than the manufacturing sector, which is still characterized by a very small size and low level of technological advancement. Hence, in the case of a possible real exchange rate appreciation, the reduction of economic dynamics due to the so-called spill-over loss effect will

[13] It is to be noted that the inflow of foreign aid in Mozambique during the last decade has also been considerable, accounting for circa 20% of GDP in 2005, while not having caused Dutch disease like problems (see also Foster and Killick 2006).

mainly result from the agricultural rather than the manufacturing sector. However, so far there are no indications for this to happen.

As discussed in section 3.2 and 3.3, another risk of a large share of primary products in total exports is that of exchange rate volatility resulting from potential natural resource price fluctuations. Substantial exchange rate volatility will have a negative impact on ('normal') investments by economic agents while (in case of downward resource price movements) it also may cause difficulties in repaying foreign debts, thereby invoking macro-economic instability. However, we believe the risk of exchange rate volatility to be relatively small in the case of Mozambique since for the time to come a considerable part of primary exports in Mozambique is subject to a relatively stable price regime. For example, the majority of electricity exports is and will be subject to long-term contracts which usually do not allow for large price fluctuations. Concerning aluminum, coal and minerals extracted from the heavy sands deposits, their world market prices are in general much less volatile than crude oil prices.[14] In addition, their export prices are to a large extent also subject to long-term contracts that typically take the form of a fixed market price with standard escalation. Moreover, the prices of all these resource (electricity, coal, aluminum, minerals) are expected to gradually increase for the time to come due to the fact that increasing demand will outpace supply at the regional and international markets. Concerning electricity, the excess demand at the regional electricity market is principally driven by South Africa, while the increasing demand for the other resources is mainly caused by emerging economies like China, India and Brasil. However, if Mozambique turns into an oil producing country it will definitely become much more vulnerable to exchange rate volatility given the relatively large volatility of international oil prices in combination with the relatively large share of oil exports in total exports (see section 2).

Finally, in section 3.3 we also discussed the risk of reducing investments by the government in productive capacity, including education and infrastructure, as a result of the false sense of wealth brought by windfall profits from natural resources. If we do not consider potential windfall profits from oil exploration, we regard this risk as relatively small, simply because there are not much windfall profits to be expected. So far, the contracts between the Government of Mozambique and the companies exploring natural gas, hydro and mineral sands do foresee in very small revenues for the Mozambican government – both in relation to the

[14] For example, between 1950 and 2006 average annual fluctuation of real coal prices was -0.34% with a standard deviation of 0.11. During the same period, real oil prices fluctuated on average with 6.41% per year, while the standard deviation was 0.36 (Source: Energy Information Administration USA, www.eia.doe.gov)

profits of the companies involved as well as in relation to total internal state revenues. Concerning the latter, we estimate that fiscal state revenues from the various large companies in the primary sector will increase to around 120 million US$ by 2010 and 250 million US$ by 2020, which is equivalent to circa 7-8% of total fiscal and other internal revenues.[15] The underlying reason is that so far, the Government of Mozambique has granted very large tax benefits to these companies. Somewhat ironically, one could conclude that a positive effect of this is that there are simply no large amounts of money to be wasted on consumption goods or non-productive investments. The latter is further ensured, at least to some extent, by the continued strong role of the international community in providing financial resources for Mozambique. Again, this situation might change in case Mozambique will produce considerable quantities of oil, which might easily lead to large windfall profits in the case of (sudden) positive price movements at the international oil market. For example, if Mozambique becomes a small oil producer (like Chad or Gabon, 200,000 Barrels/day), a price increase of 10 US$ per Barrel implies an additional income of over 700 million US$. If we presume that oil contracts are such that 50% of these windfall profits will be captured by the oil companies, the state receives an additional 350 million US$, which might be more than 10% of total internal revenues. It needs no argument that if oil production will be more than the aforementioned 200,000 Barrels/day, these values easily become much larger and so does the risk of a false sense of wealth brought by windfall profits.

4.2 Problems of Institutional Nature

As discussed in section 3.4, institutions have been identified by many authors as the key mechanism behind the resource curse that might explain the large differences in welfare across resource abundant countries. To assess the potential role of institutions in avoiding or enhancing the risk of resource curse in Mozambique, we show in Table 7 the score of Mozambique on the aforementioned Worldbank Aggregate Governance Indicators ranking (Kaufmann et al. 2006), in comparison with other countries. As mentioned before, these indicators are measured in units ranging from -2.5 to 2.5, with higher values corresponding to better governance outcomes. We combine this information with the estimated resource intensity of Mozabique in 2010/15 (like in Table 4).

[15] Based on fiscal revenues projections from the Quadro Macro (MPD), assuming a 10% increase in 'normal' fiscal revenues as of 2010 and including Mozal (aluminum), HCB (hydro), Mphanda Nkuwa (hydro), the 2 new thermal power plants in Inhambane and Moatize, Sasol (natural gas), and the companies exploring the Moatize coal field and the Moma and Chibuto heavy sands deposits. See Annex 3 for more details.

Table 7. Institutional Quality, Resource Intensity and Economic Development

	WB Institutions indicator (-2.5 – 2.5)	**Fuel + ores and metals exports (% of GDP)**	**Fuel + ores and metals exports (% of exports)**	**GDP per capita (US$)**	**GDP per capita, PPP (US$)**	**HDI rank 2000 (1 - 177)**
	2000			*2000*	*2000*	*2000*
Sweden	1.68	2.1%	5.6%	27,012	24,526	6
Australia	1.64	6.3%	38.5%	20,285	26,181	3
Canada	1.61	6.8%	17.5%	23,198	27,880	5
Germany	1.51	1.2%	3.9%	22,750	26,075	20
Norway	1.50	25.2%	70.0%	39,322	35,132	1
United States	1.48	0.3%	3.8%	34,599	34,114	10
Japan	1.12	0.2%	1.6%	37,409	25,974	11
Chile	1.06	11.8%	46.5%	4,964	9,197	37
Botswana	0.77	3.6%	7.1%	3,135	7,525	131
Trinidad and Tobago	0.49	34.3%	65.4%	6,326	8,951	57
South Africa	0.27	4.9%	21.0%	2,910	9,434	120
Malaysia	0.23	11.6%	10.7%	3,881	8,952	61
Mali	-0.20	0.1%	0.3%	223	792	174
Malawi	-0.33	0.1%	0.4%	166	599	165
Mozambique 2010	**-0.40**	**40.4%**	**82.5%**	**208**	**874**	**168**
Mozambique 2010, sem alumínio	**-0.40**	**19.1%**	**39.0%**	**208**	**874**	**168**
Mozambique 2015, com Petroleo**	**-0.40**	**38.2%**	**87.6%**	**208**	**874**	**168**
Burkina Faso	-0.41	0.3%	3.3%	231	1,013	175
Zambia	-0.46	13.1%	63.9%	328	777	166
Gabon	-0.58	42.5%	85.0%	3,920	6,127	123
Nigeria	-0.99	49.7%	99.6%	332	878	158
Congo, Rep.*	-1.43	48.7%	88.0%	934	961	142
Angola	-1.78	6.2%	6.9%	715	1,952	160

* Natural Resource Data are of 1995

From the Table it can be concluded that with an average score of -0.40 in 2000, the institutional quality in Mozambique is still to be considered very weak. Again, by way of illustration, the right hand side of Table 7 lists the HDI ranking as well as GDP per capita for the selected countries in 2000. All together this raises a picture of Mozambique as a country that turns rapidly (within a couple of years) into a natural resource dependent economy with a weak institutional infrastructure and low levels of income and welfare. As discussed in section 3, this mix makes Mozambique very vulnerable for a resource curse that operates through the indirect link of institutions. To explore this risk somewhat further let us zoom in on the quality of institutions in Mozambique in international perspective. Table 8 shows the scores of Mozambique on the separate Government Indicators in comparison with a selection of other countries.

Table 8. Governance Indicators for Mozambique in International Perspective

2000	AVERAGE	Voice and Accountability	Political Stability	Government Effectiveness	Regulatory Quality	Rule of Law	Control of Corruption
SWEDEN	1.68	1.45	1.29	1.77	1.30	1.87	2.43
AUSTRALIA	1.64	1.48	1.13	1.89	1.43	1.89	2.00
CANADA	1.61	1.18	1.14	1.94	1.29	1.87	2.25
GERMANY	1.51	1.18	1.14	1.92	1.30	1.84	1.67
NORWAY	1.50	1.33	1.22	1.63	0.87	1.90	2.07
UNITED STATES	1.48	1.11	1.08	1.74	1.45	1.79	1.73
JAPAN	1.12	0.86	1.06	1.15	0.73	1.66	1.28
CHILE	1.06	0.47	0.66	1.31	1.19	1.23	1.50
BOTSWANA	0.77	0.79	0.75	0.84	0.71	0.56	0.95
TRINIDAD AND TOBAGO	0.49	0.58	0.33	0.61	0.73	0.38	0.31
SOUTH AFRICA	0.27	0.96	-0.31	0.40	-0.03	0.15	0.49
MALAYSIA	0.23	-0.35	0.15	0.71	0.28	0.39	0.21
MALI	-0.20	0.26	0.21	-0.72	0.17	-0.69	-0.45
MALAWI	-0.33	-0.31	-0.09	-0.57	-0.17	-0.59	-0.23
MOZAMBIQUE	**-0.40**	**-0.30**	**-0.33**	**-0.53**	**-0.12**	**-0.71**	**-0.39**
BURKINA FASO	-0.41	-0.36	-0.31	-0.38	-0.06	-0.61	-0.76
ZAMBIA	-0.46	-0.25	-0.73	-0.63	0.25	-0.55	-0.84
GABON	-0.58	-0.49	-0.45	-0.72	-0.36	-0.65	-0.81
NIGERIA	-0.99	-0.61	-1.64	-1.00	-0.45	-1.10	-1.16
CONGO	-1.43	-1.55	-1.85	-1.80	-1.09	-1.26	-1.05
ANGOLA	-1.78	-1.47	-2.47	-1.86	-1.85	-1.52	-1.52

From the Table it can be concluded that Mozambique scores relatively low in all dimensions of governance, and particularly with respect to the Rule of Law and Government Effectiveness. Table 7 and 8 show also, for example, that in terms of institutional quality, GDP/capita and welfare (HDI) Mozambique is not at all comparable to a rich resource abundant country like Norway, but very much comparable to Zambia. On the other hand, Mozambique scores much better than resource abundant countries like Angola, Congo and Nigeria in terms of institutional quality.

As we argued in section 3.4, the different types of natural resources make a country more or less vulnerable. Economies rich in concentrated resources – so-called point-sources (which can be easily controlled) like oil, natural gas, minerals, diamantes, etc. – are much more vulnerable to rent-seeking and other unproductive activities than economies rich in widely scattered resources (see also Bulte et al. (2003) for a cross country analysis confirming this point). The underlying reason is that point resources can be easily controlled by relatively small groups in society. As a result, elites in control of point resources might easily weaken their interest in broad based economic development, including promotion of education and democratic practices since this will dilute their power base. In section 2 we have shown that almost all major natural resources found in Mozambique are point resources: natural gas, mineral coal, mineral sands and maybe oil. Concerning the elites in control of these resources, fortunately we cannot conclude that they are actively resisting broad based economic development and weakening institutions in Mozambique. On the contrary, the government program has defined as its main goal the fight against poverty and many initiatives are taken in this respect. Moreover, Mozambique formally is a democracy and there is active involvement of the international community in all areas of policy making. However, it is also to be noted that Mozambique has a young and thus vulnerable democracy with effective control of the government being still relatively weak. In addition, the treatment of existing projects of large dimensions, the so-called mega projects – most of which operate in the area of natural resource exploration,[16] is so far characterized by a persistent lack of transparency and granting of extraordinary large fiscal benefits. If this situation is to be continued, Mozambique indeed is vulnerable to suffer at least the risk of continued weak institutional quality.

In this respect it is also to be realized that improvement of institutions is a complex and long-term process (North, 1990). To illustrate this we show in Table 9 the evolution of the 6 indicators for institutional quality in Mozambique for the period 1996-2005.

Table 9. Institutional Quality Mozambique 1996-2005

	1996	1998	1998	2000	2002	2003	2004	2005
Voice and Accountability	-0.26	-0.13	-0.13	-0.30	-0.30	-0.10	-0.11	-0.06
Political Stability	-0.59	-0.65	-0.65	-0.33	0.47	0.31	0.08	0.04
Government Effectiveness	-0.54	-0.42	-0.42	-0.53	-0.45	-0.48	-0.42	-0.34
Regulatory Quality	-1.07	-0.40	-0.40	-0.12	-0.55	-0.46	-0.43	-0.60
Rule of Law	-1.29	-1.00	-1.00	-0.71	-0.61	-0.71	-0.69	-0.72
Control of Corruption	-0.54	-0.87	-0.87	-0.39	-0.83	-0.80	-0.81	-0.68
Average	-0.72	-0.58	-0.58	-0.40	-0.38	-0.38	-0.40	-0.39

Source: Kaufmann et al. 2006

From the Table it can be concluded that in spite of continued high economic growth, political stability and considerable FDI (see also Table 6 in section 4.1), and a consistent political *discours* in favor of good governance, the regulatory quality and control of corruption in Mozambique have deteriorated significantly over the last 5 years. The only factor showing considerable improvement is political stability, as a result of which the overall quality of institutions in Mozambique (measured as the unweighted average of the 6 indicators) has been more or less constant since 2000. Again, this is not exactly the ideal starting point for large scale natural resource exploration, given the experience in other (African) countries during the last decades.

[16] Like, for example, the Mozal aluminium smelter, the exploration of natural gas by Sasol, the exploration of heavy sands in Moma and Chibuto and the exploration of coal in Moatize by the Brazilian company Vale do Rio Doce.

5. Ways to Revert a Resource Curse

As we have argued throughout this paper, the resource curse is not an inevitable phenomenon that comes automatically with natural resource wealth. In the end, a number of examples exist where countries with natural resource abundance have avoided a resource curse (like Botswana) and some even have benefited greatly from their resource wealth to construct a prosperous society on the basis of sustainable economic development (like Norway). Hence, the obvious key question is: how to revert the risk of resource curse in Mozambique? Without pretending to be exhaustive, we discuss below several options to decrease the risk of a resource curse to occur.

The first three options are principally motivated by the wish to reduce revenue volatility caused by fluctuations in natural resource prices. In general, volatility is a bad thing: it hampers investment by increasing interest rates and uncertainty, it makes government planning difficult and it tends to raise debts and deficits because it is easier to raise spending when prices rise than to cut it back when prices fall.

Prudent and anti-cyclical spending and borrowing

The first option to mitigate the negative effects of volatility is that the government sticks to a policy of prudent budgeting as well as to avoid pro-cyclical spending and borrowing. Such a policy also helps to curb Dutch disease like phenomena, such as inflation, that may be aggravated by increased government spending of resource revenues. Needless to say that this policy prescription is easier to give than to implement, especially in poor countries like Mozambique: it requires a strong finance minister who is able to fight uphill political battles to save, not spend, windfall profits while there are many public and politically networked interests in spending money. An unorthodox solution for this problem is to distribute resource revenues directly to the public and require the government to rely on normal fiscal principles to determine appropriate levels of taxation and expenditure (Sandbu 2006, Sala-i-Martin and Subramanian 2003). Although an original proposal that deserves to be taken seriously, it needs no argument that the practical difficulties of implementing this proposal in a poor country like Mozambique are enormous. Anyhow, at the very least, the economic damage caused by volatility asks for prudence in borrowing money with natural resources serving as collateral, a policy that the Government of Mozambique recently adopted in its relation with China. If these contracts are designed such that the burden of resource price fluctuation falls (to a large extent) on

Mozambique, the country indeed becomes increasingly vulnerable to external shocks with potential negative effects falling disproportionably on the poor who are typically less able to cope with volatility.

Stabilization Funds

Another way to reduce volatitliy in government resources is to use natural resource revenues to create stablization funds, the so-called rainy day funds (Stiglitz, 2005), which may provide some guarantee for smoothing government spending and investment against the background of fluctuating natural resource prices. These funds also provide other functions, like: reducing the risk that high resource revenues translate into Dutch disease problems (for example, through investments in other sectors in order to diversify exports), reducing the risk of revenues being squandered and instead are utilized for investments in human and physical capital that may compensate for the exhaustion of non-renewable resources, since stabilization funds create a certain degree of separation of accounts. While there are examples of well managed oil funds (for example in Alaska and Norway), they are exceptions that confirm the rule that these funds are very hard to operate and subject to political intrigues and corruption. One possible way to increase proper management of natural resource funds is that they should be directly fed with contracts between private firms and the government, in combination with budget rules about spending the money and possible involvement of a third party, like for example the Worldbank – in order to create a certain distance from the day to day whims of politics (see Shaxson (2005) for more details).[17]

Good Contracts

A third way to diminish volatility in government revenues is to design good contracts between the government and the mining and exploration firms, for example by using moving average prices rather than current prices in contracts, in order to shift (at least part of) the volatility to the private companies (Shaxson 2005). Often, the private companies are granted a fairly stable price, while both the negative and positive prices deviations at the international market – typically beyond the control of a particular country – are taken by the hosting country, thus magnifying revenue volatility for the country. Reversing this situation will reduce the latter, while large

[17] That this is not a full guarantee against mismanagement shows the case of the Chad-Cameroon project, which was designed according to these lines (and cited by Shaxson 2005 as a good example), but that has been simply cancelled by the government of Chad in order to spend the money in its own way (like, for example, on military expenses).

private firms can relatively easily insure themselves against price risks at the international finance markets.

Diversification

Obviously, reducing dependence on natural resources will reduce the potential negative impact of natural resource exploration on the economy. Resource dependence can be decreased by diversifying economic activity to other than natural resource sectors. In other words, it is important to develop broad based economic development promoting the agricultural, manufacturing and service sectors, thus creating economic dynamics and prosperity for the population as a whole – something that will never automatically result from natural resource exploration alone. Revenues from natural resources could help Mozambique to provide essential conditions for improving productivity and economic dynamics outside the natural resource sector, for example through financing physical infrastructure (roads, electricity), investment in human capital (education) and a healthy financial sector. However, a remaining key obstacle in Mozambique in this respect is its very complicated business environment. At the 2006 World Bank ranking 'Ease of Doing Business', Mozambique ranks 140 out of 175, particularly due to red tape (on average 113 days are required to start a business, 364 days to obtain licenses), high costs of import and export, and huge difficulties in enforcing contracts (on average 38 procedures, 1010 days). In essence this is again a problem of institutional quality. We acknowledge that improving this situation is very difficult and that resource revenues are probably of not much help in this respect, apart from the possibly positive effects of increasing salaries of civil servants.

Transparency

Transparency is one of the major, if not the most important, strategy to avert a resource curse. It includes to make public the interaction between the government and the companies extracting natural resources, the bidding and licensing procedures, the contracts signed, the quantity of resources explored, the revenues received and the way the revenues are spent. Transparency reduces opportunities for corruption trough an information effect – in the sense that if the public is better informed regarding the resource revenues received by the state, and this helps to motivate the population to exert pressure on the government to monitor these funds appropriately and to spend them on investments that contribute to poverty reduction.

Given the weak institutional infrastructure in Mozambique, the international community has a key role to play in improving and guaranteeing transparency. This includes exerting pressure on (foreign) companies in making their payments to the government public, and on the government to promote and implement anti-corruption measures. An important way to materialize this exists in the form of the so-called Extractive Industries Transparency Initiative (EITI), a potential powerful instrument to promote transparency and good governance in the area of natural resource exploration through international auditing and publishing of payments made by mining and extracting industries. Mozambique is currently considering membership of EITI.

Prudent Exploration

It is important to take into consideration the fact that in a certain way extraction of non-renewable resources reduces the wealth of a country – since the stock of natural capital reduces irreversibly through exploration of non-renewable resources. Like firms include in their accounts the depreciation of their activa, degradation of natural capital should ideally also be reflected in the (annual) accounts of a country. If a country sells its natural resources and borrows money with future resource wealth as collateral, it may show an increase of consumption and GDP in the short run, while integral accounting including all kinds of capital stocks may show that in fact the country is gradually reducing its wealth because once non-renewable resources like oil, natural gas, coal, minerals etc., are extracted and sold the natural capital component of a country's wealth decreases. Investments in human and physical capital may to some extent compensate for degradation of natural capital. In this way, natural resource exploration can be seen as a reallocation of a country's portfolio with one asset (resources) being substituted for other assets (human and physical capital). In any case, high extraction rates without appropriate planning regarding ways to spend the gained revenues on productive investments may easily lead to a sub-optimal strategy to increase wealth and reduce poverty. In such a case it is better to postpone exploration of the resources, a strategy which also makes perfectly sense in the light of current rising prices of the resources at the international market. Instead of selling now at a low price, selling in let's say 20 years time at a high price can be an optimal strategy if the goal is to increase welfare across existing and future generations.

6. Conclusions

In this paper we have examined whether the exploration of Mozambique's natural resources wealth will be a blessing or a curse for the country. The motivation for this research lies in the fact that many resource rich countries are among the poorest nations in the world, in spite of decennia-long exploration of their natural wealth. This phenomenon is often referred to as the 'paradox of abundance' or 'resource curse'. Mozambique has considerable quantities of unexplored natural resources, the large scale exploration of which has just begun and is expected to grow rapidly during the next decade. Will this turn out to be a blessing for the country, or rather a curse?

To answer this question, we first have estimated the potential resource wealth of Mozambique in comparison to that of other countries. The principal natural resources of Mozambique are: coal, mineral sands, natural gas, hydro, and probably also oil. We have presented our best estimates of the reserves and likely annual production and export figures for each of these resources, except for oil due to absence of useful data. Instead, we conducted a kind of thought experiment to see what natural resource exports would look like if Mozambique becomes an oil producing country similar to, respectively, an existing very small, small, medium, or big oil producing nation. Our calculations for the period 2000-2020 show that a large part of (future) primary exports consists of aluminum (products). In addition, electricity, mineral sands and coal will be major elements of Mozambique's export, while the share of natural gas is relatively small as compared to the other natural resources. We estimate that the share of primary exports in total exports will be in the range of 70-80%, or around 40% of GDP. Without aluminum, these numbers decrease to around 40-50% and 20%, respectively. If we suppose that Mozambique becomes a medium-size oil producing country (like Brazil or Libya), the share of primary exports in total exports will easily grow to over 90%. In addition, using a methodology used by the Worldbank to estimate the wealth of nations (Worldbank, 2006), we estimated the value of subsoil assets in Mozambique to be circa 1000 US$ per capita excluding oil, which – given Worldbank estimates of other natural, produced and intangible capital – is equivalent to circa 18% of Mozambique's total wealth. If we assume that Mozambique turns into a small or medium-size oil producing nation, the share of subsoil assets in total wealth in Mozambique will increase to circa 40% or 80%, respectively. In sum, while acknowledging that our estimates can and should be improved upon if more information comes available, these numbers make clear that Mozambique turns rapidly (within a couple of years) into a highly natural resource dependent economy comparable to countries like the Republic of Congo, Gabon, Norway, Trinidad and Tobago and Zambia. In addition we conclude that the relative impact of oil exploration will be big, even if Mozambique becomes 'only' a small oil producer in international perspective.

Next, we briefly reviewed the growing body of literature on the determinants of a natural resource curse, successively discussing the impact of natural resource wealth on the exchange rate and inflation ('Dutch disease'), investments, economic policy, and institutions. Subsequently, we assessed the risks of a resource curse to occur in Mozambique in the (near) future, both through a direct negative impact of natural resource exploration on economic variables as well as via an indirect negative impact operating through a deteriorating effect on institutional quality.

First, we have considered the risk of a real currency appreciation due to a substantial inflow of foreign exchange inherent to the export of natural resources, which may lead to decreasing competitiveness of the other tradeables sector as well as an upward effect on prices and wages ('Dutch disease'). Based on estimates of the Balance of Payment effect of foreseen natural resource exports (circa 7-8% of GDP) and the current trends of gradual depreciation and reduced inflation, we have argued that this risk is relatively small. Moreover, we think that reallocation of production factors towards the natural resource sector – with the accompanying upward effect on their reward – will be small given the large share of foreign capital and low levels of employment involved in the natural resource (related) projects. Nevertheless, prudent spending of natural resource earnings remains a prerequisite for avoiding the risk of a Dutch disease to occur. This will be especially important in case Mozambique will start to export oil. Additionally, we believe the risk of exchange rate volatility to be relatively small in the case of Mozambique since a considerable part of (future) primary exports in Mozambique (aluminum, electricity, coal, natural gas, minerals) is subject to a relatively stable price regime, as a result of long-term contracts and a likely gradual price increase for the time to come because of increasing demand at regional and international markets. However, if Mozambique turns into an oil producing country it will definitely become much more vulnerable to exchange rate volatility given the relatively large volatility of international oil prices in combination with the presumably relatively large share of oil exports in total exports. Furthermore, we regard the risk of a reduction in investments by the government in productive capacity – as a result of the false sense of wealth brought by windfall profits – relatively small in Mozambique, simply because the government revenues from natural resource exploration are quite small due to granting excessive fiscal benefits to exploration projects. Again, this situation might change in case Mozambique will produce oil, which might easily lead to large windfall profits in the case of (sudden) positive price movements at the international oil market.

While we believe that the risk of direct negative impacts of natural resource exploration on the Mozambican economy is likely to be fairly small (in particular during absence of oil exploration), we consider Mozambique to be vulnerable to a resource curse caused by the negative impact that natural resource wealth may have on the economy through its deteriorating effect on institutions. The institutional quality in Mozambique is arguably very weak and not significantly improving. Rather on the contrary: in spite of continued high economic growth, political stability, considerable FDI and a consistent political *discour* in favor of good governance, the regulatory quality and control of corruption in Mozambique have deteriorated significantly since 2000. Moreover, Mozambique has a young democracy with effective control of the government being still relatively fragile. In addition, the treatment of existing projects of large dimensions – most of them operating in the area of natural resource exploration – is so far characterized by a persistent lack of transparency and granting of extraordinary large fiscal benefits. Against this background, Mozambique is rapidly developing into a natural resource dependent economy based on so-called point-resources that can be easily controlled by relatively small groups in society. If the experience of other resource abundant countries may serve as any guide, this is everything but an ideal starting point for large scale natural resource exploration given the huge risk of a vicious circle of poor institutions that are further weakened by natural resource wealth, thereby weakening the economy, which will have a negative impact on institutions, etc.

Nevertheless, a resource curse is not a deterministic phenomenon: it can be avoided. We have argued that the risk of a resource in Mozambique can in principally be averted if the right mix of policies will be adopted. These include: prudent exploration, transparent management of revenues – possibly through a stabilization fund – guided by the goal of long-term macroeconomic stability and including active involvement of the civil society and the international community, prudent and anti-cyclical spending and borrowing, designing of good contracts between the government and private firms, and promotion of diverse sustainable economic development outside the natural resource sector. Of course, to realize this will be far from easy, especially since good policies require good institutions – which are not yet in place while also under threat of the imminent revenues from natural resource exploration. While we believe that Mozambique is not likely to be afflicted by a natural resource curse in the short run, the economy is indeed vulnerable to suffer from its resource abundance in the long run, and we think the risks are particularly high once Mozambique starts to explore oil.

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ANNEX 1 – Subsoil Asset Wealth

In section 2 of the main text we estimated the stock value of subsoil assets in Mozambique according to the methodology used by the Worldbank in its study 'Where is the Wealth of Nations?' (Worldbank 2006). The aggregate results are presented in Table 5 of the main text. Below we present the details.

Table A1.1 Estimate of Value of Natural Gas Stocks

Natural Gas				
Pande/Temande		Low	Medium	High
Quantity (q)	TJ	144,494	144,494	144,494
Rents (π)	US$/TJ	1000	1500	2000
Value (V)	US$	2,643,006,804	3,964,510,206	5,286,013,608

Table A1.2 Estimate of Value of Coal Stocks

Coal				
Moatize		Low	Medium	High
Quantity (q)	1000 Ton	15,000	15,000	15,000
Rents (π)	US$/ton	20	25	30
Value (V)	US$	5,487,438,562	6,859,298,203	8,231,157,843

Table A1.3 Estimate of Value of Heavy Sands Stocks in Moma

Heavy Sands - Moma				
Moma		Low	Medium	High
Ilmenite				
Quantity (q)	1000 Ton	1,200	1,200	1,200
Rents (π)	US$/ton	60	63	67
Value (V)	US$	1,306,010,378	1,382,834,518	1,459,658,658
Zircon				
Quantity (q)	1000 Ton	84	84	84
Rents (π)	US$/ton	490	508	525
Value (V)	US$	752,876,571	779,765,020	806,653,469
Rutile				
Quantity (q)	1000 Ton	32	32	32
Rents (π)	US$/ton	315	326	336
Value (V)	US$	181,497,030	187,546,931	193,596,832
Total Moma	US$	2,240,383,979	2,350,146,469	2,459,908,959

Table A1.3 Estimate of Value of Heavy Sands Stocks in Chibuto

Heavy Sands - Chibuto		Low	Medium	High
Titanium slag				
Quantity (q)	1000 Ton	1,000	1,000	1,000
Rents (π)	US$/ton	298	301	305
Value (V)	US$	5,441,709,907	5,505,730,024	5,569,750,140
Zircon				
Quantity (q)	1000 Ton	63	63	63
Rents (π)	US$/ton	490	508	525
Value (V)	US$	560,176,020	580,182,306	600,188,593
Rutile				
Quantity (q)	1000 Ton	12	12	12
Rents (π)	US$/ton	315	326	336
Value (V)	US$	70,294,088	72,637,224	74,980,361
High-purity pig iron				
Quantity (q)	1000 Ton	491	491	491
Rents (π)	US$/ton	210	214	217
Value (V)	US$	1,886,416,754	1,917,857,034	1,949,297,313
Leucoxene				
Quantity (q)	1000 Ton	6	6	6
Rents (π)	US$/ton	350	354	357
Value (V)	US$	40,972,875	41,382,603	41,792,332
Total Chibuto	US$	7,999,569,644	8,117,789,192	8,236,008,739

Table A1.5 Estimate of Value of Oil Stocks under different assumptions

Oil				
		Low	Medium	High
200,000 Barrel/day				
Quantity (q)	1000 Barrels	73,000	73,000	73,000
Rents (π)	US$/Barrel	28	35	42
Value (V)	US$	37,387,748,070	46,734,685,087	56,081,622,104
1,500,000 Barrel/day				
Quantity (q)	1000 Ton	547,500	547,500	547,500
Rents (π)	US$/ton	28	35	42
Value (V)	US$	280,408,110,522	350,510,138,152	420,612,165,783

ANNEX 2 - Natural Resource Sector and the Balance of Payment

In this annex we briefly describe the way in which we estimated the impact of the natural resource sector on the Balance of Payment until 2020. We define the Balance of Payment effect as the direct trade balance effect (exports minus imports) minus expected debt service and profit repatriation. Our calculations took as a starting point the information provided by Andersson (2001), which we updated and revised where necessary, while adding our own calculations for those projects not included in his paper. As described in the main text, the main sources of our information are the Ministry of Energy, the Ministry of Mineral Resources, and a variety of other sources including the Unites States Geological Survey (USGS) Minerals Yearbook, African Mining Review and websites of the involved companies themselves. The information below is summarized in Table A2.1 at the end of this Annex.

Aluminium - Mozal
Export and Import figures for 2000-2005 are taken from the SADC trade database (SADC, 2007). For the period 2006-2020 we assume a doubling of production capacity in 2010 (Mozal 3), as well as the following annual growth figures: 2007 (3%), 2008-2009 (1%), 2011 (10%), 2012, (5%), 2013-2014 (1%), 2015-2020 (0.5%). Concerning Mozal 3, we assumed investment data to be the same as for Mozal 1 (circa 1,350 million USD) as given by Andersson (2001), including the assumptions of a 3 year construction phase and 10% of total inputs during construction being sourced from Mozambique. Regarding profit repatriation and debt service, we used the figures provided by Andersson (2001) and subsequently increased this linearly in accordance with the extension of production capacity over time. It is to be noted that our estimates for the Balance of Payment effect of Mozal until 2008 are very much in line with those provided by Castel-Branco and Goldin (2003), once corrected for upwardly revised export figures based on actual information until 2005 reflecting increased aluminum prices.

Electricity, Hydro - HCB
Export figures for 2000-2006 are provided by HCB, as given in Ministry of Energy (2007a), and assumed to grow from 10,817 GWh in 2006 to a maximum of 10,547 GWh as of 2009 (reflecting effective maximum capacity of HCB). In addition, we assumed export prices to gradually increase from circa 1.6 USDc/kWh in 2006 to circa 2.6 USDc/kWh by 2020. Regarding profits we assume a profit margin of 0.1 USDc/kWh, of which 82% is repatriated until 2006 and 15% as of 2007 – reflecting the transfer of ownership from Portugal to Mozambique. As a result, our numbers for HCB differ significantly from those provided by Andersson (2001) because his calculations obviously did not yet reflect the new deal with ESKOM on electricity prices (2002) as well as the transfer of majority ownership of HCB from Portugal to Mozambique in 2007. We follow Andersson (2001) in assuming that until 2006 as much as 70% of the turnover is used for debt service payments to the Government of Portugal, while we assume that this reduces to 30% as of 2007 (this would imply a total debt payment of around 1 billion US$ for the period 2007-2020, which is roughly the amount of debt agreed upon with the transfer of ownership).

Electricity, Hydro – Mphanda Nkuwa
We assume Mphanda Nkuwa to become operational in 2014. Export figures are based annual export of 4,555 GWh against 2.75 USDc/kWh in 2014, with an annual increase of 1%. Furthermore we assume total construction costs of 1,600 million US$ (Ministry of Energy, 2007b), of which 10% will be sourced from Mozambique, and a 5-year construction period (2009-2013). Regarding profits we assume again a profit margin of 0.1 USDc/kWh and foreign ownership of 70%, implying that 70% of total profits will be repatriated. Finally, we assume annual debt service repayments to be 10% of total debt, with debt being 70% of total investment costs (assuming 30% equity).

Electricity, Thermal, Natural Gas, Inhambane
We assume the new 700 MW natural gas fired electricity plant in Inhambane will become operational in 2010. Export figures are based on a price of 3.20 USDc/kWh in 2010, with an annual increase of 1%, and on the scenario that initially all its electricity will be exported to South Africa, while as of 2014 about 100

MW will be acquired by EdM and as of 2017 an additional 200 MW goes to the Corridor Heavy Sands project. Furthermore we assume total construction costs of 800 million US$, of which 10% will be sourced from Mozambique, and a 4-year construction period (2007-2010, with major works in 2008-2009). Similar to Mphanda Nkuwa we assume again a profit margin of 0.1 USDc/kWh and foreign ownership of 70%, implying that 70% of total profits will be repatriated. Finally, we assume annual debt service repayments to be 10% of total debt, with debt being 70% of total investment costs (assuming 30% equity).

Electricity, Thermal, Coal, Moatize

We assume the new 1,500 MW natural gas fired electricity plant in Moatize will become operational in 2012 (1,000MW) and 2015 (500MW). Export figures are based on a price of 3.50 USDc/kWh in 2010, with an annual increase of 1%, and on the assumption that 90% of its production will be exported. Furthermore we assume total construction costs of 1,300 million US$, of which 10% will be sourced from Mozambique, and a 7-year construction period (2009-2015), with major works in 2009-2011 and 2015). Similar to Mphanda Nkuwa and the gas-fired thermal plant in Inhambane, we assume again a profit margin of 0.1 USDc/kWh and foreign ownership of 70%, implying that 70% of total profits will be repatriated. Finally, we assume annual debt service repayments to be 10% of total debt, with debt being 70% of total investment costs (assuming 30% equity).

Natural Gas - SASOL

Export figures for 2000-2006 are provided by Sasol, as given in Ministry of Energy (2007a), and assumed to grow from 102,061 TJ in 2006 to 137,269 TJ as of 2010 (reflecting effective maximum capacity of HCB). In addition, we assumed export prices to gradually increase from circa 1.20 TJ US$/GJ in 2006 to circa 1.49 US$/GJ by 2020. Regarding the Balance of Payment effect, we used the figures provided by Andersson (2001) and subsequently increased this linearly in accordance with the extension of export quantities over time.

Coal - MOATIZE

We assume the large-scale exploration of the Moatize coal mine to start in 2009. Export figures are based on 90% of total production of 15 million ton/year at a price of 35 USD/ton. Furthermore we assume total construction costs of 1,000 million US$, of which 10% will be sourced from Mozambique, and a 4-year construction period (2006-2009), with major works in 2008-2009). We assume profits to be 40% of total sales and foreign ownership of 90%, implying that 90% of total profits will be repatriated. Finally, we assume annual debt service repayments to be 10% of total debt, with debt being 70% of total investment costs (assuming 30% equity).

Heavy Sands - CORRIDOR

We assume the large-scale exploration of the Chibuto heavy sands mine to start in 2010. Export figures are based on the information provided in Table 3 in the main text Furthermore we assume total construction costs of 1,000 million US$, and a 10-year construction period (2007-2016), with major works in 2008-2009 and 2014-16). Regarding the Balance of Payment effect, we used the figures provided by Andersson (2001) and subsequently increased this linearly in accordance with the extension of production over time.

Heavy Sands - MOMA

We assume the large-scale exploration of the Moma heavy sands mine to start in 2007. Export figures are based on the information provided in Table 3 in the main text. Furthermore we assume total construction costs of 200 million US$, and a 3-year construction period (2005-2007). Profits figures are taken from Mirabaud (2007) and we assume foreign ownership (Kenmare Resources) of 95%, implying that 95% of total profits will be repatriated. Finally, we assume annual debt service repayments to be 10% of total debt, with debt being 70% of total investment costs (assuming 30% equity).

Table A2.1a Trade Balance & Balance of Payment Effect (million USD)

Aluminium - MOZAL	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	1,106	1,117	1,128	1,692	1,861	1,954	1,974	1,993	2,003	2,013	2,023	2,034	2,044	2,054
Import	580	586	592	887	976	1,025	1,035	1,046	1,051	1,056	1,061	1,067	1,072	1,077
Import construction phase			212	845	160									
Trade Balance Effect	526	531	324	-41	725	929	938	948	953	957	962	967	972	977
Profits Repatriated	124	124	124	186	205	215	217	217	217	217	217	217	217	217
Debt Service	160	160	160	240	264	277	280	280	280	280	280	280	280	280
Balance of Payment Effect	242	247	40	-467	256	437	442	451	456	460	465	470	475	480

Electrcity, Hydro - HCB	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	206	219	233	245	250	252	255	257	260	262	265	268	270	273
Import														
Trade Balance Effect	206	219	233	245	250	252	255	257	260	262	265	268	270	273
Profits	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Profits Repatriated	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Debt Payment	62	66	70	73	75	76	76	77	78	79	79	80	81	82
Balance of Payment Effect	142	151	161	169	172	174	176	178	179	181	183	185	187	189

Electricity, Hydro - MPHANDA NKUWA	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	0	0	0	0	0	0	0	125	127	128	129	130	132	133
Import														
Import construction phase			270	360	450	180	180							
Trade Balance Effect	0	0	-270	-360	-450	-180	-180	125	127	128	129	130	132	133
Profits	0	0	0	0	0	0	0	10	10	10	10	10	10	10
Profits Repatriated	0	0	0	0	0	0	0	7	7	7	7	7	7	7
Debt Repayment								112	112	112	112	112	112	112
Balance of Payment Effect								6	8	9	10	11	13	14

Electricity - Thermal Natural Gas - Inhambane	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	0	0	0	141	143	144	146	140	141	143	96	97	98	99
Import														
Import construction phase	90	270	315	45										
Trade Balance Effect	-90	-270	-315	96	143	144	146	140	141	143	96	97	98	99
Profits	0.0	0.0	0.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Profits Repatriated	0.0	0.0	0.0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Debt Repayment				56	56	56	56	56	56	56	56	56	56	56
Balance of Payment Effect				37	83	84	86	80	82	83	37	37	38	39

Table A2.1b Trade Balance & Balance of Payment Effect (million USD)

Electricity - Thermal Coal - Moatize	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	0	0	0	0	0	221	223	225	341	345	348	351	355	359
Import														
Import construction phase			150	270	270	90	180	180	45					
Trade Balance Effect	0	0	-150	-270	-270	131	43	45	296	345	348	351	355	359
Profits	0	0	0	0	0	7	7	7	11	11	11	11	11	11
Profits Repatriated	0	0	0	0	0	5	5	5	7	7	7	7	7	7
Debt Repayment						91	91	91	91	91	91	91	91	91
Balance of Payment Effect			-150	-270	-270	35	-53	-51	198	246	250	253	257	260

Natural Gas - SASOL	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export		148	163	168	171	175	178	182	186	189	193	197	201	205
Import														
Trade Balance Effect	132	148	163	168	171	175	178	182	186	189	193	197	201	205
Balance of Payment Effect	19	21	23	24	25	25	26	26	27	27	28	28	29	29

Coal - MOATIZE	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	0.2	0.2	472.5	472.5	472.5	472.5	472.5	472.5	472.5	472.5	472.5	472.5	472.5	472.5
Import														
Import construction phase	270	450	90											
Trade Balance Effect	-270	-450	383	473	473	473	473	473	473	473	473	473	473	473
Profits	0.1	0.1	189.0	189.0	189.0	189.0	189.0	189.0	189.0	189.0	189.0	189.0	189.0	189.0
Profits Repatriated	0.0	0.0	132.3	132.3	132.3	132.3	132.3	132.3	132.3	132.3	132.3	132.3	132.3	132.3
Debt Repayment			70	70	70	70	70	70	70	70	70	70	70	70
Balance of Payment Effect			180	270	270	270	270	270	270	270	270	270	270	270

Heavy Sands - CORRIDOR	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	0	0	0	238	241	244	246	249	251	254	257	260	703	711
Import														
Import construction phase	96	288	200	5	1	1	1	100	300	100				
Trade Balance Effect	-96	-288	-200	233	240	243	245	149	-49	154	257	260	703	711
	4	12	35	33	49	49	50	50	51	51	52	52	141	143

Heavy Sands - MOMA	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Export	119	122	125	191	196	200	205	209	214	219	224	229	234	239
Import														
Import construction phase	50													
Trade Balance Effect	69	122	125	191	196	200	205	209	214	219	224	229	234	239
Profits	27	48	51	55	59	62	65	69	73	77	81	85	89	94
Profits Repatriated	26	46	48	52	56	59	62	66	69	73	77	81	85	89
Debt Repayment	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Balance of Payment Effect	30	62	62	125	126	127	129	130	131	132	133	134	135	136

ANNEX 3 - Natural Resource Sector and Government Revenues

In section 4.1 we referred to an estimate of the contribution of the natural resource sector to government revenues. Our estimate is based on fiscal revenues projections from the Quadro Macro (MPD), assuming a 10% increase in 'normal' fiscal revenues as of 2010 and including specific projections for the different mega projects. The table below provides more details.

Table A3.1 Fiscal Effect (million USD)

	2000	**2002**	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**	**2016**	**2018**	**2020**
Fiscal Revenues	450	461	791	871	1,155	1,350	1,634	1,977	2,392	2,894	3,502
Natural Resources (mega projects)	11	18	26	44	64	122	156	182	201	215	256
MOZAL	4	9	16	16	16	26	37	46	56	68	83
HCB	7	9	8	12	11	10	10	11	11	10	10
MPHANDA NKUWA	0	0	0	0	0	0	0	13	13	13	13
CENTRAL TERMICA – Natural Gas	0	0	0	0	0	8	8	8	8	8	8
CENTRAL TERMICA - Coal	0	0	0	0	0	0	12	12	18	18	18
SASOL - Gas Natural Inhambane	0	0	2	16	36	49	51	53	55	57	60
MOATIZE coal mine - Moatize Tete	0	0	0	0	0	24	24	24	24	24	24
CORRIDOR Heavy Sands - Chibuto Gaza	0	0	0	0	1	5	13	13	13	14	38
MOMA Heavy Sands - Moma Zambezi	0	0	0	0	0	0	1	2	2	2	2
Other	439	443	765	827	1,091	1,350	1,634	1,977	2,392	2,894	3,502
Other Revenues	25	28	34	39	90	57	68	83	100	121	147
TOTAL	**475**	**488**	**824**	**909**	**1,245**	**1,407**	**1,777**	**2,151**	**2,602**	**3,149**	**3,810**
% Natural Resources (megaprojects)	2.3%	3.7%	3.1%	4.8%	5.2%	8.7%	8.8%	8.5%	7.7%	6.8%	6.7%

ANNEX 4 – POTENTIAL OIL FIELDS MOZAMBIQUE