TSE WP working paper series

09-012

Research Group: *Environmental Economics and Natural Resources*

February 12, 2009

Taxation of Oil Products and GDP Dynamics of Oil-Rich Countries

JULIEN DAUBANES

Ecole d'économie de Toulouse (TSE) - Manufacture des Tabacs
Aile Jean-Jacques Laffont - 21, allée de Brienne - 31000 TOULOUSE
Tél : +33 (0) 5 61 12 85 89 - Fax : +33 (0) 5 61 12 86 37 - **www.TSE-fr.eu** - contact@TSE-fr.eu

Toulouse School of Economics

Taxation of Oil Products and GDP Dynamics of Oil-rich Countries*

Julien Daubanes**

CER-ETH at ETHZ (Swiss Federal Institute of Technology Zürich) and LERNA at TSE (Toulouse School of Economics)

This version, February 12, 2009

Abstract

This article proposes a complementary explanation for why oil-rich economies have experienced a relative low GDP growth over the last decades: the proportion of taxes in the prices of petroleum products have been globally increasing in the last four decades, making oil revenues grow slower than output from manufacturing and yielding a low GDP growth for oil-exporting countries. This is illustrated in a two-country model of oil depletion which examines why a net oil-exporting country and a net oil-importing country are differently affected by increased taxes on resource use. The hypothesis is constructed on the theory of non-renewable resources taxation. The argument is based on the distributional effects of taxes on exhaustible resources, which are mainly borne by the suppliers. The theoretical predictions are not invalidated by available statistics.

JEL classification: Q3; O4; F4
Keywords: Oil curse; Non-renewable resources; Taxes; Oil revenues; GDP

*I am very much indebted to Sjak Smulders and Jean-Pierre Amigues for very useful comments leading to substantial improvements of the paper. I also thank Saraly Andrade de Sa, Christa Brunnschweiler, Justin Caron, André Grimaud, Pierre Lasserre, Lisa Leinert, Raphael Levy, Thomas Rutherford, Simone Valente and Cees Withagen, as well as the participants at the Montreal Natural Resources and Environmental Economics Workshop for making helpful suggestions on an earlier draft. However, they should not be held responsible for the views expressed in the paper.

**CER-ETH, Center of Economic Research at ETHZ, ZUE F 14, Zürichbergstrasse 18, 8092 Zürich, SWITZERLAND
E-mail: jdaubanes@ethz.ch; phone: +41 44 632 24 27; fax: +41 44 632 13 62

1 Introduction

Development economists and resource economists have advanced several complementary theories for why oil-exporting economies have experienced low income growth. Alternatively, an explanation may be provided on the basis of the literature about the taxation of exhaustible resources. The rent extraction effect of those taxes and their trend over the last decades may account for a substantial part of oil-rich economies' GDP dynamics. This is the hypothesis developed in this paper: the GDP of oil-rich countries may have relatively decreased because a growing share of their rents has been captured by tax revenues of top oil-consuming countries.

The resource curse literature in fact deals with the role of all kinds of natural resources, mostly non-renewable though, and does not focus exclusively on petroleum. Many scholars have supported the view that resource-abundant economies have tended to grow slower than others. In particular, the seminal study by Sachs and Warner (1995 and 2001) assesses a negative relationship between the ratio of natural resource exports to GDP and economic growth. Now revisited on the basis of other measures of resource-abundance, the negative influence of large quantities of natural resources on economic growth is still debated (e.g. Brunnschweiler and Bulte, 2008).

However, evidence bears clear witness to the negative effect of large oil endowments on growth. Indeed, some of the most tremendous development failures are among oil-exporting countries. Gylfason (2002) computes that, between 1965 and 1998, OPEC members experienced a yearly average 1.3% decrease in their per capita GNP, whereas lower- and middle-income developing countries as a whole grew by an average rate of 2.2% over the same period. Figure 1 illustrates this difference in growth rates. In particular, GNP per capita in Nigeria remained constant over this period. The rate of growth of per capita GNP was on average -1% per year in Iran and Venezuela, -2% in Libya, -3% in Iraq and Kuwait and -6% in Qatar (from 1970 to 1995 for this latter country)[1].

More recently, Kaldor, Karl and Said (2007) select a group of oil-dependent states, defined as countries with high ratios of fuel-based exports to merchandize exports in 2004, and compare their per capita GDP growth between 1980 and 2004. Figure 2 shows that many oil dependent states experienced much lower growth rates than both the world average and the average amongst lower-income developing countries[2]. Some of them had very low, negative growth rates over this period. This was particularly true for three major oil-producing countries, namely the United Arab Emirates, Saudi Arabia and Venezuela.

Hence, if the curse of natural resources is a debated issue, the low growth performances of oil-exporting countries is unequivocal, and case studies on the latter countries have often provided illustrations of the curse (e.g. Auty, 2001, and Gylfason, 2002).

The economics literature has formulated several classes of explanations for the so-called curse of natural resources. Of course, these theories are not necessarily competing and it is believed that they all play some role in explaining the low economic performances

[1]Source: World Bank, World Development Indicators (2000).
[2]Source: World Bank, World Development Indicators (2006).

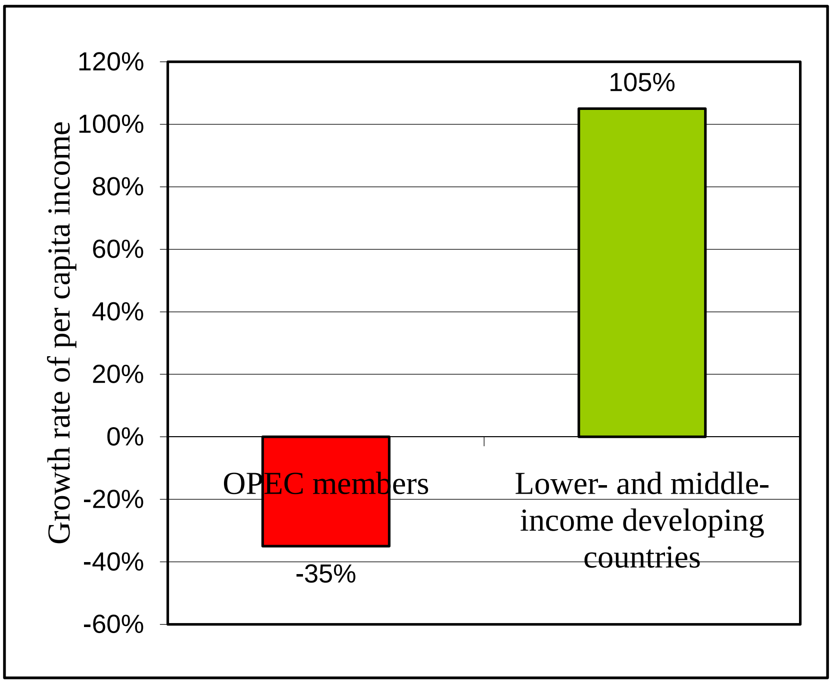

Figure 1: Rate of growth of per capita income in OPEC countries and lower- and middle-income developing countries from 1965 to 1998.

of resource-rich countries. Let us mention the main classes of explanations and discuss their ability to convincingly explain oil-abundant countries' situations.

The controversial Prebisch-Singer hypothesis (Prebisch, 1950, and Singer, 1950) points to a tendency for prices of primary commodities to decline relatively to those of manufactured goods. Although this fact seems to be verified for oil prices, the tendency is far from settled in general (Sapsford, 1990, and Kellard and Wohar, 2003). This dynamics of relative prices would be partly explained by the increasing competitive structure of primary sectors relative to manufacturing sectors. This seems to hardly apply to the case of oil production.

Another explanation is provided by the overshooting theory. Rodríguez and Sachs (1999) emphasize that a temporary resource boom pushes an economy towards its steady state, thus experiencing slower post-boom transitional dynamics. In their model, an economy can even rise above its long term steady-state. In this case, it experiences negative growth after the resource boom. This dynamics is somewhat exaggerated by the exogeneity of the extractive activity and the assumption that resource revenues can only be used in the form of capital, thus forcing the accumulation engine. However, this theory argues very convincingly that resource-abundant economies live temporarily "beyond their means" and the model approximates the Venezuelan economy's performance over its oil boom. Nevertheless, the "key assumption (...) that exports of natural resources cannot expand at the same rate as other industries" remains unexplained.

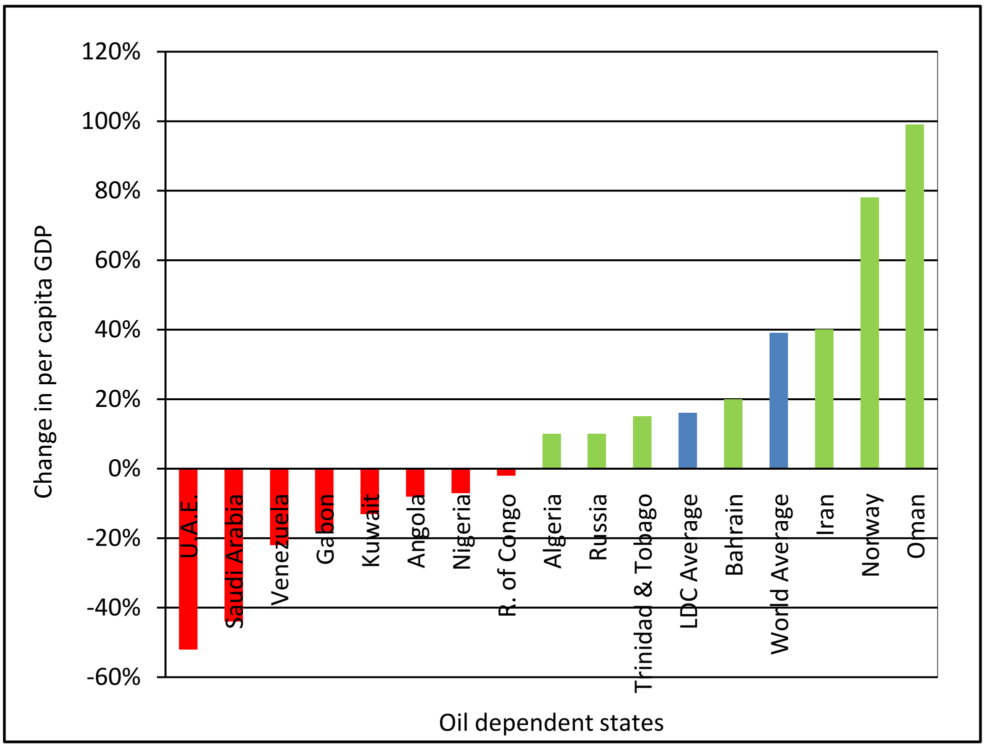

Figure 2: Change in per capita GDP in oil dependent countries between 1980 and 2004.

The Dutch disease theory supports the view that a natural resource boom can lead an economy to shift resources away from other sectors, possibly explaining temporarily low economic performance. The basic argument is that larger exports of natural resources entail a currency appreciation, shifting resources to the production of non-tradable goods at the expense of the production of tradable goods. If the tradable sector is more capital-intensive (Corden and Neary, 1982) or more favorable to growth in some way (In Krugman, 1987, and Matsuyama, 1992, manufacturing features learning-by-doing), the resource-abundant economy can experience slow capital accumulation or can irreversibly lose competitiveness in manufacturing, leading to relatively low growth even after the boom has subsided. However, it can be argued that oil extraction can be a long-lasting (though not permanent), continuous process and is, after all, given the discovery and transformation processes it is going with, comparable to manufacturing (Davis and Tilton, 2005). A simple related story is that of the frictions which render the switch from resource extraction back to traditional tradable sectors after a boom difficult.

It has been also suggested that a possible cause of low development in oil-rich countries relies in the concentration of identifiable rents from resource-abundance. This is likely to encourage socially damaging rent-seeking behaviors (Auty, 1997). The symptoms are manifold; they can take the form of protection, other privileges, corruption..., all contributing to the deterioration of institutions and to lower economic growth (Bardhan, 1997).

Resource-abundance may also give people a "false sense of security" (Gylfason, 2001), providing governments with low incentives to adopt good economic policies. In particular, this results in relatively low openness to trade, and bureaucratic and institutional inefficiencies (Sachs and Warner, 1999). These government failures may also explain why resource-rich countries, especially the OPEC member countries, have devoted inadequate expenditures to education (Gylfason et al., 1999, and Gylfason, 2001).

The present paper develops a complementary hypothesis that has yet to be suggested: the proportion of taxes in the prices of petroleum products, which has increased substantially, contributed to low GDP growth in oil-exporting countries.

The argument is based on the theory of the taxation of exhaustible resources. Since the seminal article by Hotelling (1931), several contributions, among which Dasgupta and Heal (1979), Dasgupta, Heal and Stiglitz (1980) and Sinn (1982), have evoked the distributional effects of taxes (anticipated or not) on exhaustible resources. These taxes capture the pure rents generated by mining activity, thus transferring a part of the profits from extraction to the tax revenues of the fiscal authority. This can be explained by the rather inelastic resource supply induced by the finiteness of cumulated extracted flows (Sinn, 2008). There is no general argument about the effect of standard commodity taxation on the exporters and the importers of the commodity. However, we shall see that the exhaustible nature of non-renewable resources is critical. For instance, in a multi-country model where an exhaustible resource is entirely owned by one region, resource taxation results in an international transfer from the exporting-region to the importing ones. This has been examined by Bergstrom (1982), Brander and Djajic (1983) and Daubanes and Grimaud (2006).

Nevertheless, these papers have not drawn all the implications of the distributional effect of exhaustible resources taxation. In particular, they have not investigated how this transfer affects the GDP components of the resource-importing and the resource-exporting countries and how the dynamics of these components is altered by variations in the resource taxes over time. Moreover, due to a lack of data on oil-product taxation at the global level, the historical trend in taxes on these products has not been assessed until now. Doing so will enable us to formulate our hypothesis.

The paper is organized as follows. Section 2 refers to the available empirical studies showing that the share of taxes in petroleum products prices has been rising over the last decades. Section 3 proposes a dynamic, general equilibrium, two-country (oil-exporter and oil-importer) model of oil depletion. This aims at illustrating how this historical trend, taken as exogenous, has differently affected the GDPs of the oil-exporting and the oil-importing regions. In particular, it shows that the increasing path of taxes entailed lower GDP growth in the exporting country. Section 4 confronts the intermediary theoretical prediction that oil revenues grew slower than output from manufacturing to available statistics. Moreover, there is evidence that the effect of increasing taxes on oil products may have been of substantial magnitude. Section 5 draws the implications of the analysis.

2 Trends in taxes on oil products

One can encounter difficulties in assessing trends in fuel taxes. This is partly due to a lack of empirical work on the issue. Let us refer here to some statistical studies. Although partial, they suggest an increase in the proportion of tax in the prices of fuel products over the last four decades.

Recent data are available for the EU15, which represented 20% of world oil consumption in the early 2000s[3]. Indicator Fact Sheets of the European Environment Agency (2002 and 2007) provide data[4] on prices and taxes of four categories of oil-based products, namely unleaded gasoline for transport, diesel for transport, heating oil for households and fuel oil for industry, for the periods 1985-2001 and 1991-2005. For the period 1985-2001, the proportion of tax in final energy prices has increased for all categories at important rates. For instance, the average[5] proportion of tax in fuel oil prices has risen by 140%. For the period 1991-2005, the data suggest significant increases in the proportion of tax in prices of all kinds of oil products. Put together, these two studies describe the increases in the proportions of tax in prices over the longest possible periods, between 1985 and 2005. These are represented in Figure 3, where a jump in energy taxes in the EU15 can clearly be seen.

Europe is one of the top oil-consuming regions but is not representative of the World as a whole. Hence, it is worth focusing on how tax rates on petroleum products have evolved on a larger scale. Gupta and Mahler (1995) provide data on regional average tax rates, as percentage of tax exclusive retail price, for five categories of petroleum products (Premium gasoline, regular gasoline, kerosene, automotive and heavy fuel oil) in 1974 and 1990[6]. In the OECD countries, which represented more than 62% of world oil consumption in 1990[7], the figures show a sharp increase in ad valorem tax rates on oil products between 1974 and 1990. Figure 4 illustrates these changes.

Data are less readily available for non-OECD countries. However, Gupta and Mahler (1995) compute average tax rates at the continental and world levels. Figure 5 shows that the tax rates on oil products have globally increased, except for regular gasoline, whose tax rate has decreased by 1%. The tax increases are more moderate at the world level than in the OECD. However, for some products, the ad valorem tax rate has risen drastically. For example, the world average tax rates on kerosene and heavy fuel oil have jumped by 71% and 166% respectively.

This global increase should not hide regional disparities. In Africa and Central and South America, which together represented 6% of world oil consumption in 1990[8], tax rates have increased much more moderately than in the OECD, whereas in Asian non-OECD member countries, representing 10% of world oil consumption in 1990[9], they have

[3]Source: Energy Information Administration (2003).

[4]Source: Eurostat.

[5]Member states are weighted according to their respective energy consumption.

[6]Sources: Saito (1975), OECD (1990, 1991, 1992), Energy Détente and authors' estimates.

[7]Source: Energy Information Administration (2003).

[8]Source: Energy Information Administration (2003).

[9]Source: Energy Information Administration (2003).

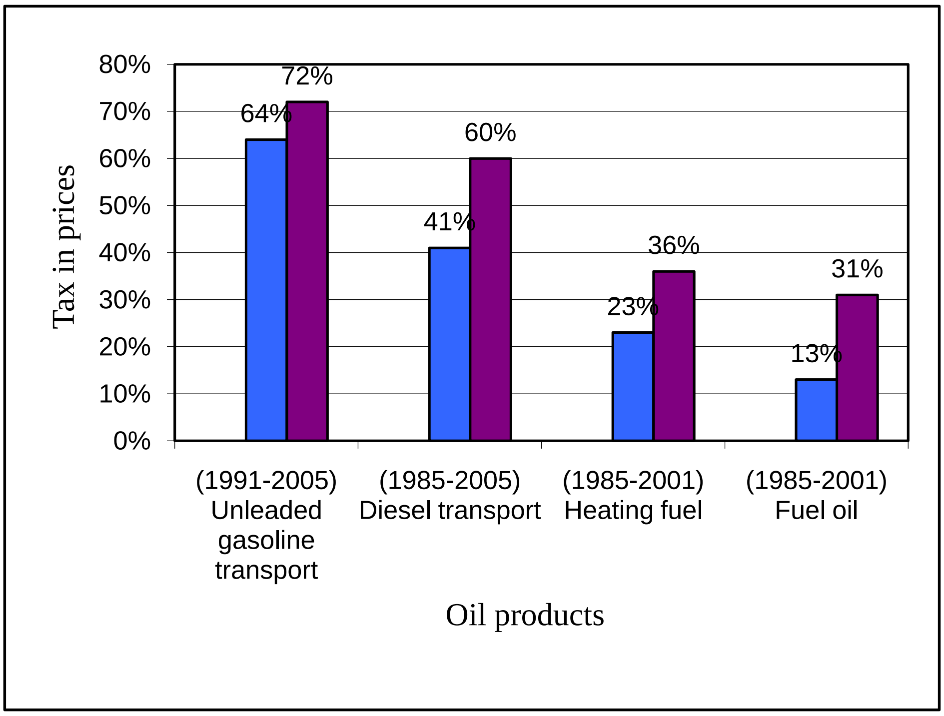

Figure 3: Proportion of tax in final energy prices in the EU15 (longest possible period given available data).

decreased markedly. As for the Middle East, data are far from being complete. However, they suggest that tax rates have either decreased or remained constant[10].

Because of the specific tax components of energy prices, tax rates and proportions of tax in the prices are influenced by the tax exclusive prices and are therefore rather volatile. Taking this volatility into account would require having more complete time series. Nevertheless, the variations noted above are marked enough to draw a reasonable conclusion about the trends in fuel taxes.

Overall, the ad valorem tax rates on oil products (or the proportions of tax in final prices)[11] can be considered to have significantly risen at the global scale, this increase being especially marked in top oil-consuming regions. For the sake of simplicity[12], we will assume that taxes have increased homogeneously at the world level, i.e. at the same rate in all regions.

[10]Some data are available for Ecuador, Indonesia, Nigeria, Saudi Arabia and Venezuela.

[11]The rate of growth of the ad valorem tax rate and of the corresponding proportion of tax in the final price have the same sign.

[12]This is made in order to keep the point clear and to avoid computational difficulties. We will come back later on why regionally differentiated tax increases would not bias the results substantially.

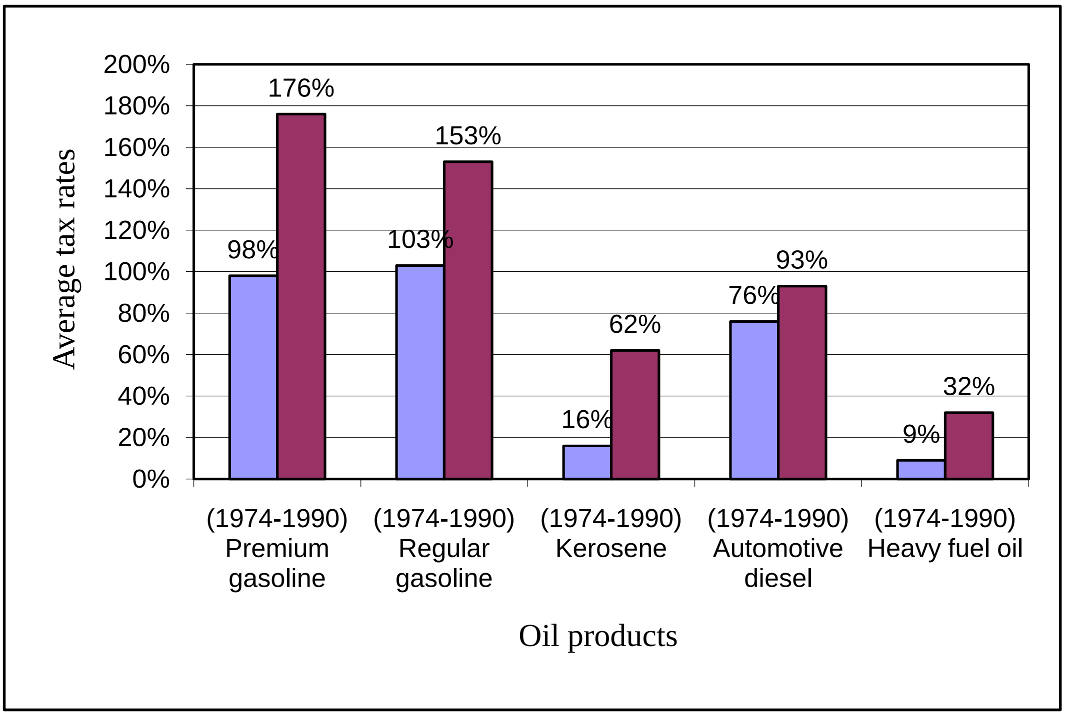

Figure 4: Average tax rates (as percentage of tax exclusive retail price) in OECD.

3 A simple oil importer-exporter model

3.1 Basics

At each date $t \geq 0$, the final output Y_i of each country's $(i = I, E)$ production sector is given by the production function[13]

$$Y_i = R_i^{\alpha}(A_i L_i)^{1-\alpha},\ \alpha \in (0,1),\ i = I, E, \tag{1}$$

where L_i is the quantity of labor employed and R_i the flow of resource consumed in country i. Moreover, A_i is an index of labor productivity in country i and allows for a productivity gap between both countries. Technical improvement is given exogenously by the common rate of growth of labor productivities indexes[14]:

$$g_{A_I} = g_{A_E} = x > 0. \tag{2}$$

The resource is freely extracted from two stocks located in both regions:

$$S_i(t) = S_{i0} - \int_0^t R_i^S(s)\,ds,\ S_{i0} \text{ given}, i = I, E, \tag{3}$$

[13]For simplicity, the time argument of each variable is dropped as long as this does not create ambiguity.

[14]The derivative with respect to time of any variable X is denoted by $\dot{X}$. Its rate of growth is denoted by $g_X = \dot{X}/X$.

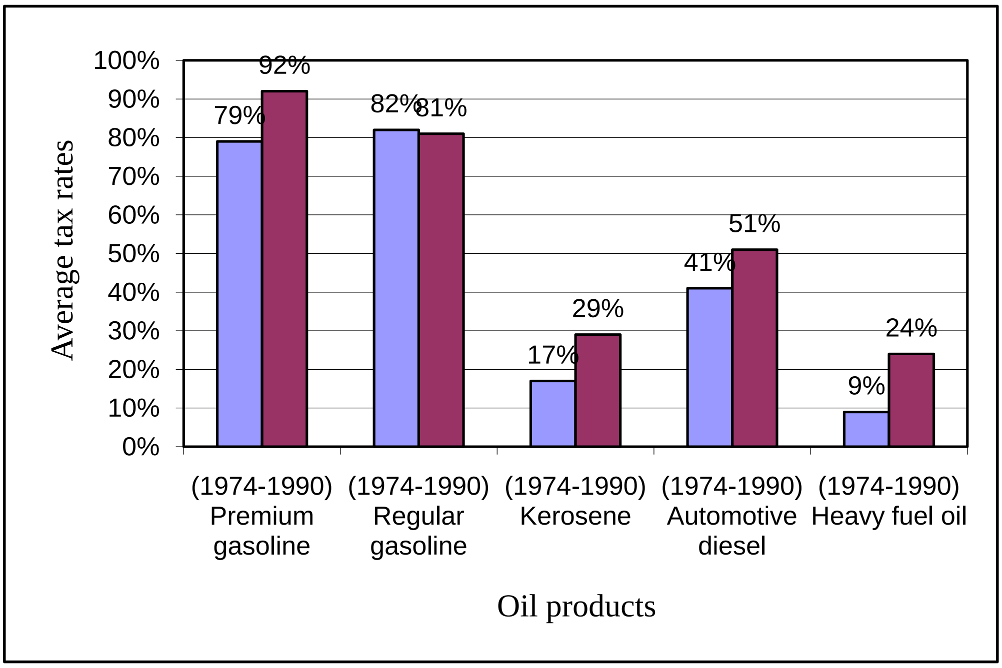

Figure 5: Average tax rates (as percentage of tax exclusive retail price) in the World.

where S_i is the size of the reserves in country i and R_i^S the instantaneous flow extracted from country i's stock.

The preferences of both countries' infinitely-lived representative households are identical and represented by the intertemporal utility functions

$$U_i = \int_0^{+\infty} \frac{(C_i/L_i)^{1-\epsilon}}{1-\epsilon} e^{-\rho t}\, dt,\ \rho > 0,\ i = I, E, \tag{4}$$

where C_i is the consumption level of country i's households and ρ is a psychological discount rate.

Households of country i are endowed with the local stock of resource S_i and the constant quantity of labor L_i.

Labor is immobile while the final good and the resource extracted are freely transportable.

The world resource constraints for the resource input and the final good are:

$$R_I + R_E = R_I^S + R_E^S, \tag{5}$$

$$C_I + C_E = Y_I + Y_E. \tag{6}$$

3.2 Equilibrium dynamics under a global tax increase

Assume there are two local labor markets on which wages are denoted by w_i, a world market for the resource extracted whose producer price is denoted by p, a world market for the final good whose price is normalized to unity and a world financial market on which the interest rate is denoted by r.

A multiplicative tax[15] $\tau_i > 1$ is applied to the price of the resource consumed in country i, so that the unit consumer price of the resource paid by the firms located in country i is $p\tau_i$. Tax revenues of country i are then $p(\tau_i - 1)R_i$. They are equally redistributed to the households of this country. These taxes grow at a given positive rate:

$$g_{\tau_I} = g_{\tau_E} = g_\tau > 0. \tag{7}$$

The optimizing behavior of households results in the standard Ramsey-Keynes conditions:

$$g_{C_I} = g_{C_E} = \frac{r - \rho}{\epsilon}. \tag{8}$$

The profit-maximizing behavior of both extraction sectors leads to the standard Hotelling rule,

$$g_p = r, \tag{9}$$

and to asymptotic exhaustion of both resource stocks:

$$\int_0^{+\infty} R_i^S(t)\, dt = S_{i0},\ i = I, E. \tag{10}$$

These two conditions determine uniquely the world extraction path but leave indeterminate the dynamics of the local stocks and extraction rates. Let us restrict the local depletion dynamics to be balanced in the sense that the two local extraction flows evolve at the same rate. In other words, the local relative stocks will be independent of time, or equivalently, the relative supply, R_I^S / R_E^S, will be constant over time[16].

The profit-maximizing behavior of the final sectors leads to the equalization of prices and marginal productivities:

$$\alpha \frac{Y_i}{R_i} = p\tau_i, \tag{11}$$

$$(1 - \alpha)\frac{Y_i}{L_i} = w_i, \tag{12}$$

where $i = I, E$.

The following proposition gives the dynamics of the regional economies and the split of resource extraction flows and resource consumption levels.

[15]The magnitude of taxes can be expressed in different terms. In order to be clear about how the increasing trend in taxes is introduced, it is worth mentioning what an increase in the multiplicative tax τ means. An increase in τ is equivalent to an increase in the associated ad valorem tax rate (tax rate expressed as a percentage of the tax exclusive final price) $\tau - 1$ and to an increase in the proportion of tax in the final price $(\tau - 1)/\tau$.

[16]This is a standard assumption of symmetry. First, this restriction is necessary for allowing a comparison of both countries' dynamics. Indeed, without it, the dynamics of resource revenues, and thus of GDPs, can be nearly everything and anything. Second, this symmetry between the depletion of the two stocks is supported by the observed strong correlation between national instantaneous supplies and estimated national remaining reserves.

Proposition 1 *In a balanced equilibrium,*

$$g_{C_I} = g_{C_E} = g_{Y_I} = g_{Y_E} = \frac{-\alpha\rho + (1-\alpha)x - \alpha g_\tau}{1-\alpha(1-\epsilon)}, \tag{13}$$

$$g_{R_I} = g_{R_E} = g_{R_I^S} = g_{R_E^S} = \frac{-\rho + (1-\alpha)(1-\epsilon)x - g_\tau}{1-\alpha(1-\epsilon)}, \tag{14}$$

$$\frac{R_I}{R_E} = \left(\frac{\tau_E}{\tau_I}\right)^{\frac{1}{1-\alpha}} \frac{A_I L_I}{A_E L_E}, \tag{15}$$

$$\frac{R_I^S}{R_E^S} = \frac{S_{I0}}{S_{E0}}. \tag{16}$$

Proof of Proposition 1 *See the Appendix.*

Since both regional taxes, τ_I and τ_E, grow at the same rate, the relative local final price of the resource remains constant. As a result, a constant fraction of the world extraction flow is used in each country. This implies that the quantities of resource used in each country, R_I and R_E, and thus the regional outputs, Y_I and Y_E, grow respectively at the same rates. The economy is therefore balanced in the sense that every variable grows at the same rate in both countries.

In this model of perfect foresight, the future path of taxes is correctly anticipated and influences economic growth. The anticipated variations of the tax over time distort the path of the resource price, thus affecting the intertemporal arbitrage of the extractors. This is why the growth rate of the taxes, g_τ, negatively enters the expressions for the rate of growth of resource use and output. In essence, if the taxes are expected to be higher in the future, it will be more profitable to extract the resource now rather than later. This effect of anticipated future taxes is emphasized in many papers, among which Sinclair (1992), Grimaud and Rougé (2005) and Groth and Schou (2007). This is due to perfect foresight. However, we argue that our results are perfectly independent of anticipated taxes but depend on the effect of actual taxes[17].

In equilibrium, the distribution of the world extraction flow between the two final sectors is determined by the equalization of marginal productivities of the resource input to its final price in both countries respectively. As a result, the relative resource use in country I is decreasing with the relative tax in this country because the relative local price increases with the level of the local tax. Moreover, the relative resource use is increasing with the relative local effective labor quantity which improves, by complementarity, the local productivity of the resource.

The relative resource supply in each country is, because of symmetric extraction, proportional to relative reserves in the country.

[17] In a model of imperfect foresight where actual tax increases and expected tax increases are allowed to differ, the expected rate of growth of the taxes would replace g_τ in equations (13) and (14). However, the results of the paper relative to the effects of the increasing trend in actual taxes on oil products are robust to imperfect foresight. In this the paper, for simplicity, we don't make this point and stick to the standard perfect foresight assumption.

3.3 On the GDPs of the resource-importing and the resource-exporting countries

One of the two countries is a net resource-importer while the other is a net resource-exporter. Let us assume that I is the importing country and E the exporting one.

Using equations (15) and (16), this amounts to assuming

$$\frac{S_{I0}}{S_{E0}} < \left(\frac{\tau_E}{\tau_I}\right)^{\frac{1}{1-\alpha}} \frac{A_I L_I}{A_E L_E}. \tag{17}$$

Indeed, (17) can be shown to be equivalent to

$$R_E^S - R_E = -(R_I^S - R_I) > 0. \tag{18}$$

Hence, the exporting country is the one endowed with large reserves relative to its quantity of effective labor, and extracts more of the resource than it uses. Equipped with our main ingredients, namely an oil-importing country, an oil-exporting country and an exogenous increasing trend in taxes on oil products, we can go into the details of the GDPs' dynamics.

On the income side, the GDP of country $i = I, E$ equals the market value of its final output, plus the value of resource supply, minus the payment for the resource input, plus tax revenues: $GDP_i = Y_i + pR_i^S - p\tau_i R_i + p(\tau_i - 1)R_i$, i.e.

$$GDP_i = Y_i + pR_i^S - pR_i, \ i = I, E, \tag{19}$$

where $g_{Y_I} = g_{Y_E}$, $g_{pR_I^S} = g_{pR_E^S}$ and $g_{pR_I} = g_{pR_E}$, the components of the GDPs growing respectively at the same rate in both countries. Indeed, our assumptions[18] guarantee there being no sources of growth differential between the two countries but the globally increasing trend in taxes on oil products. It is worth noting that the taxes do not appear in the previous expression of the GDPs. This is because the taxes included in the gross payment for the resource input are collected back by the local residents and thus reinjected into the GDP. Hence, in this expression, the term on the far right represents the payment for the resource use net of this tax collection.

However, the tax increase and the different structures of the GDP of the resource importer and of the resource exporter will result in different GDP growth rates.

The GDPs can be decomposed as such:

$$\begin{cases} GDP_I = Y_I + \underbrace{p(R_I^S - R_I)}_{(<0) \text{ net payment for the resource}} \\ GDP_E = Y_E + \underbrace{p(R_E^S - R_E)}_{(>0) \text{ net resource revenues}} \end{cases}. \tag{20}$$

These expressions highlight that, beyond the value of manufacturing, the GDP of the importer is reduced by the net payment for the resource and that of the exporter is increased by the net resource revenues.

[18]The critical ones are the identical technologies, the world financial market, the homogeneity of the tax increase and the symmetry of local extraction.

Now, because of the tax increase, these two terms won't grow at the same rate as outputs. From (11), $g_{Y_i} = g_{pR_i} + g_\tau$, $i = I, E$. Moreover, from Proposition 1, $g_{pR_I} = g_{pR_E} = g_{pR_I^S} = g_{pR_E^S}$ and $g_{Y_I} = g_{Y_E}$. Then, since $g_\tau > 0$,

$$g_{Y_I} = g_{Y_E} > g_{pR_I} = g_{pR_E} = g_{pR_I^S} = g_{pR_E^S}, \tag{21}$$

thus implying $g_{Y_I} = g_{Y_E} > g_{p(R_I^S - R_i)} = g_{p(R_E^S - R_E)}$. Finally, this and the different structures of the GDPs (as expressed in (20)) lead to a difference in GDP growth.

Proposition 2 *If country E is the net resource-exporting country and country I the net resource-importing country and if taxes on oil products rise globally, then country E will experience a lower GDP growth than country I.*

Proof of Proposition 2 *See the Appendix.*

This relies on the distributional effects of the non-renewable resource taxation. Because of the Cobb-Douglas specification of the production function, the payment for the resource input is always a constant fraction of output. From (11), $p\tau_i R_i = \alpha Y_i$, $i = I, E$. If taxes are constant, i.e. $g_\tau = 0$, then the net of the tax extractor's unit revenue pR_i is also a constant fraction of output. However, if $g_\tau > 0$, pR_i decreases relative to output. Why is that? Taxes are paid by the consumers but not earned by the resource producers. Because of the relative inelasticity of the resource supply entailed by the exhaustibility constraint, the taxes on oil products have little effect on the final price (including the tax), but do affect the distribution of revenues between the resource suppliers and the national fiscal authorities. Hence, oil products taxes are borne by the suppliers and are transferred into the consuming country government's income. This partial capture of the resource rent increases as taxes increase, widening the gap between manufacturing output and resource revenues. Since the resource-exporting country supplies more resource than it uses, the increasing trend in fuel taxes yields a lower growth of output in this country relative to the resource-importing country[19].

This effect depends on the asymmetric structure of the GDPs in the two countries, favoring growth in the country with relatively low reserves at the expense of the resource-rich country. Hence, relative low growth of the resource-exporting country will get worse as it is more resource-dependent.

Proposition 3 *The gap between the rate of GDP growth in the resource-importing country and the resource-exporting country widens with the stock of resource in the latter region.*

Proof of Proposition 3 *See the Appendix.*

[19] In a model where taxes are imperfectly anticipated, one would still have this rent capture and the lower growth of the net exporter's GDP, thus showing that Proposition 2 has nothing to do with the assumption of perfect foresight.

4 Dynamics of oil revenues in the oil-exporting countries' GDPs, stylized facts and expected magnitude

4.1 On the dynamics of oil revenues in the oil-exporting countries' GDPs

According to the proposed hypothesis, the effect of changes in taxes over time on GDP growth in the oil-exporting countries is borne by the difference between the growth rates of oil revenues and output. Indeed, the model predicts that an increase in ad valorem taxes on oil results in a slower increase of rents than manufacturing output. This is a key point.

In the literature, this is the basic assumption of the overshooting theory such as formulated in Rodríguez and Sachs (1999): "Our key assumption is that exports of natural resources cannot expand at the same rate as other industries". However, one can see from Proposition 1 that without any variation in oil taxes ($g_\tau = 0$), this does not hold (i.e. $g_{pR_i^S} = g_{Y_i}$) in our standard model of oil depletion. This is due in particular to the implicit assumption, resulting from the Cobb-Douglas specification, that the price elasticity of the demand for the resource is constant over time. Here, the lower growth of oil revenues compared to that of manufacturing output requires a tax increase. The above theory thus suggests that this low growth may be a consequence of a global tax increase: oil revenues would rise at a lower rate than the value of final output, i.e. formally, if $g_\tau > 0$, then $g_{pR_i^S} < g_{Y_i}$, which is equivalent to $g_{pR_i^S} < g_{GDP_i}$, $i = I, E$.

This intermediate implication can be confronted to empirical evidence. In the case of Venezuela, Rodríguez and Sachs (1999) find that per capita petroleum exports have declined faster than per capita GDP over the period 1960-1990.

Between 1990 and 2000, OPEC net oil export revenues remained stable[20]. Over the same period, the GDP of all OPEC members grew (from 1.6% in Venezuela to 4.9% in Kuwait, per annum on average). Accordingly, the output of industry (including mining) grew faster than that of manufacturing (industry excluding mining) in 6 out of 8 countries for which data are available[21].

Over the period 1980-2004, per capita OPEC oil revenues have decreased by about 65%. At the same time, the worst performance on per capita GDP growth was that of the UAE with slightly less than -50%[22].

The intermediate prediction that oil revenues grew slower than output from manufacturing is thus not invalidated.

[20] Source: Energy Information Agency (2006).

[21] Source: World Bank, World Development Indicators (2007).

[22] Source: World Bank, World Development Indicators (2006), for 7 countries for which data are available out of 11 OPEC members.

4.2 On regional tax increases

According to the observations made in Section 2, a more realistic assumption about the increases in regional taxes on oil use would allow them to differ. Indeed, the data suggest that taxes on oil products (as a proportion of the final price) have increased more drastically in top consuming regions than in oil-producing countries, where they may have remained constant or even decreased. Hence, it would be more accurate to assume $g_{\tau_I} > 0 \geq g_{\tau_E}$.

First, the assumption that $g_{\tau_I} > 0$ would still imply low relative growth in the oil-exporting region. However, if $g_{\tau_I} > g_{\tau_E}$, another feature would be the widening gap between the final prices of the resource in the two countries. This would increase the fraction of the world resource supply used in the resource-exporting country, thus, in turn, favoring growth of output in this region. So, at the cost of complicated computations of the unbalanced dynamics of the two-country economy, it might be found that this effect could mitigate our result if the exporter is not sufficiently resource-dependent.

However, in reality, oil is largely used outside of the top oil-producing countries[23] and the fraction of the total oil supply used outside of these countries has remained stable since 1960[24]. This suggests that the increased difference in final (including taxes) prices in oil-exporting and oil-importing regions had little influence on the distribution of the extraction flow, implying that the above mitigating effect was of marginal magnitude.

It is thus reasonable to think that the presumed relatively lower increase in taxes on oil products in the top oil-exporting countries has played a marginal role on their GDP dynamics.

4.3 Expected magnitude

In the absence of any econometric analysis, little can be said about the portion of the low GDP growth in oil-exporting countries which can be explained by the global increasing trend in fuel products taxes. However, the explanatory power of this hypothesis is likely to be high if the effect of this increasing trend in taxes and this trend itself are of a large magnitude.

The study of the increasing trend in oil products taxes led to the conclusion that it has been rather marked at the global level and rather drastic in top oil-consuming regions. What about its effect on the GDP growth in oil exporting countries? It is expected to be high because taxes in top oil-consuming regions are very high and capture a large part of oil revenues and because oil revenues usually represent a very large fraction of oil-exporting countries' GDPs.

Indeed, taxes on oil products constitute 6% of the total fiscal revenues in OECD countries[25]. Through these taxes, the G7 countries captured $517 billion per year over

[23] The Middle-East represents 6.7% of world oil consumption. Source: Energy Information Administration (2004).

[24] Source: Energy Information Administration (2000).

[25] Source: International Energy Agency.

the 2003-2007 period, while OPEC's annual oil revenues were lower than this amount[26]. This amount is enormous relative to the OPEC countries' GDPs. For instance, in order to give some order of magnitude, if the share of Nigerian oil in the G7's consumption were identified with its share in world consumption[27], the G7 (only) would have captured around 15% of Nigeria's GDP each year between 2003 and 2007.

The governments of oil-exporting countries acknowledge frequently that taxes on oil products affect their revenues. This is true even if the taxes are levied on the consumption of a transformed product from oil. Indeed, transformation is a standard industry, not characterized by pure rents. The rents captured by the product taxation are thus those supposed to be earned by the owners of the primary resource.

Variations in these taxes over time may thus entail far from negligible variations in the GDPs of oil-dependent, oil-producing countries.

5 Concluding implications and future research

Available data suggest a marked increasing trend in the proportion of tax in the final prices of oil products over the last decades. In a two-country model of oil depletion, this trend has been shown to deteriorate the relative GDP growth in the net resource-exporting country. This occurs because globally increasing taxes on the resource use make resource revenues rise more slowly than output from manufacturing. Data confirm this key intermediate prediction.

This work thus provides a hypothesis, based on the theory of non-renewable resource taxation, for why oil-exporting countries have experienced a relatively low GDP growth over the last 40 years. It does not question the existing theories on the oil curse and is thought to be complementary.

The major implication of our hypothesis is that the dynamics of the taxes on oil products has to be controlled for when measuring the explanatory power of other factors of the resource curse. Of course, a measurement of the explanatory power of the proposed hypothesis itself needs to be implemented. However, the lack of time-series data on oil taxes at a large scale is a major obstacle, and such a study thus seems impossible in the short run. This is kept for future research.

Appendix

Proof of Proposition 1 *Let us denote by Y, C and R, the world output, the world consumption level and the world flow of resource extracted and used.*

From the production functions (1), one gets $Y_I/Y_E = (R_I/R_E)^{\alpha}(A_I L_I/(A_E L_E))^{1-\alpha}$. *On the other hand, equations (11) give:* $Y_I/Y_E = (R_I/R_E)(\tau_I/\tau_E)$. *These two equations imply* $R_I/R_E = (\tau_E/\tau_I)^{1/(1-\alpha)}(A_I L_I)/(A_E L_E)$ *and* $Y_I/Y_E = (\tau_E/\tau_I)^{\alpha/(1-\alpha)}(A_I L_I)/(A_E L_E)$. *The former equation is (15).*

[26] OPEC (Organization of Petroleum Exporting Countries), 2008.

[27] Source: International Energy Agency.

The two later equations imply $g_{Y_I} = g_{Y_E} = g_Y$ and $g_{R_I} = g_{R_E} = g_R$. From (8) and the constraint on the use of the final good (6), one gets: $g_Y = g_C = (r - \rho)/\epsilon$.

On the other hand, using (9), equations (11) imply $g_Y = g_R + r + g_\tau$. This and the log-differentiation of the production functions (1) imply $g_Y = -\alpha/(1-\alpha)(r + g_\tau) + x$.

Overall, the two above relations between g_Y and r lead to $r = [(1-\alpha)\rho + (1-\alpha)x - \alpha\epsilon g_\tau]/(1 - \alpha(1-\epsilon))$ and to equation (13). Using, from above, $g_R = g_Y - r - g_\tau$, one gets equation (14).

Since, by (7), the growth rate of the producer price is the same for both producers, their problems are similar. However an indeterminacy in local extraction flows remains. The restriction made in Section 2 is $g_{R_I^S} = g_{R_E^S} = g_R$. From (10), it implies $S_{i0} = R_i^S(t) \int_0^{+\infty} e^{\int_t^s g_R(u)\, du}\, ds$, $i = I, E$, which implies equation (16).

Proof of Proposition 2 *From Proposition 1, condition (17) implies $R_I^S/R_E^S < R_I/R_E$. Since $R_I^S + R_E^S = R_I + R_E$, it also implies $R_E^S - R_E = -(R_I^S - R_I) > 0$.*

The GDPs, as expressed in (19), can be rewritten, $GDP_i = Y_i + p(R_i^S - R_i)$, $i = I, E$. In this expression, the second term, representing net of tax transfers resource revenues, is positive for E and negative for I: $p(R_E^S - R_E) > 0$ and $p(R_I^S - R_I) < 0$.

Moreover, from Proposition 1 and (9), one can get $g_{Y_E} = g_{Y_I}$ and $g_{pR_E^S} = g_{pR_E} = g_{pR_I^S} = g_{pR_I} = g_{Y_E} - g_\tau = g_{Y_I} - g_\tau$, thus implying, since $g_\tau > 0$, $g_{p(R_E^S - R_E)} = g_{p(R_I^S - R_I)} < g_{Y_E} = g_{Y_I}$.

Overall, this results in $g_{GDP_E} < g_{GDP_I}$.

To sum up, if (17), so that $R_E^S - R_E = -(R_I^S - R_I) > 0$ and because of $g_\tau > 0$, then $g_{GDP_E} < g_{GDP_I}$.

Proof of Proposition 3 *From (19), one can show $g_{GDP_i} = g_{Y_i - pR_i}(Y_i - pR_i)/GDP_i + g_{pR_i^S} pR_i^S/GDP_i$, $i = I, E$. Using (11), $Y_i - pR_i = Y_i(1 - \alpha/\tau_i)$. Moreover, from (19), $(Y_i - pR_i)/GDP_i = 1 - pR_i^S/GDP_i$. Finally, $g_{GDP_i} = g_{Y_i(1-\alpha/\tau_i)} + (g_{pR_i^S} - g_{Y_i(1-\alpha/\tau_i)})pR_i^S/GDP_i$, $i = I, E$.*

From Proposition 1, note that $g_{pR_I^S} = g_{pR_E^S} = g_{pR_I} = g_{pR_E} = g_{pR}$ and that $R_I^S = R - R_E^S$. Hence, the gap between both GDPs' rates of growth writes

$$\begin{aligned} g_{GDP_E} - g_{GDP_I} &= g_{Y_E(1-\alpha/\tau_E)} - g_{Y_I(1-\alpha/\tau_I)} \\ &+ (g_{pR_E} - g_{Y_E(1-\alpha/\tau_E)})pR_E^S/GDP_E \\ &- (g_{pR_I} - g_{Y_I(1-\alpha/\tau_I)})p(R - R_E^S)/GDP_I,\ i = I, E. \end{aligned} \tag{22}$$

First, let us show that $g_{Y_i(1-\alpha/\tau_i)} > g_{pR_i}$, $i = I, E$. $g_{Y_i(1-\alpha/\tau_i)} = g_{Y_i - pR_i} = g_{pR_i - Y_i} = g_{pR_i} pR_i/(pR_i - Y_i) - g_{Y_i} Y_i/(pR_i - Y_i) = g_{pR_i} - (g_{Y_i} - g_{pR_i})Y_i/(pR_i - Y_i)$, $i = I, E$. We know that $Y_i > pR_i$. Moreover, from (21), we know that $g_{Y_i} > g_{pR_i}$. Hence, $g_{Y_i(1-\alpha/\tau_i)} > g_{pR_i}$, $i = I, E$.

Second, since $GDP_i > pR_i^S$, $i = I, E$, pR_E^S/GDP_E is increasing in R_E^S, in turn increasing in S_{E0}. Similarly, $-p(R - R_E^S)/GDP_I$ is increasing in S_{E0}.

Finally, $g_{GDP_E} - g_{GDP_I}$ is decreasing in S_{E0}.

References

[1] Auty, R.M., 1997, *Natural Resource Endowment, the State and Development Strategy*, Journal of International Development 9, 651-663.

[2] Auty, R.M., 2001, *Resource Abundance and Economic Development*, WIDER Studies in Development Economics, Edited by R.M. Auty.

[3] Bardhan, P., 1997, *Corruption and Development: A Review of the Issues*, Journal of Economic Literature 35, 1320-1346.

[4] Bergstrom, T.C., 1982, *On Capturing Oil Rents with a National Excise Tax*, American Economic Review 72, 194-201.

[5] Brander, J. and S. Djajic, 1983, *Rent-Extracting Tariffs and the Management of Exhaustible Resources*, Canadian Journal of Economics 16, 288-298.

[6] Brunnschweiler, C.N. and E.H. Bulte, 2008, *The Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings*, Journal of Environmental Economics and Management 55, 248-264.

[7] Corden, W.M. and J.P. Neary, 1982, *Booming Sector and De-Industrialisation in a Small Open Economy*, Economic Journal 92, 825-848.

[8] Dasgupta, P.S. and G.M. Heal, 1979, *Economic Theory and Exhaustible Resources*, Oxford University Press.

[9] Dasgupta, P.S., Heal, G.M. and J.E. Stiglitz, 1981, *The Taxation of Exhaustibe Resources*, NBER Working Papers 0436.

[10] Daubanes, J., 2008, *Fossil Fuels Supplied by Oligopolies: On Optimal Taxation and Rent Capture*, Economics Bulletin 17, 1-11.

[11] Daubanes, J. and A. Grimaud, 2006, *On The North-South Effects of Environmental Policy: Rent Transfers, Relocation and Growth*, LERNA Working Papers, 06.26.219.

[12] Davis, G.A. and J.E. Tilton, 2005, *The Resource Curse*, Natural Resources Forum 29, 233-242.

[13] EEA (European Environment Agency), 2002, *Fuel Prices and Taxes*, Indicator Fact Sheet.

[14] EEA (European Environment Agency), 2007, *Energy Taxes*, Indicator Fact Sheet.

[15] Gaudet, G. and P. Lasserre, 1990, *Dynamiques Comparées des Effets de la Taxation Minière*, L'Actualité Economique 66, 467-497.

[16] Grimaud, A. and L. Rougé, 2005, *Polluting Non Renewable Resources, Innovation and Growth: Welfare and Environmental Policy*, Resource and Energy Economics 27, 109-129.

[17] Groth, C. and P. Schou, 2007, *Growth and Non-renewable Resources: The Different Roles of Capital and Resource Taxes*, Journal of Environmental Economics and Management 53, 80-98.

[18] Gupta, S. and W. Mahler, 1995, *Taxation of Petroleum Products: Theory and Empirical Evidence*, Energy Economics 17, 101-116.

[19] Gylfason, T., 2001, *Natural Resources, Education, and Economic Development*, European Economic Review 45, 847-859.

[20] Gylfason, T., 2002, *Lessons from the Dutch Disease: Causes, Treatment and Cures*, Paradox of Plenty: The Management of Oil Wealth, Centre for Economic Analysis.

[21] Hotelling, H., 1931, *The Economics of Exhaustible Resources*, Journal of Political Economy 39, 137-175.

[22] Kaldor, M., Karl, T.L. and Y. Said, 2007, *Oil Wars*, Pluto Press, Edited by M. Kaldor, T.L. Karl and Y. Said.

[23] Kellard, N. and M.E. Wohar, 2003, *Trends and Persistence in Primary Commodity Prices*, Royal Economic Society Annual Conference 2003 118, Royal Economic Society.

[24] Krugman, P., 1987, *The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher : Notes on Trade in the Presence of Dynamic Scale Economies*, Journal of Development Economics 27, 41-55.

[25] Matsuyama, K., 1992, *Agricultural Productivity, Comparative Advantage, and Economic Growth*, Journal of Economic Theory 58, 317-334.

[26] OPEC (Organization of Petroleum Exporting Countries), 2008, *Who Gets What from Imported Oil?*, OPEC Public Relations and Information Department.

[27] Prebisch, R., 1950, *The Economic Development of Latin America and its Principal Problems*, United Nations, Lake Success.

[28] Rodríguez, F. and J.D. Sachs, 1999, *Why do Resource-abundant Economies Grow More Slowly?*, Journal of Economic Growth 4, 277-303.

[29] Sachs, J.D. and A.M. Warner, 1995, *Natural Resource Abundance and Economic Growth*, NBER Working Papers 5398.

[30] Sachs, J.D. and A.M. Warner, 1999, *Natural Resource Intensity and Economic Growth*, in: Mayer, J., Chambers, B. and A. Farooq (Eds), 1999, *Development Policies in Natural Resource Economies*, Edward Elgar.

[31] Sachs, J.D. and A.M. Warner, 2001, *The Curse of Natural Resources*, European Economic Review 45, 827-838.

[32] Saito, K.W., 1975, *An Examination of Changes in the Retail Price and Taxation of Petroleum Products*, Studies in Domestic Finance 9, World Bank, Development Economics Department.

[33] Sapsford, D., 1990, *Primary Product Prices and the Terms of Trade*, Economic Record 65, 342-356.

[34] Sinclair, P.J.N., 1992, *High Does Nothing and Rising is Worse: Carbon Taxes Should Keep Declining to Cut Harmful Emissions*, Manchester School 60, 41-52.

[35] Singer, H.W., 1950, *The Distribution of Gains Between Investing and Borrowing Countries*, American Economic Review 40, 473-485.

[36] Sinn, H.-W., 1982, *Taxation, Growth and Resource Extraction: A General Equilibrium Approach*, European Economic Review 19, 357-386.

[37] Sinn, H.-W., 2008, *Public Policies Against Global Warming: A Supply Side Approach*, International Tax and Public Finance 15, 360-394.