WP 2006-20
October 2006

Working Paper

Department of Applied Economics and Management
Cornell University, Ithaca, New York 14853-7801 USA

Macroeconomic Impact of Mineral Revenues on General Market Equilibrium and Poverty Alleviation in Sub-Saharan Africa

Ahmad Slaibi and Steven Kyle

Macroeconomic Impact of Mineral Revenues on General Market Equilibrium and Poverty Alleviation in Sub-Saharan Africa

Ahmad Slaibi, Steven Kyle

October, 2006

Department of Applied Economics and Management,

Cornell University, Ithaca NY 14853.

Contact Slaibi at: aas54@cornell.edu or 607-262-6073

Contact Kyle at: sck5@cornell.edu or 607-255-2104

Table of Contents

I. Abstract

A combination of higher oil production as well as higher oil prices is creating oil revenue windfalls for some Sub Saharan African countries. If well managed, these revenues have the potential to reduce poverty and bridge the development gap; if not they could lead to Dutch disease and an increase in income inequality. Our research examines the potential impact of government expenditure on the nontraded sector and its implications on production and wages in other sectors. Not surprisingly our results show that government's nontraded expenditure leads to a reduction in output of other sectors and a decrease in the wages of these sectors leading to Dutch disease and income disparity. A tariff applied to protect a leading part of the traded sector could in the short term reduce the negative impact and help raise wages in the protectable sector. However, in the medium term, once learning by doing is introduced, the potential benefit of the tariff was minimized. When these oil windfalls diminish in the long term the tariff has a definite negative impact on the protectable sector. We conclude that some Sub Saharan African countries could consider applying a tariff in the short term to reduce the impact of the nontraded expenditure on the traded sector of the economy. This tariff is not recommended for medium or long term and it should be associated with infrastructure investments to support the country's comparative advantages.

II. Introduction

The presence and development of any valuable resource in any country, and especially in developing ones, is an opportunity for these countries to develop and provide their citizens with a better quality of living. A globally demanded resource, if well managed and transparently utilized, can help pay government debt, reduce budget deficit, and bridge the gap to better development. At the same time, mismanagement of this same resource can lead to social unrest, monetary imbalances, and fiscal disparity.

Twelve sub-Saharan African countries have been endowed with varying reserves of crude oil and natural gas. These countries are: Nigeria, Angola, Gabon, Congo, Democratic Republic of Congo, Chad, Sudan, Mauritania, Sao Tome, Cote D'Ivoire, Cameroon, and Equatorial Guinea. Some of these countries have been producing oil since the 60's, others have only started recently and some will come into production in the near future.

Proven crude oil reserves in this part of the world have been growing. Exploration and investments have increased in several countries as well. The sharp increase in production coupled with the current record oil prices, and assuming that prices stay relatively high, will secure these countries large gross hydrocarbon revenues and subsequently higher government take from these revenues. However, what are the economic implications of this unexpected wealth? Will this boom lead to poverty elevation and faster development or would these revenues be mismanaged?

This paper will first present a picture of the current and expected windfalls of the energy sector in Sub-Saharan Africa oil exporting countries. Following that we will examine previous macro-economic research and management policies recommended to help these countries manage these resources. Then we will present a simple model to study the potential impact of the hydrocarbon windfall on the productive sectors in the economy and local households' income. This model extends recent treatments of the Resource Curse to a multi-period four sector disaggregation of the economy to enable analysis of issues directly relevant to the structure of African oil exporters. The model will later be further developed to examine the implications of a potential tariff to protect part of the tradable sector under both conditions of full employment and conditions of unemployment. Finally, Angola will be taken as a study case and the model's theoretical results will be empirically tested to evaluate our conclusions and offer policy advice that may help reduce income disparity and promote poverty elevation in Sub-Saharan oil exporting countries.

III. Oil Reserves, Production, and Revenues in Sub-Saharan Africa

According to the BP Statistical Review[1], as of December 2004 the above 12 countries[2] combined carry about or 4.7% of the global proved crude reserves[3] (Figure 1). In the last 12 years, despite aggressive production in several of these countries, proven reserves have more than doubled (110% increase). The growth of these reserves has outpaced the industry average elsewhere in the world. On average, global proven reserves have increased only 12% in the last 12 years. In all other regions proven reserves have either started to decrease or are increasing at around a third of the rate in

---

[1] Putting energy in the spotlight. BP Statistical Review of World Energy December 2004.
[2] The review states that there are no proven barrels of oil in Mauritania and Sao Tome, however we know that oil was discovered in Sao Tome and Mauritania.
[3]BP defines proven reserves as estimated quantities of oil which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under current economic and operating conditions

Sub-Saharan Africa. The region has additional potential for finding more reserves and development of current resources. Furthermore, the geographical location of these reserves (mostly in West Africa) increases their importance to major consumers, like the US and Western Europe, in view of the fact that these reserves are closer (and therefore somewhat less costly to transport) and an alternative to Persian Gulf oil.

Ten Sub-Saharan countries are currently exporting oil. In 2006 they will be joined by Mauritania. Production in Sao Tome will come later as little or no development has occurred in the discovered fields. In 2005 the cumulative annual production of these countries was around 2 billion barrels, a 26% increase from production in 2000 (1.57 billion barrels). By 2010, production is forecast to increase by more than 40% to reach more than 2.8 billion barrels. Overall, by the end of this decade Sub-Saharan oil production would have increased by around 80% from the 2000 levels. Figure 1 illustrates this sharp increase; production after 2010 will depend on finding new reserves (exploration) and further developing current resources. Initial data expects a sharp decline after 2010; however, based on historical experience, with proper licensing and management and capital investments in exploration and development, production could continue to increase until 2015 or even 2020 and the inevitable decline that will follow will be slow.

Each country's proven reserves and 2005 production is presented in Table 1. Cameroon, Chad, Democratic Republic of Congo, and Gabon are declining producers. These four countries combined will supply around 135 million barrels in the year 2010 less then than they were supplying in 2000. Another producer that has been recently declining is Congo, however new discoveries and mainly more investment in developing

Figure 1: Total daily oil production in Sub-Saharan Africa.

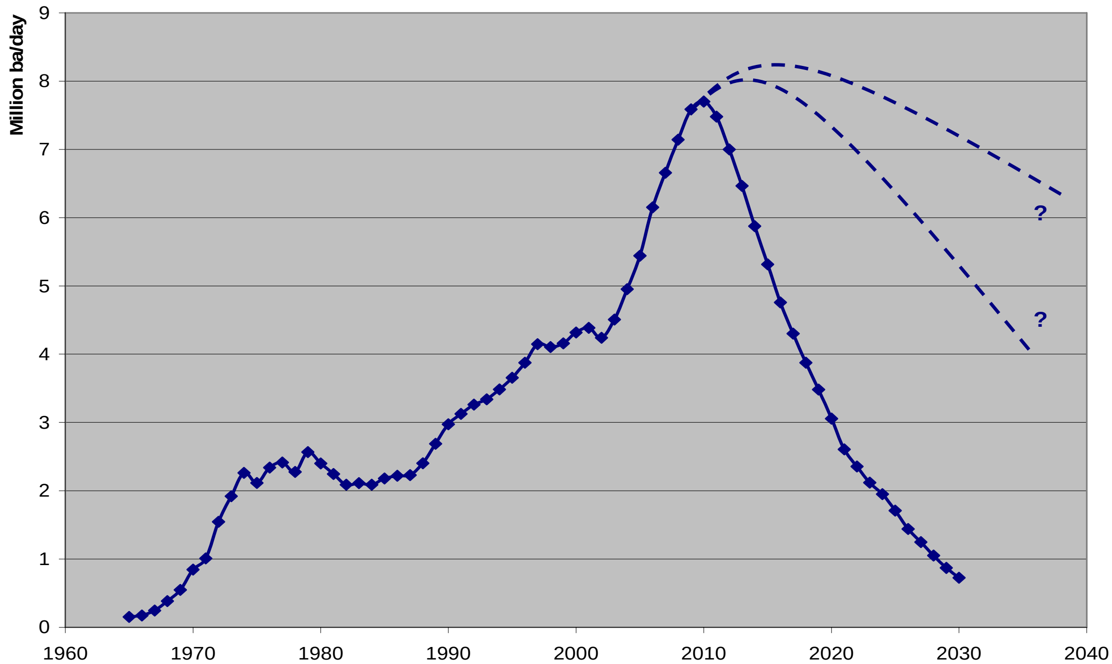


Table 1: Basic estimates of Sub-Saharan oil production in 2000, 2005, and the forecasted production in 2010; and the ratio of proven reserves to 2005 production.[4]

Country	Production mbl/yr 2000	Production mbl/yr 2005	Production mbl/yr 2010	Proven Reserves to 2005 Production Ratio
Angola	268	453	870	19.4
Cameroon	41	31	14	12.8
Chad	78	48	26	18.6
Congo	102	96	105	18.8
Cote d'Ivoire	4	20	29	5.1
Dem. Rep. Congo	10	6	0.4	29.8
Eq. Guinea	45	139	100	9.2
Gabon	97	95.	55	24
Mauritania	0	0	50	0
Nigeria	860	969	1384	36.4
Sudan	71	129	184	48.9

[4] Figure 1 and Table 1 are taken from the World Bank ESMAP Knowledge Exchange Series: Macro-Economic Impact of Oil Revenues on Sub-Saharan Africa by Ahmad Slaibi; July 27, 2005.

current resources will lead to an increase in future production. Cote d'Ivoire, Equatorial Guinea, and Sudan are the fastest growing producers in Sub-Saharan Africa. Production in these four countries started in the 90's; however these producers gained importance in the last few years as more fields came into production. These four countries, in addition to the new producer Mauritania, will supply at least an additional 240 million barrels in the year 2010 more than they were producing in 2000. Finally, most of the increase in crude production in sub-Saharan Africa will be in the two mature producers: Angola and Nigeria. These two countries will supply an additional 1.127 billion barrels in 2010 more than their production in 2000.

The second column in the Table 1 shows how many years of proven production can be sustained at the 2005 production levels. Proven reserves include only oil that can be extracted with reasonable certainty using current technology; that does not include oil that could be discovered or even additional oil that ultimately can be recovered from the current resources. Nevertheless, given the current cumulative production, even under optimistic assumptions, existing sub-Saharan proven reserves could be depleted in less than 25 years. Production in these countries will continue to increase so unless new reserves are added, sub-Saharan oil supply will significantly decrease in 15 years.

This increase in reserves and production coupled with the current increase in hydrocarbon prices is creating huge revenue windfalls for these countries. In the period 2000 – 2005, total governments' take from oil revenues in sub-Saharan Africa summed to more than $186 billion. In the next five years, assuming oil prices at $50 per barrel the total governments' take will be more than $430 billion.[5] A higher price scenario ($80 per barrel) increases total governments' take to $670 billion.[6]

In 2005, if we assume the annual price averaged $50 per barrel, gross oil revenues dominated the economies of most of these countries (Table 2). Oil revenues, oil exports, and the subsequent government take constituted a large portion of the GDP, total exports, and total government revenues of countries like Angola, Chad, Congo, Equatorial Guinea, Gabon, and Nigeria. For these countries oil revenues were more than 80% of total government revenues and most of their exports. Other countries like Sudan, Cameroon, and Democratic Republic of Congo are also highly dependent on oil. Oil revenues in these three countries were less than 30% of GDP; however they composed more than 30% of government revenues and a significant portion of their exports. Only in Cote d'Ivoire, were oil revenues a relatively limited portion of the economy. In the case of Mauritania, when production commences in 2006 we expect oil to constitute around 30% of the 2006 GDP and 60% of the 2006 exports.

The last column in Table 2 shows the division of governments' oil takes in 2005 per capita for all the countries under study. The share of every man, women, and child in countries like Congo, Angola, Gabon, and Equatorial Guinea will be $512, $1010, $2062, and $6963 respectively. For countries with large populations such as Nigeria and Sudan these figures are $248 and $128. Only in Chad, Cameroon, Democratic Republic of Congo, and Cote d'Ivoire are the annual per capita takes expected to be less than $100. These numbers show the potential of the hydrocarbon sector to help develop these

---

[5] Prices assumed: $50 in 2006 and they increase at an annual rate of 2.5%. Formula used: $P_t = P_{(t-1)}*(1+2.5/100)$.

[6] Prices assumed: $80 in 2006 and they increase at an annual rate of 2.5%. Formula used: $P_t = P_{(t-1)}*(1+2.5/100)$.

Table 2: Basic estimates of the impact of oil revenues in 2005 on the economies of oil exporting countries in Sub-Saharan Africa.[7]

Country	Basic Estimates of Oil Revenues on the Economies of Oil Exporting Countries			
	Gross Oil Revenues as % of GDP	**Gross Oil Revenues as % of Exports**	**Gov. Take as % of Total Gov. Revenues**	**Government Oil Take/ Capita US$**
Angola	84	98	97	1010
Cameroon	11	38	40	69
Chad	82	na	83	29
Congo	76	88	88	512
Cote D'Ivoire	7	15	10	15
DRC	8	35	42	5
Eq Guinea	89	na	95	6963
Gabon	57	81	85	2062
Nigeria	60	94	83	248
Sudan	29	na	80	128

[7] Table 2 is taken from the World Bank ESMAP Knowledge Exchange Series: Macro-Economic Impact of Oil Revenues on Sub-Saharan Africa by Ahmad Slaibi; July 27, 2005.

countries and reduce poverty. This potential could be a unique opportunity as oil prices may not stay this high[8] and oil reserves will not keep on expanding forever. This window of opportunity will most likely last around 30 years (even less for most of these countries) to manage their resources successfully and partially bridge the development gap.

IV. Literature Review

Historically the economies of most oil exporting countries in the developing world have grown at a slower rate than resource poor countries. This has been supported by Ranis (1991), Sachs and Warner (1995), Auty (2001), and Gylfason (2001). Some of the reasons that can help explain this phenomenon include: government corruption, mismanagement of revenue windfalls, and Dutch Disease.

Resource rich developing countries are also countries with higher incentives for government corruption. Eifert, Gelb, and Tallroth (2002 and 2003) examine the fiscal policy and economic management of oil exporting countries within a political science framework. They compare the performance of these countries and identify some of the factors that have lead to better management of oil revenues. The study concludes that the political economy (democracy, civil rights, transparency,…) rather than technical factors have had more impact on the success of managing rents. The authors recognize maturing democracies as a process to better revenue management and advise oil exporting countries to hold large reserves, to adopt more conservative and transparent budgeting, and to transfer parts of rent to individual citizens during boom periods.

---

[8] Slaibi, A., Chapman, D., and Daouk, H., (2006) propose that oil prices have been historically stable in a range that guarantees suppliers reasonable and stable revenues without hindering economic growth of consumers. They argue that oil prices varied between $15- $20 from 1986 to 1997 and $23 - $30 from 2000 to 2003 and that prices in the future may fall again into a new calmer framework.

The main problems in managing oil revenues is estimating the future stream of these revenues and making spending/saving decisions. In most oil exporting countries, annual oil revenues are a large portion of government income. This means that estimating future revenues and stabilizing the inflow of oil revenues is crucial to reducing risk and smoothing expenditure. Mashayekhi (1998) examines the impact of oil revenues on the growth and sustainability of the public sector in oil exporting countries. Governments spend oil revenues on development projects but in future years, when these revenues are not necessarily there, more money is needed to maintain and operate these projects. The study concludes that public spending should be conservative and sustainable and recommends privatization of public enterprises, promotion of private enterprises, and strengthening the tax system.

The spending/saving choice is another important problem. Oil revenues are an exhaustible resource that must be shared with future generations; in order to ensure intergenerational fairness some portion of this rent must be saved for new generations to enjoy the benefits. Devlin and Titman (2004) discus the optimal savings and investments strategy for oil exporting countries in the context of stabilizing oil funds. They examine different established funds to explore their potential benefits in stabilizing expenditure, distributing revenues over longer periods of time to reduce market impact, and managing oil price uncertainty. They conclude that although these funds helped manage windfalls and create productive investments, the funds were only partially successful in reducing the impact of oil price volatility and consequently stabilizing government revenues. The authors following Engel and Mellor (1993), Larsen and Varagis (1996), Claessens and

Duncan (1993), and World Bank (1999) recommend using financial market instruments to solve this problem.[9]

The third reason that could explain the poor economic growth in oil rich developing countries is Dutch Disease. Spending oil revenues can help reduce poverty and develop infrastructure in developing countries. However, spending these revenues has also negative effects on other sectors of the economy. These effects have been described as the Dutch Disease or the Resource Curse and were examined mainly in the early and mid 1980's (after the sharp oil price increase in the early 1980's).[10] Simply, these effects could be summarized as: the increase in government oil revenues and their subsequent expenditure on the non-traded sector leads to a shift of resources (labor) from the productive sector (tradable) to the non-tradable sector; and in addition, these revenues lead to an appreciation of local currency making local tradable production more expensive compared to the rest of the world and hence this country loses their competitive advantage in the tradable sector.[11]

More recently this topic has gained interest as some new countries have come to enjoy the "curse" of natural resource abundance. Howard (2002) examines the relationship between exports, imports and income in the economy of Trinidad and Tobago after the discovery of hydrocarbons. The study concludes that the economy is driven by petroleum exports and that in turn has lead to a boom in the non-tradable sector and an increase in overall income. Kyle (2002) similarly examines Dutch disease in Sao

[9] These instruments include swaps, futures, and options.
[10] Cordon and Neary (1980), Forsyth and Kay (1980), Neary and Purvis (1982), Bruno (1982), Bruno and Sachs (1982), Cordon (1984), Wijnbergen (1984, 1984, and 1985), and Krugman (1987) are some of the best research on this topic.
[11] In the short run, the tradable sector will be negatively impacted as resources are drained away from it and it becomes less competitive. In addition, in the long run even if the oil revenues stop there is a loss of know-how that could revive this sector.

Tome e Principe. He recommends investing oil revenues productively such that the country's comparative advantages (mainly the agricultural sector) are supported. He believes this will guarantee improving efficiency and productivity in a tradable sector and an equitable distribution of the revenues that will lead to poverty alleviation.

Several governments in West Africa are currently considering applying or increasing tariffs to protect their local traded sectors. The proposal to apply a tariff to protect the tradable sector in a country has been studied extensively over the past half century. The impact of a tariff on wages was initially examined by Stolper and Samuelson (1941), Metzler (1949), and Bhagwati (1959) among others. Mussa (1974) and Burgess (1980) reexamined the potential of applying tariffs to protect the tradable sector and they reached the same conclusion: tariffs in the short term helps the traded sector where as it hurts this sector long term as it shifts resources from the unprotected to the protected industries. More recently Galor (1994) and Dinopoulos and Segerstrom (1999) examined the same problem taking into consideration new economic insight (either overlapping generations or skill acquisition rates). Although neither advocated protectionism, Galor establishes that imposing a tariff could lead to an increase in welfare level in a small over-lapping generations economy; Dinopoulos and Segerstrom show that tariffs will increase wages for unskilled labor however it retards the development of human capital as in the long run it increases the fraction of the population remaining in the unskilled category.

We believe that new research is needed to reexamine the Dutch Disease question using current economic methods within the framework of an open economy that has lowered trade barriers and increased capital mobility. Hausmann and Rigobon (2003) is an excellent example of such research, they examine the different theories used to explain the "Resource Course" and provide an inefficient specialization model that examines the impact of government expenditure on the non-tradable sector. The study shows that the economy will suffer from higher interest rates on non-tradables, lower capital and wages, and a more depreciated exchange rate.

This paper uses the Hausmann and Rigobon model as a good starting point to further develop the resource curse and better explain the factors at play and their respective implications.[12] We are convinced that the resource curse problem in Sub-Saharan oil exporting countries is not labor availability or scarcity of land and capital. The problem is a resource curse that is negatively impacting wages and production in the tradable sector leading to the unemployment of resources and migration from the rural areas to urban areas where the non-tradable sector is booming. This problem leads to pressure a government to take steps to mitigate adverse consequences for traded sectors suffering from these problems, such pressure often takes the form of protectionism; indeed we have seen precisely this in the past in Nigeria where rice imports were banned for a short period.

Our model addresses this issue directly by dividing the tradable production into two sectors: one worth protecting and one that is not. We assume that labor mobility is not perfect and that wages differ from one sector to the other. We will examine the implication of a tariff in such an economy on households and the productive sectors. Later on in the paper we will relax the assumption that the economy is at full employment and examine the implications on production and poverty alleviation. Medium and long

[12] The model assumes that production is divided into only tradables and non-tradables, there is one kind of households, economy is at full employment, and labor mobility is perfect (hence wages are equal in all sectors).

term implications of the tariff will be also examined under the learning by doing and returns to infrastructure scenarios. Finally, we will consider Angola as a study case and examine the implications of our model.

V. Modeling Oil Revenue Impact on the Tradable and non-Tradable Sectors

The model we use assumes inefficient specialization in an economy that has four sectors: protectable tradables, unprotectable tradables, non-tradables, and minerals (oil, gas, diamonds …). The protectable tradable sector is a promising sector of the traded economy that employs a significant amount of local resources and produces an output that is insufficient to satisfy local demand and hence still needs to be imported. In addition, it can often be a sector whose growth has significant implications for poverty alleviation given the structure of production and consumption if, for example, it is dominated by a traded staple grain or some similar commodity. On the other hand the unprotectable tradable sector is made up either of small industries that produce tradable goods in small quantities (i.e. mostly imported from outside world) or the industries that are currently exporting to the outside world.[13] The mineral sector consumes no local inputs and generates income only for the government. This income along with other revenues coming from the sale of other raw minerals, as well as aid and international loans are spent by the government mostly on non-tradables but also on the two kinds of tradable goods. This is a reasonable characteristic of oil production in Sub-Saharan Africa where it is operated as a virtually self contained enclave (there is no use of domestic factors of production). The model assumes that production in the country can be divided into protectable tradables, unprotectable tradables, and non-tradables. On the other hand consumption is driven by four factors: households that earn their living in the protectable tradable sector, households that earn their living in the unprotectable tradable

[13] Our assumption divides the tradable sector into two parts: the protectable tradable goods' sector and the unprotectable tradable goods' sector. The labeling "protectable" does not mean that it is currently protected; rather it is the subject of protectionist pressures which may or may not result in an actual tariff. Our goal is to analyze the consequences following each possible path.

sector, households that earn their living in the non-tradable sector, and government expenditure.

The model will be analyzed in three consecutive periods. The above assumptions hold in all periods. In period one, we will examine the impact of the revenue windfalls on the different production sectors, study the effect of government consumption of the nontradable goods on wages in the tradable sector, and examine the potential impact of a tariff to protect the protectable tradable sector. In period two, we include a learning factor in our model and assume that the productivity of labor increases due to learning by doing. This is intended to model time dependent productivity effects which may affect certain sectors as maintaining adequate levels and qualities of human capital is dependent upon production patterns in a given period. Productivity in the nontraded and protectable tradable sectors benefit from learning by doing; whereas, the unprotectable tradable sector suffers from "dislearning" by doing. We will examine the potential impact this might have on our results and whether the tariff is still beneficial in such a scenario. In period three we assume that the windfalls diminish and that the economy enjoys returns to infrastructure investments made by the government in the previous periods. All sectors will benefit from the returns to infrastructure investments.

A. Impact of Revenue Windfalls on Local Economy (Period One)

i. Production

We will assume that the protectable tradable (P), unprotectable tradable (U), and non-tradable sectors (N) are composed respectively of N_P, N_U, and N_N small firms that are price takers. Similar to Hausmann and Rigobon we assume that these firms use capital and labor (l) to produce y_P, y_U, and y_N. Total production of protectable tradables, unprotectable tradables, and non-tradables are respectively Y_P, Y_U, and Y_N. We assume that capital investment is irreversible and it is treated as a fixed factor that is specific to the industry in which it is used. Labor is the only mobile factor of production and neither consumers nor firms save. The firms require one unit of capital to produce and their production functions are:

$$y_P = l_P^{(1-\alpha)} \qquad \text{and} \qquad Y_P = N_P * y_P \qquad (1)$$

$y_N = l_N^{(1-\alpha)}$ and $Y_N = N_N * y_N$ (2)

$y_U = l_U^{(1-\alpha)}$ and $Y_U = N_U * y_U$ (3)

Firms are assumed to be profit maximizers and subsequently they solve:

$$\max \quad P_P * l_P^{(1-\alpha)} - W_P * l_P \tag{4}$$

where : P_P are the prices of protectable tradables

W_P are the wages paid in the protectable tradable sector

Solving for profit maximization (first order conditions give):

$$W_P = (1-\alpha) * l_P^{-\alpha} * P_P \tag{5}$$

Hence:

$$l_P = [(1-\alpha) * P_P / W_P]^{1/\alpha} \tag{6}$$

and

$$y_P = [(1-\alpha) * P_P / W_P]^{(1-\alpha)/\alpha} \tag{7}$$

and therefore profit is:

$$\pi_P = \quad [\alpha / (1-\alpha)] * W_P * [(1-\alpha) * P_P / W_P]^{1/\alpha} \tag{8}$$

Similarly, firms in the unprotectable tradable sector solve:

$$\max \quad P_U * l_U - W_U * l_U \tag{9}$$

where : P_U are the prices of unprotectable tradables

W_U are the wages paid in the unprotectable tradable sector

Solving for profit maximization (first order conditions give):

$$W_U = (1-\alpha) * l^{-\alpha}{}_U * P_U \tag{10}$$

Hence:

$$l_U = [(1-\alpha) * P_U / W_U]^{1/\alpha} \tag{11}$$

and therefore production becomes

$$y_U = [(1-\alpha) * P_U / W_U]^{(1-\alpha)/\alpha} \tag{12}$$

Similarly, non-tradable firms solve:

$$\max \quad P_N{*}l_N - W_N{*}l_N \tag{13}$$

where : P_N are the prices of non-tradables
W_N are the wages paid in the non-tradable sector

Solving for profit maximization (first order conditions give):

$$W_N = (1-\alpha) * l^{-\alpha}{}_N * P_N \tag{14}$$

Hence:

$$l_N = [(1-\alpha) * P_N / W_N]^{1/\alpha} \tag{15}$$

and therefore production becomes

$$y_N = [(1-\alpha) * P_N / W_N]^{(1-\alpha)/\alpha} \tag{16}$$

ii. Consumption

We assume that the three different kinds of households and the government are the only sources of consumption in the economy. The households are three kinds: some earn their income from working in the protectable tradable sector (proportion θ of the households), some earn their income from working in the unprotectable tradable sector (proportion π of the households), and some earn their income from working in the non-tradable sector (proportion $(1-\theta-\pi)$ of the households).[14] Consumers are not taxed and they do not directly benefit from oil revenues, in addition consumers derive no utility from government consumption. The households derive utility from consuming protectable tradables (C_P), unprotectable tradable goods (C_U), and non-tradables (C_N). The utility function is Cobb-Douglas with equal weights on protectable tradable, unprotectable tradable, and non-tradable consumption.

[14] The existence of households that earn their income from labor in two or three sectors was included in our initial model however it complicated the calculations and did not alter results or conclusions and hence it will not be discussed here.

The households that earn their income from the protectable tradable sector solve:

$$\max \quad C^{\beta}_{U} * C^{\gamma}_{P} * C^{(1-\beta-\gamma)}_{N} \tag{17}$$

$$\text{st} \quad P_P * C_P + P_N * C_N + P_U * C_U \leq W_P * l_P$$

The first order conditions give:

$$C^{P}_{P} = \gamma * W_P * l_P / P_P \tag{18}$$

$$C^{P}_{N} = (1 - \gamma - \beta) * W_P * l_P / P_N \tag{19}$$

$$C^{P}_{U} = \beta * W_P * l_P / P_U \tag{20}$$

The households that earn their income from the unprotectable tradable sector solve:

$$\max \quad C^{\beta}_{U} * C^{\gamma}_{P} * C^{(1-\beta-\gamma)}_{N} \tag{21}$$

$$\text{st} \quad P_P * C_P + P_N * C_N + P_U * C_U \leq W_U * l_U$$

The first order conditions give:

$$C^{U}_{T} = \gamma * W_U * l_U / P_P \tag{22}$$

$$C^{U}_{N} = (1 - \gamma - \beta) * W_U * l_U / P_N \tag{23}$$

$$C^{U}_{U} = \beta * W_U * l_U / P_U \tag{24}$$

Similarly, households that earn their income from the non-tradable sector solve:

$$\max \quad C^{\beta}_{U} * C^{\gamma}_{P} * C^{(1-\beta-\gamma)}_{N} \tag{25}$$

$$\text{st} \quad P_P * C_P + P_N * C_N + P_U * C_U \leq W_N * l_N$$

The first order conditions give:

$$C^{N}_{P} = \gamma * W_N * l_N / P_P \tag{26}$$

$$C^{N}_{N} = (1 - \gamma - \beta) * W_N * l_N / P_N \tag{27}$$

$$C^{N}_{U} = \beta * W_N * l_N / P_U \tag{28}$$

The government consumption is its total revenues[15] (TR) divided into (TR_P, TR_U, and TR_N) spent respectively on protectable traded, unprotectable traded, and non-traded goods. Hence, government consumption of the traded and non-traded goods (G_P, G_U, G_N) is equal to total revenue spent on that sector divided by the respective price.[16]

$$G_P = TR_P / P_P \tag{29}$$

$$G_N = TR_N / P_N \tag{30}$$

$$G_U = TR_U / P_U \tag{31}$$

iii. Equilibrium

In the following analysis, we will try to quantify the impact of government expenditure on wages and output of the tradable sectors. Following that we will examine the potential effect of a proposed tariff to promote the protectable tradable sector. There are two equilibria in our model that are of interest. The non-tradable sector must clear as these goods or services cannot be imported and hence demand for non-tradable goods must be equal to the output of that sector. In addition, the combined expenditure of the households and the government must be equal to the income generated from production of traded and non-traded goods as well as the expected revenues of the government.

a. <u>Clearing of the non-Tradable Sector:</u>

Total consumption of non-tradables becomes:

$$\theta*C^p_N + \pi*C^u_N + (1-\theta-\pi)*C^N_N + G_N = [(1-\gamma-\beta)*[\theta*W_p*l_p + \pi*W_u*l_u + (1-\theta-\pi)*W_N*l_N]]/P_N + G_N \tag{32}$$

Consumption of non-tradables must be equal to production:

$$[(1-\gamma-\beta)*[\theta*W_p*l_p + \pi*W_u*l_u + (1-\theta-\pi)*W_N*l_N]]/P_N + G_N = N_N*[(1-\alpha)*P_N/W_N]^{(1-\alpha)/\alpha} \tag{33}$$

Simple cross multiplication and rearrangement give:

[15] We are assuming that government revenues include mostly oil revenues, revenues from the sale of other natural resources, and international aid or loans.
[16] We assume that government spending on these goods is allocated a priori regardless of the prices of these goods.

$$W_P = \frac{N_N*[(1 - \alpha)/W_N]^{(1-\alpha)/\alpha} *P^{1/\alpha}{}_N - (1 - \gamma - \beta)*[\pi *W_U*l_U + (1 - \theta - \pi)*W_N*l_N] - P_N*G_N}{(1 - \gamma - \beta)*\theta* l_P} \quad (34)$$

It follows that:

$$P_N = [(1- \gamma- \beta)*\theta*l_P*W_P + [\pi *W_U*l_U + (1 - \theta - \pi)*W_N*l_N] + TR_N]^{\alpha} / N^{\alpha}{}_N*[(1-\alpha)/W_N]^{(1-\alpha)} \quad (35)$$

Equation (34) shows that wages in the tradable sector (whether it is protectable or unprotectable) are negatively impacted by any and all amounts of money that accrue to the government and are spent in the non-tradable sector. This negative impact could help explain the shift of labor from the tradable sector to the non-tradable one. This shift is usually manifested in many countries by the migration from rural (mainly tradable agriculture sector) to urban areas (mostly services and non-tradable production). On the other hand, equation (35) shows, as expected, the increase in government spending in the non-tradable sector would lead to an increase in the price of non-tradables.

b. <u>Equating Total Expenditure and Total Income</u>

Total Expenditure is equal to:

$$\theta*(P_P*C_P+P_N*C_N+P_U*C_U)+\pi*(P_P*C_P+P_N*C_N+P_U*C_U)+(1 - \theta - \pi)*(P_P*C_P+P_N*C_N+P_U*C_U)+P_P*G_P+P_N*G_N +P_U*G_U \quad (36)$$

Total Income is equal to:

$$P_P*Y_P + P_N*Y_N + P_U*Y_U + TR \quad (37)$$

Equating (36) and (37):

$$P_P*C_P + P_N*C_N + P_U*C_U + P_P*G_P + P_N*G_N + P_U*G_U = P_P*Y_P + P_N*Y_N + P_U*Y_U + TR \quad (38)$$

But the value of non-tradable good demanded equal that supplied:

$$P_N*C_N + P_N*G_N = P_N*Y_N \quad (39)$$

Thus, the above factors of the equation can be cancelled. Equation (38) becomes:

$$P_P*C_P + P_U*C_U + P_P*G_P + P_U*G_U = P_P*Y_P + P_U*Y_U + TR \quad (40)$$

$$P_P*(C_P + G_P – Y_P) = P_U*(Y_U – C_U – G_U) + TR \quad (41)$$

Using simple calculations gives:

$$Y_P = \frac{P_P*(C_P + G_P) + P_U*(C_U + G_U – Y_U) – TR}{P_P} \quad (42)$$

It can also be written as:

$$Y_P = \frac{P_P*C_P + P_U*(C_U – Y_U) – TR_N}{P_P} \quad (43)$$

Equation (43) shows that as government expenditure on non-tradables increases it will have a negative impact on the total production of protectable tradable goods produced in the country. Notice also that as expected if the government spends all these revenues on unprotectable and protectable tradables and nothing on non-tradables (i.e. $TR = P_P*G_P + P_U*G_U$) the output of the tradable sector increases with this expenditure.

B. Implications of a Tariff on the Protectable Tradable Goods

i. Impact of the Tariff on the Protectable Tradable Sector

Another method to reduce the impact of government non-tradable expenditure could be to increase P_P (by applying a tariff). To examine the impact of raising the price of protectable tradables on output we derive equation (43) with respect to the price of protectable goods (presented in equation (44)). If the country exports more unprotectable tradable goods than it imports (in value) than equation (44) is very likely to be positive and an increase in P_P leads to an increase in the output Y_P. However, this scenario is unlikely, since we know that the country imports more than it produces unprotectable tradables; therefore the sign of equation (44) depends on the difference between government expenditure on non-tradables and the value of the imports of unprotectable tradable goods and change (negative) of protectable good consumption.

$$\partial Y_P / \partial P_P = \partial C_P / \partial P_P + [TR_N - P_U*(C_U - Y_U)] / P^2_P \qquad (44)$$

In addition, an increase in P_P will also lead to an increase in consumption of alternatives (substitution effect); hence C_U will increase causing more negative impact on Y_P. However, the government's tariff revenues will be mostly spent on non-tradables; hence TR_N will increase as well. Therefore, if the government income and subsequent expenditure on the non-traded sector is larger than the value of the country's consumption of imported unprotectable goods then increasing the tariff on protectable tradable goods would reduce the impact of the government's non-tradable expenditure on the total production of tradable goods and hence lead to an increase in the output of Y_P (i.e. if the reduced government's income effect is larger than the substitution effect then increasing P_P will increase Y_P). We do know that for some of these countries this is the case (later in the paper this will be demonstrated for Angola).

Therefore, we have established that given the right conditions applying a tariff on the protectable tradable sector will increase output as well. The following analysis will examine implications of this tariff on the other sectors in the economy and more importantly on the total income available for household expenditure.

ii. Impact of the Tariff on the Unprotectable Tradable Sector

In order to calculate the impact of an increase in P_P on the output of the unprotectable sector, let us first determine total consumption of the unprotectable tradable goods. To do that we need to sum the consumption of the three different kinds of households (sum equations (20), (24), and (28)) and replace the summation of households' income by total income from production:

$$\theta*C_U + \pi*C_U + (1 - \theta - \pi)* C_U + G_U = \beta*(\theta*W_P*l_P + \pi*W_U*l_U + (1 - \theta - \pi)*W_N*l_N) / P_U + G_U \qquad (45)$$

$$C_U = [\beta* (P_P*Y_P + P_N*Y_N + P_U*Y_U) + TR_U] / P_U \qquad (46)$$

$$\partial C_U / \partial P_P = \beta* Y_P / P_U \qquad (47)$$

Equation (47) is always positive; thus any increase in P_P would actually lead to an increase in the consumption of the unprotectable tradable goods (this is expected due to substitution effect). However, this increase in consumption will not necessarily lead to an increase in production in that sector since this is after all a traded sector. Therefore the two possible impacts are either an increase in imports (I_U) or an increase in production of unprotectable tradable goods. More importantly P_U will not change as it is traded and no tariff has been imposed. However, if we assume that the economy is not at full employment (which we know is the case in all the above countries) then this increase in demand will at least be partially supplied locally. This means Y_U will have to increase, taking into consideration equation (3) means the increase will either be: in the number of firms supplying these goods, in the amount of labor used, or in the wages.

iii. Impact of the Tariff on the non-Tradable Sector

Similar to the unprotectable sector we expect an increase in the consumption of the non-traded goods due to substitution. Total consumption of the non-traded goods is the summation of equations (19), (23), and (27) given by:

$$C_N = [(1 - \gamma - \beta)*(P_P*Y_P + P_N*Y_N + P_U*Y_U) + TR_F] / P_N \tag{48}$$

$$\partial C_N / \partial P_P = (1 - \gamma - \beta)* Y_P / P_N \tag{49}$$

In the non-traded sector there are no imports and hence this increase will have to be supplied locally. This could only be achieved by either an increase in P_N or an increase in Y_N. Similar to the unprotectable traded sector any increase in Y_N means the increase will either be: in the number of firms supplying these goods, in the amount of labor used, or in the wages.

iv. Impact of the Tariff on Total Households' Income

We have seen the potential impact of a tariff on the potential output of each production sector; however how will the different households be affected? The total amount of money available for households' expenditure (E) is equal to the total income generated from production of traded and non-traded goods in the country.[17] Hence, total consumption (C) is equal to total expenditure (we assumed no saving) equal to:

$$E = P_P*Y_P + P_N*Y_N + P_U*Y_U \qquad (50)$$

We have proved that P_P as well as Y_P will increase; also either P_N or Y_N will definitely increase. P_U will stay the same; Y_U can stay the same but most likely will increase. Therefore the combined income of all households will increase significantly. However, will all the different households benefit from this tariff?

v. Impact of the Tariff on Firms' Demand for Labor

The exact impact of any tariff application on the other two sectors of the economy will depend on the general supply of labor. We know that the tariff will lead to a substitution effect that would increase demand of unprotectable and nontradable goods. This demand increase can either be fulfilled by increasing supply (needs more labor) or by increasing prices of these goods. Hence if local economy is at full employment (L) prior to the tariff, the increase in P_P could lead to an increase in the prices of alternative goods and a reallocation of labor instead of enlarging the current sectors from unemployed resources. In such a scenario, the economy will:

$$\begin{aligned}
\max \quad & P_P*Y_P + P_N*Y_N + P_U*Y_U && (50)\\
\text{st} \quad & Y_P = N_P * l_P^{(1-\alpha)} = L_P^{(1-\alpha)} \\
& Y_N = N_N * l_N^{(1-\alpha)} = L_N^{(1-\alpha)} \\
& Y_U = N_U * l_U^{(1-\alpha)} = L_U^{(1-\alpha)} \\
& L_P + L_N + L_U = L
\end{aligned}$$

Taking first order conditions and solving for the industry demand of labor:

[17] As we have assumed that oil revenues go directly to the government.

$$L_P = \frac{L}{[(P_N)^{1/\alpha} * (P_P)^{-1/\alpha} + (P_U)^{1/\alpha} * (P_P)^{-1/\alpha} + 1]} \tag{51}$$

$$L_N = \frac{L * (P_N)^{1/\alpha} * (P_P)^{-1/\alpha}}{[(P_N)^{1/\alpha} * (P_P)^{-1/\alpha} + (P_U)^{1/\alpha} * (P_P)^{-1/\alpha} + 1]} \tag{52}$$

$$L_U = \frac{L * (P_U)^{1/\alpha} * (P_P)^{-1/\alpha}}{[(P_N)^{1/\alpha} * (P_P)^{-1/\alpha} + (P_U)^{1/\alpha} * (P_P)^{-1/\alpha} + 1]} \tag{53}$$

The derivative of the above demand function with respect to P_P shows that only $\partial L_P / \partial P_P$ will be positive. Hence, as predicted by the Stolper Samuelson Theorem there will be a shift in resources (labor in our case) from the two unprotected industries to the now protected one. Hence, such a tariff will have mixed results, although protecting one sector will increase wages in this sector, this protection is unsustainable since it will shift resources from the exporting and non-traded sectors hindering their growth.

We believe that none of the countries being examined is at full employment. On the contrary unemployment is a major problem in many of these countries particularly in areas devoted to non-oil traded sectors. If the economy has unemployed human resources then the increase in demand for any of the above goods can be readily supplied by increasing production without any increase in the price of unprotectable and nontradable goods. In such a scenario, only the protectable goods will exhibit an increase in prices. We believe that this is a more realistic view of the potential impact of the tariff on the labor market equilibrium. In the remainder of this paper we assume that the economy is not at full employment and hence any increase in the demand for any good is offset by an increase in the supply of that good; hence prices wouldn't change (except prices of the protectable traded goods which will increase due to the taxation).

vi. Impact of the Tariff on the Different Households

The exact impact of a tradable goods tariff on the overall welfare of the three representative households in our model is complicated because it depends on the consumption basket for each household in every country. In our case study, we shall quantify this impact on each of the different households. One thing is certain, as our primary analysis below shows households that earn their leaving from the protected industry will benefit.

Let us assume that the households that work in the protectable tradable sector actually work in agriculture and hence own the output. Thus, plugging equation (5) in the constraint of equation (17) gives:

$$\max \quad C^{\beta}_{U} * C^{\gamma}_{P} * C^{(1-\beta-\gamma)}_{N} \tag{55}$$
$$\text{st} \quad P_P * C_P + P_N * C_N + P_U * C_U \leq (1 - \alpha) * l_P^{-\alpha} * P_P * l_P = (1 - \alpha) * P_P * y_P$$

If we assume that farms produce a lot more of the tradable good than they consume, then any increase in the price of the tradable good will lead to an increase in the disposable income of these households. On the other hand, households that work in the unprotectable tradable sector and the non-tradable sector will have the same income but the protectable tradable goods in their consumption basket will be more expensive. So the composition of their consumption basket, the nature of the goods that are protected, and the degree of substitution, will determine the extent of the decrease in their welfare.[18]

Perhaps we can summarize our results in a tentative way: Our model shows that oil windfalls, if spent on the nontradable sector, will have detrimental impact on the tradable sectors. Our results confirm a decrease in the output of the tradable sectors as well as a decrease in the respective wages in these sectors. There seems to be potential benefit in a short term tariff application to protect a section of the tradable sector. Assuming local economies are not at full employment; this tariff will increase production in the protected industries and have minimal impact on the other sectors. Overall, the tariff could raise the total income available for households' expenditure with varying implications on the different households under study.

18 However, in such a scenario a large number of unemployed households whose consumption has been ignored so far due to the lack of income will now be employed by the increase in demand for local goods in the protectable tradable sector, non-tradable and potentially unprotectable tradable sectors. The consumption of these previously unemployed households will fuel more demand and the national income pie will grow leading to even less unemployment and poverty.

C. Implications of Learning by Doing on the Model (Period Two)

We have determined that in the short term a tariff could have potential benefits; however, what are the medium and long term implications? Let us assume that in period two all the previous assumptions still hold; however, learning by doing leads labor in the protected tradable and nontradable sectors to increase productivity whereas labor in the unprotected tradable sector will be negatively effected by this development (i.e. a process of dislearning).[19] Hence, the production functions for the sectors that benefit from learning by doing will exhibit increasing returns to scale and the unprotectable tradable sector will exhibit decreasing returns to scale. Thus the production functions now become:

$$y_P = l_P^{(1-\alpha/2)} \quad \text{and} \quad Y_P = N_P * y_P \tag{51}$$
$$y_N = l_N^{(1-\alpha/2)} \quad \text{and} \quad Y_N = N_N * y_N \tag{52}$$
$$y_U = l_U^{(1-2\alpha)} \quad \text{and} \quad Y_U = N_U * y_U \tag{53}$$

Solving for profit maximization of the firms in the different sectors yield:

$$W_P = (1 - \alpha/2) * l_P^{-\alpha/2} * P_P \tag{54}$$
$$l_P = [(1 - \alpha/2) * P_P / W_P]^{2/\alpha} \tag{55}$$
$$y_P = [(1 - \alpha/2) * P_P / W_P]^{(1-\alpha)*2/\alpha} \tag{56}$$
$$W_U = (1 - 2\alpha) * l_U^{-2\alpha} * P_U \tag{57}$$
$$l_U = [(1 - 2\alpha) * P_U / W_U]^{1/2\alpha} \tag{58}$$
$$y_U = [(1 - 2\alpha) * P_U / W_U]^{(1-2\alpha)/2\alpha} \tag{59}$$
$$W_N = (1 - \alpha/2) * l_N^{-\alpha/2} * P_N \tag{60}$$
$$l_N = [(1 - \alpha/2) * P_N / W_N]^{2/\alpha} \tag{61}$$
$$y_N = [(1 - \alpha/2) * P_N / W_N]^{(1-\alpha)*2/\alpha} \tag{62}$$

[19] We assume that the unprotected tradable sector will lag behind as resources shift to the now more beneficial protected sector. The non-tradable sector will continue to boom driven by the government's spending.

Preferences of the different groups remains unchanged however the results of the market equilibrium change. Clearing of the nontradable sector will give:

$$W_P = \frac{N_N*[(1-\alpha/2)/W_N]^{(1-\alpha)*2/\alpha} *P^{(2-\alpha)/\alpha}_N - (1-\gamma-\beta)*[\pi*W_U*l_U + (1-\theta-\pi)*W_N*l_N] - P_N*G_N}{(1-\gamma-\beta)*\theta*\, l_P} \quad (63)$$

Wages in the protected tradable sector are still negatively impacted by government consumption of nontradable goods; however, due to the increase in productivity in the nontradable sector these wages in the protected sector will be positively impacted. Another way of looking at it can be that the government demand of untradable goods requires fewer resources; hence the negative implications of this government expenditure are less.

Equating total expenditure and total income yields the same equation (equation (64) is exactly similar to equation (43)); however the dislearning in the unprotected tradable sector will actually lead to a decrease in local output of unprotected local goods and subsequently to an increase in the imports of these goods.

$$Y_P = \frac{P_P*C_P + P_U*(C_U - Y_U) - TR_N}{P_P} \quad (64)$$

$$\partial Y_P / \partial P_P = \partial C_P / \partial P_P + [TR_N + P_U*Y_U - P_U*C_U)] / P^2_P \quad (65)$$

Equation (64) shows that any decrease in Y_U will lead to an increase in Y_P (negatively correlated). However, the derivative of equation (64) shows that as Y_U decreases the positive impact of a tariff decreases as well (and may even make the impact of a tariff negative). Therefore, at best the impact of a tariff in this stage is a minimal positive gain in the output of the protected sector and in the worst case (more likely) it will lead to a negative impact on Y_P. Thus the projected tariff in period one may protect the desired sector short term; however, in the long term removing the tariff could have a better impact on the protected tradable sector.

We can extend the analysis to a third period in which, we assume that there are positive returns to government investments in infrastructure, and government expenditure on nontraded goods slows down either due to lower oil revenues or less infrastructure projects are needed. Hence the three sectors of the economy will benefit from the government investments made in previous periods and the productivity of labor in all three sectors now improves proportionally; to reflect this we assume the production functions become:

$$y_P = l_P^{(1-\alpha/6)} \tag{66}$$

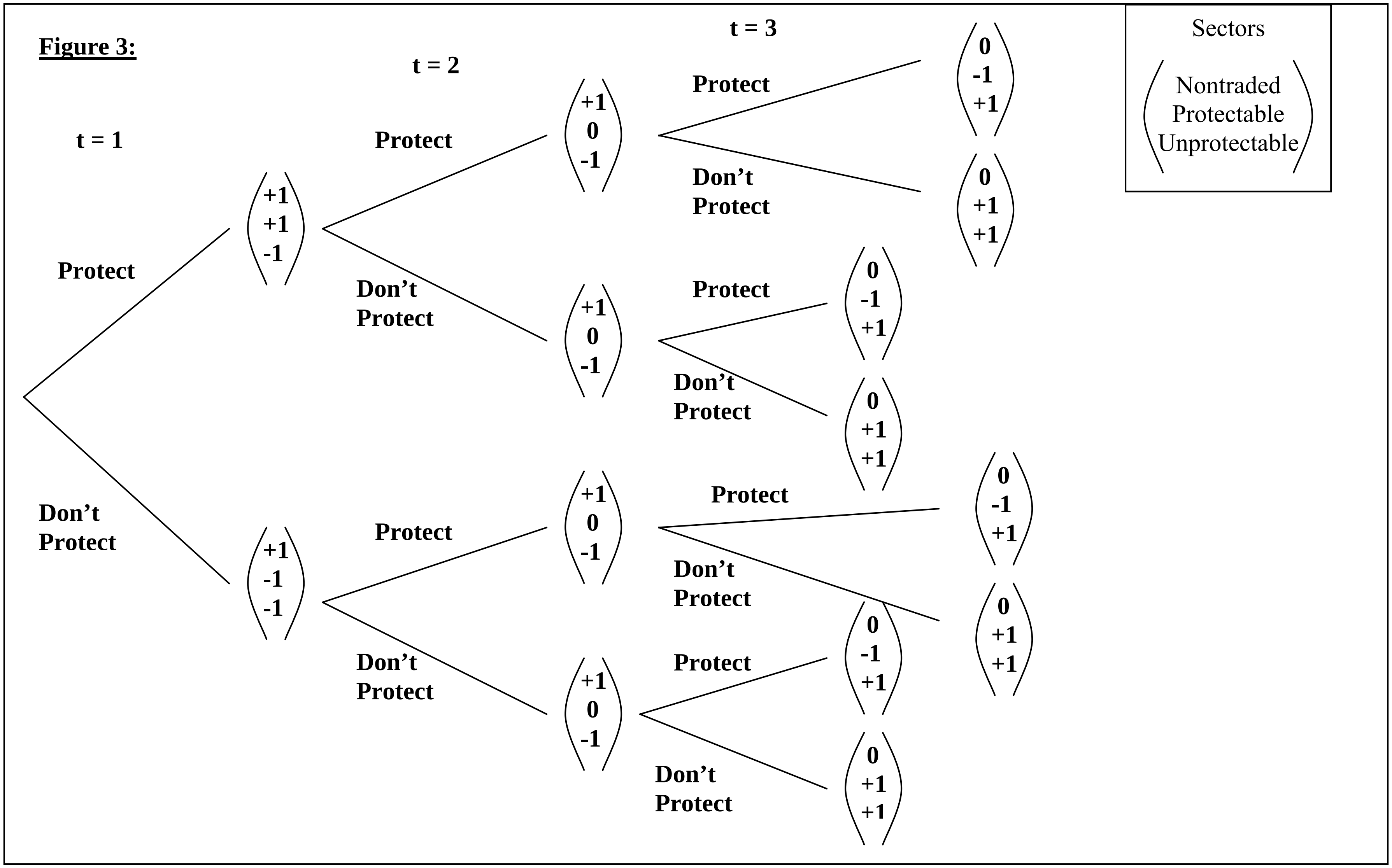
$$y_N = l_N^{(1-\alpha/6)} \tag{67}$$

$$y_U = l_U^{(1-2\alpha/3)} \tag{68}$$

This will lead to even higher production in all sectors and reduces the negative impact of any government expenditure on the tradable sectors. The reduction in government nontraded expenditure would make the application of any tariff clearly inefficient and reduces the negative impact this expenditure has on wages in the tradable sectors. If a process of returns to infrastructure is included in the model, the impact of a tariff becomes even more negative particularly to the protected sector and may be even to total households' income.

In summary, a tariff applied to protect a small section of the tradable sector may be a good short-term policy to reduce the impact of Dutch Disease on that sector; however, in the medium and long term this tariff will hurt the development of the sector it is trying to protect. This is illustrated in Figure (3); the decision tree examines the development of local output in the three sectors given the assumptions made in each period. At t = 1, government expenditure on nontradables will lead to increase in output in that sector (hence +1 is recorded) and decrease in the output of the unprotectable sector. If the government chooses to protect the protectable sector then this will positively impact the output of that sector. In t = 2, government expenditure will still positively drive the output of the nontradable sector; however, due to learning by doing the positive impact of protecting the protectable sector is no longer clear. When the oil windfalls cease in the third period, their positive impact on the nontraded sector ceases as

Figure 3:


t = 1
t = 2
t = 3
Sectors
Nontraded
Protectable
Unprotectable
Protect
Don't Protect
+1 +1 -1
+1 -1 -1
Protect
Don't Protect
+1 0 -1
Protect
Don't Protect
0 -1 +1
0 +1 +1

well. However, due to returns to infrastructure, now the unprotectable traded sector benefits. The protectable traded sector will benefit only if it is no longer protected by a tariff.

V. Case Study: Angola

Angola is a perfect example for our analysis. Oil revenues in 2005 were more than 80% of GDP, 95% of total exports, and around 96% of government revenues. The oil and gas boom has come at the expense of other sectors, particularly agriculture. Angola's traditional agricultural exports (most notably maize and coffee) ceased during the post-independence civil conflict and the country became a net importer of all these commodities. Despite the fact that in 2005 the per capita government take from oil revenues was more than $1000, this money did not reach most of the population. In short, the oil windfalls created negative pressure on income in the agricultural sector in general and rural people in particular.

For simplicity let us consider protecting maize in Angola. This is a staple grain for a large part of the population and was also a major export crop prior to Angola's civil war and oil boom, reaching export levels of 400,000 metric tons per year in the 1970's. Today, Angola imports more than 250,000 metric tons per year.

In order to estimate the negative pressure of oil revenues we will use equation (34) to determine the impact of oil revenues in 2004 on wages in the protectable tradable sector of the economy. In 2003, the government take from the hydrocarbon sector was around $4,000 million.[20] In that year total government expenditure was around $6,200 million and approximately $4,130 of this was expenditure on non-tradable goods.[21] In 2004, government take from the hydrocarbon sector were around $6,000 million and total

---

[20] Data source: The World Bank Group country unit staff estimates.

[21] Data source: Angola Selected Issues and Statistical Appendix. (IMF Country Report No 05/125; April 2005). According to Angolan authorities and country unit staff estimates, government expenditure was around 468 billion kwanza in 2003 (exchange rate during that year averaged 74.6 kwanza per US$). Hence government expenditure was around $6.2 billion. The government's non-tradable expenditure includes spending on defense (30 billion kwanza), education (32 billion kwanza), health (25 billion kwanza), welfare and housing (46 billion), transportation and general public services (106 billion and 69 billion respectively). This approximately adds to $4,129 million.

government expenditure was around \$9,350 million and around \$6,080 million of this expenditure was on non-tradable goods.[22] Equation (34) estimates:

$$(1-\gamma-\beta)*\theta*l_P*W_P = N_N*[(1-\alpha)/W_N]^{(1-\alpha)/\alpha}*P^{1/\alpha}{}_N - (1-\gamma-\beta)*[\pi*W_U*l_U + (1-\theta-\pi)*W_N*l_N] - TR_N \quad (34)$$

The left hand side represents the amount of money available as compensation for labor input in the protectable sector (maize production) of the economy. In 2003, the non-tradable sector ($N_N*[(1-\alpha)/W_N]^{(1-\alpha)/\alpha}*P^{1/\alpha}{}_N$) contributed around \$4,510 million to the economy.[23] Government expenditure on non-tradables (G_N) was around \$4,130 million and the demand of households that work in the unprotectable and non-tradable sectors for non-tradable goods ($(1-\gamma-\beta)*[\pi*W_U*l_U + (1-\theta-\pi)*W_N*l_N]$) was around \$350 million[24]. Hence, around \$30 million was available as compensation for labor input in the protectable sector of the economy. If we redo the same analysis for 2004, we find that the non-tradable sector contributed around \$6,450 million[25] to the economy; government expenditure on non-tradables was \$6,080 million and the demand of households that work in the unprotectable and non-tradable sectors for non-tradable goods was still around \$350 million. Hence in 2004, around \$20 million (33% less than 2003) was available as compensation for labor input in the protectable sector of the economy. This means either wages in this sector went down or less labor hours were put into production (i.e. some land was taken out of production and/or migration of underemployed resources to cities).

Keeping in mind that total government expenditure, in 2003, was around \$6,200 million and approximately \$4,130 of this was expenditure on non-tradable goods; net

[22] Data source: The World Bank Group country unit staff estimates. The exact figure on government non-tradable expenditure is not available, we assume that similar to previous years it is around 65% of total government expenditures.
[23] Data source: Angola Selected Issues and Statistical Appendix. (IMF Country Report No 05/125; April 2005). According to Angolan authorities and country unit staff estimates, the non-tradable section of the 2003 GDP was around 337 billion kwanza distributed among services (155 billion), commerce (146 billion), construction, electricity, and water (36 billion).
[24] Data source: Angola Selected Issues and Statistical Appendix. (IMF Country Report No 05/125; April 2005). According to the National Institute of Statistics, monthly consumer expenditure included 2,182 million kwanza on non-tradable goods (housing, health, education, transportation, communication, leisure, and recreational activities). For 2003, these figures would have totaled \$350 million for the whole year.
[25] Data source: World Bank, Angola at a Glance, country staff estimates, August 2005.

unprotected goods' imports in the same year were around $4,103 million.[26] Angolan maize consumption, in 2003, was 0.81 million metric tons and the international price of maize was around $100 per metric ton. Using equation (43) yields Y_P = 0.55 million metric tons of local maize production. The actual 2003 maize production in Angola reported by the FAO and the Ministry of Agriculture and Rural Development was around 0.54515 million metric tons.[27]

Let us now assume that a 25% tariff was imposed on maize imports and 65% of the tax revenues were also spent on non-tradables.[28] Consumption of maize will decrease due to the substitution effect. If we assume 12.5% of consumers can no longer afford to buy maize (0.1 million metric tons of demand) and hence buy other alternatives (i.e. the price elasticity of maize demand is -0.5). The substitutes will be other non-maize foods (unprotected goods). Hence, C_U will increase by the value of $10 million (the value of 0.1 metric ton). Using equation (43) yields a new Y_P = 0.56 million metric tons of local maize production (an increase of around 2% in local output).

Therefore, as our model predicts, raising the tariff could reduce the negative impact of government expenditure on non-tradable production. However, what are the implications of such a tariff on the households and government incomes? Obviously, government income increases as it collects the returns from the tariff. Households' income increases as well; this is better illustrated when we apply equation (50) to our analysis:

$$E = P_P{*}Y_P + P_N{*}Y_N + P_U{*}Y_U \qquad (50)$$

Before applying a tariff the total amount of money available for households' expenditure (E) is equal to $2,120 million [(100 $/ton)*(0.55 million tons) + ($350

---

[26] Data source: World Trade Organization "Mirror Imports of Angola" reports that imports of unprotected goods were around $4,130 million out of which $27 million were Maize imports (0.266 million metric tons).

[27] Data source: Special Report "FAO/WFP Crop and Food Supply Assessment Mission to Angola"; August 2004.

[28] In 2003, 65% of government expenditure was on non-tradables. We are assuming that 65% of the maize tariff revenues will also be spent similarly.

million) + ($1,715 million[29])]. Once a tariff is applied the value of the protected production increases by around $15 million (125 $/ton)*(0.56 million tons), and the value of the unprotected production as well as that of the non-tradable production will increase by around $5 million due to substitution effect that will be partially supplied locally.[30] Thus E becomes $2,140 million. Hence, the application of this tariff does increase the overall amount of money available for households' expenditure by almost 1%. More importantly this increase is benefiting the poorest of the poor in Angola as our next analysis demonstrates.

The average farm size in Angola is around 1.5 hectares. FAO estimates that in sub-Saharan Africa yield for maize is around 0.55 tons per hectare.[31] Hence in 2003, the total revenues for an average farm were on the order of $82.5. If a tariff had been applied this figure would have been $103. So in addition to an increase in local production our proposed tariff would also increase total maize farm revenues by 25%. However, households that do not earn their income from maize production will have to pay more to keep their consumption basket unchanged. Depending on the income of these different households the tariff would have reduced their disposable income by 3.5% to 8%.[32]

To summarize, as oil revenues in Angola increase there is definite negative impact on the production and wages in the protectable tradable sector of the economy. Our case study shows that as oil revenues and subsequently government expenditure increased by around 50% from 2003 to 2004 financial compensation for wages in the protectable sector decreased by around 33%. If a 25% tariff was imposed in 2003 on imported maize, this would have lead to: an increase in local maize production by around

[29] Data source: Angola Selected Issues and Statistical Appendix. (IMF Country Report No 05/125; April 2005). Non-maize agricultural activity in Angola in 2003 was valued around $575 million; manufacturing activity in the same year was valued around $1,140 million.

[30] Although we believe that maize will most likely be substituted by cassava that is locally produced; other unprotected goods and even non-tradable services could possibly act as alternative targets of this substitute spending. Hence, we assume that at least 50% of the 1 million ton of maize demand lost to substitution (valued at $10 million in 2003) will be locally supplied.

[31] Data source: Special Report "FAO/WFP Crop and Food Supply Assessment Mission to Angola"; August 2004. Angolan Maize yield in 2003 varied between 0.15 tons/ha (in Cunene in the south) and 0.8 tons/ha (in Cabinda in the north). The simple average of the 18 regions producing maize in 2003 was 0.55 tons/ha.

[32] The exact impact is difficult to estimate. According to unpublished research by Paulo Filipe at Cornell University maize flour constitutes around 40% of the basic food basket in Angola. The basic food basket includes maize flour, beans, vegetable oil, salt, and cassava. If we assume that the basic food basket varies between 40% and 80% of total household income in Angola; then, taking into consideration the possibility of substitution (price elasticity for maize demand is -0.5), a 25% increase in the price of maize would reduce disposable income by 3.5% to 8%.

10,000 metric tons, and a 25% increase in average farm income. This tariff would have also increased total households' income in Angola by around 1%.

VI. Conclusion

The current increase in oil prices coupled with the steady increased in production in Sub-Saharan Africa will guarantee several oil exporting countries in this region huge windfalls. Although reserves have been continuously growing at a rate exceeding any other region in the world, they are still a limited exhaustible resource. Hence there is a unique and limited window of opportunity for these countries to benefit from their endowment and achieve poverty alleviation and faster development.

This paper has explored the consequences of large flows of mineral income for the non-oil economy, particularly in terms of the implications for poverty and production in non-oil traded sectors in African oil exporting economies. In doing this we are following a well established tradition exemplified by the literature on Dutch Disease and the Resource Curse. We extend the traditional analysis in several ways.

First, we explicitly treat the mineral income as the result of a total enclave production sector with no linkages whatever to the national economy. This means that the only effect of the oil income is via a government spending effect. This assumption is not really an abstraction since it mirrors closely the actual situation for those countries producing off-shore oil through contracting arrangements with companies which import 100% of their inputs.

Second, we explicitly analyze the effects of an oil boom on a disaggregated representation of the non-oil traded sector, part of which is assumed to possess a latent comparative advantage in the absence of oil-induced distortions (e.g. agriculture) and part of which may not. This allows analysis of the effects of protectionist policies directed toward part of the traded goods sector. We take a phased approach to the analysis, looking at each segment of the oil boom: an initial period of increasing revenues and a subsequent period of decline.

If there are learning-by-doing effects in play in the traded goods sector, then there is a basis for wanting to prevent decline and eventual stagnation of those parts of this sector which have a potential comparative advantage since there will be large efficiency losses if these sub-sectors cannot produce at peak efficiency after the oil revenue boom has passed. A preferable way to achieve this would be to invest in technological efficiency improvements for this sub-sector since this would prevent additional distortions from affecting other parts of the traded goods sector as well as the non-traded sectors. However, we show that a tariff could also be welfare increasing if and only if the tariff is confined to the period during which oil revenues are large. If protection continues into the "bust" period of the oil revenue cycle then benefits turn into losses. Therefore a tariff could be helpful in the short run on the demand side; however it should be associated with infrastructure investments to support the country's comparative advantages and the supply side.

This analysis is relevant to the current situation in some African countries where the relevant traded subsector is agriculture, which employs more than half the population and where most of the extreme poverty is located. In essence, the benefits of policies promoting this trade-exposed sector accrue almost entirely to those who most need them while the costs fall on the rich and on those parts of the poor population who consume but do not produce agricultural products. Herein lies the political economy issue for African governments: While helping the agricultural sector has positive poverty implications for the largest number of people it has negative implications for those who are located where they can most directly affect the government: i.e. in cities.

The paper considers as a numerical example the case of Angola illustrating the relevance of this analysis empirically. Indeed, this case is found to parallel our analysis very closely in terms of quantitative measures of revenue flows and sectoral results. In particular, the enclave nature of oil production and the appropriation of the rents by the government generate a situation where the majority of the population may not share in any of the benefits of oil production but is nevertheless subject to the negative effects inflicted on non-oil traded production through their reliance on agricultural production. In such a situation all of the positive effects of tariff protection accrue to the poorest who most need them while the usual negative effects fall disproportionately on the rich. However, it remains the case that any tariff protection must be temporary if it is to be welfare increasing. The prospects for achieving this must therefore temper any attempt to base policy on analytical results.

References

Adam, S.A. and Bevan, D.L. "Aid and the Supply Side: Public Investment, Export Performance and Dutch Disease in Low Income Countries." *The World Bank Economic Review*, 2006, 20(2), pp. 261-290.

Auty, R. "The Political State and the Management of Mineral Rents in Capital-Surplus Economies: Botswana and Saudi Arabia." *Resources Policy*, 2001, 27, pp. 77-86.

Bhagwati, J. "Protection, Real Wages and Real Income." *The Economic Journal*, 1959, 69 (276), pp. 733-748.

Borjas, G.W. and Ramey, V.A. "Time Series Evidence on the Sources of Trends in Wage Inequality." *American Economic Review*, May 1994, 84 (2), pp. 10-16.

Bruno, M. and Sachs, J. "Energy and Resource Allocation: A Dynamic Model of the Dutch Disease." *Review of Economic Studies*, 1982, 49 (5), 845-859.

Bruno, M. "Adjustment and Structural Change Under Supply Shocks." *Scandinavian Journal of Economics,* 1982, 84 (2), pp. 199-221.

Burgess, D.F. "Protection, Real Wages, and the Neoclassical Ambiguity with Interindustry Flows." *The Journal of Political Economy*, 1980, 88 (4), pp. 783-802.

Claessens, S. and Duncan, R.C. *Managing Commodity Price Risk in Developing Countries*. John Hopkins University Press, Baltimore, MD, eds 1993.

Corden, W.M. "Booming Sector and Dutch Disease Economics: Survey and Consolidation." *Oxford Economic Papers*, 1984, 36, pp. 359-380.

Corden, W.M. and Neary, J.P. "Booming Sector and De-industrialization in a Small Open Economy." *The Economic Journal*, December 1982, 92, pp. 825-848.

Devlin, J. and Titman, S. "Managing Oil Price Risk in Developing Countries." *The World Bank Research Observer*, 19 (1), 2004.

Dinopoulos, E. and Segerstorm, P. "A Schumpeterian Model of Protection and Relative Wages." *The American Economic Review*, 1999, 89 (3), pp. 450-472.

Eifert, B., **Gelb, A., Tallroth, N.B.**, "The Political Economy of Fiscal Policy and Economic Management in Oil Exporting Countries." World Bank Policy Research Working Paper 2899, October 2002.

Eifert, B., **Gelb, A., Tallroth, N.B.**, "Managing Oil Wealth." *Finance and Development*, March 2003, 40 (1).

Engel, E. and Meller, P. *External Shocks and Stabilization Mechanisms*. John Hopkins University Press, Baltimore, MD, eds 1993.

Forsyth, P.J. and Kay, J.A. "The Economic implications of North Sea Oil Revenues." *Fiscal Studies*, July 1980, pp. 1-28.

Galor, O. "Tariffs, Income Distribution and welfare in a Small Overlapping-Generations Economy." *International Economic Review*, 1994, 35 (1), pp. 173-192.

Gylfason, T. "Natural Resources, Education and Economic Development." *European Economic Review,* 2001, 45: 847-859

Hausman, R. and Rigabon, R. "An Alternative Interpretation of the 'Resource Curse': Theory and Policy Implications." NBER Working Paper Series, WP 9424, Cambridge: National Bureau of Economic Research, 2002.

Howard, M. "Causality Between Exports, Imports and Income in Trinidad and Tobago." *International Economic Journal,* Winter 2002, 16 (4), pp. 97-106.

Kyle, S. "Dutch Disease in Sao Tome e Principe: Policy Options for the Coming Oil Boom." Department of Applied Economics and Management Working Paper No. 2002-04, February 2002.

Krugman, Paul. "The Narrow Moving Band, The Dutch Disease, And The Competitive Consequences of Mrs. Thatcher." *Journal of Development Economics*, 1987, 27, pp. 41-55.

Larsen, D. and Varangis, P. "Dealing with Commodity Price Uncertainty." Policy Research Working Paper 1667. World Bank, Washington, D.C., 1996.

Mashayekhi, A.N. "Public finance, oil revenue expenditure and economic performance: a comparative study of four countries." *System Dynamics Review*, 1998, 14, pp. 189-219.

Metzler, L.A. "Tariffs, the Terms of Trade, and the Distribution of National Income." *The Journal of Political Economy*, 1949, 57(1), pp. 1-29.

Murphy, K.M. and Finis, W. "The Structure of Wages." *Quarterly Journal of Economics*, February 1992, 107 (1), pp. 285-326.

Mussa, M. “Tariffs and the distribution of Income: The Importance of Factor Specificity, Sustainability, and Intensity in the Short and Long Term.” *The Journal of Political Economy*, 1974, 82 (6), pp. 1191-1203.

Neary, J.P. and Purvis, D.D. “Sectoral Shocks in a Dependent Economy: Long-run Adjustment and Short-run Accommodation.” *Scandinavian Journal of Economics*, 1982, 84, pp. 229-253.

Ranis, G. “Towards a model of development.” In L.B. Krause and K. Kihwan, eds., *Liberalization in the Process of Economic Development*. Berkeley, CA: University of California Press 1991.

Sachs, J., A. Warner. “Economic Convergence and Economic Policy.” NBER Working Paper Series, WP 5039. Cambridge: National Bureau of Economic Research, 1995.

Slaibi, A., Chapman, D. and Daouk, H. “An Econometric Evaluation of A Geopolitical Theory of Oil Price Behavior.” *The Energy Journal* (In Review).

Stolper, W.F. and Samuelson, P.A. “Protection and Real Wages.” *The Review of Economic Studies*, Nov. 1941, 9(1), pp. 58-73.

World Bank. “Commodity Risk Management in Developing Countries: A Proposed Market-Based Approach.” International Task Force on Commodity Risk Management in Developing Countries, Washington DC, 1999.

Wijnbergen, S.V. “Inflation, Employment, and the Dutch Disease in Oil-Exporting Countries: A Short-Run Disequilibrium Analysis.” *The Quarterly Journal of Economics*, 1984, 99 (2), pp. 233-250.

Wijnbergen, S.V. “The ‘Dutch Disease’: A Disease After all.” *The Economic Journal*, March 1984, 94, pp. 41-55.

Wijnbergen, S.V. “Optimal Capital Accumulation and the allocation of Investment between Traded and Nontraded Sectors in Oil-producing Countries.” *Scandinavian Journal of Economics*, 1985, 87 (1), pp. 89-101.