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RESEARCH ARTICLE

Natural Resources and Rent Seeking Collusion in the Context of Dutch Disease

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ABSTRACT
A new model is proposed in this paper by concentrating on the Dutch disease phenomenon along with rent seeking to demonstrate how a natural resource abundance (or a resource boom) affects resource movement and national income under rent seeking collusion in the energy sector. Dutch disease and rent seeking problems are studied under the natural resource curse theory which states that countries with natural resources usually perform worse than resource-poor countries. The resource movement is considered one of the effects of the Dutch disease. The resource movement occurrence or the movement of labor inputs from services to the energy sector depends on the degree of the boom. The boom may also facilitate rent seeking depending on its degree and the number of firms in the energy sector. In the duopoly case (n=2), a sufficiently small degree of the boom is necessary for rent seeking to be facilitated. However, with more than two firms (n>2), rent seeking activities will not happen because profits in collusion will be less than those without collusion in the model. Hence, the paper analyzes rent seeking by concentrating on duopoly results (n=2). The impact of the boom on national income depends on parameter values.

Keywords: Collusion, Rent-seeking, Dutch disease
JEL Classification: D43, O12, O13

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1. Introduction

The Dutch disease is a paradox that shows that the export of natural resources negatively affects the non-resource sector and causes an exchange rate appreciation along with an increased unemployment rate (Bruno & Sachs, 1982; Corden & Neary, 1982; Corden, 1984). Corden and Neary (1982) analyzed the phenomenon by describing the natural resource boom as a degree of technological improvement in the resource sector. The core factors of the model are resource movement and spending effects. The resource movement effect is considered the movement of capital and labor to the resource sector from other parts of the economy. The spending effect happens because of additional revenue induced by the boom.

Rent seeking is considered another problem which negatively affects national income (Baland & Francois, 2000; Lane & Tornell, 1996; Tornell & Lane, 1999; Torvik, 2002) in resource-rich countries. According to Hindricks and Myles (2013, p. 389), rent seeking was the dissipation of resources for making profitable opportunity that was harmful to society. The existing empirical studies show how damaging rent seeking can be for countries with abundant resources (Auty, 2001a, 2001b; Bertrand & Céline, 2015; Caselli & Guy, 2013; Kolstad & Wiig, 2009; Muradov, 2022; Van der Ploeg, 2010, 2011; Vicente, 2010). Under the boom, more natural resources lead to lower welfare due to rent seeking activities within the economy (Torvik, 2002). Moreover, monopolies in the energy sector can use prices as rent seeking tools and dissipate resources by negatively affecting the overall economy (Muradov, 2022).

To explain how this study differs from the previous rent seeking models (Baland & Francois, 2000; Lane & Tornell, 1996; Muradov, 2022; Tullock 1967; Tornell & Lane, 1999; Torvik, 2002), Cournot (1838) the competition and collusion model will be used. Another significant difference is related to the formulation of rent in this paper. The rent is formulated as the difference between profits in collusion and no collusion cases. Here, the model will show how colluding firms with rent seeking activities in the energy sector will affect labor

input and national income by focusing on two sectors (energy and services). The reason is that collusion and rent seeking in the energy sector is widespread in several countries according to past studies (Gillies, 2020; Ogbuabor & Onuigbo, 2019). Additionally, rent seeking collusion (with different rent formulations as well) analyzing the Dutch disease is not mentioned in previous studies to the best knowledge of the author, and, thus, it will be another contribution to the literature on Dutch disease and rent seeking.

The rent seeking activities of colluding firms (n=2) will be analyzed, and it will be shown how they affect the resource movement and national income. A duopoly was chosen in the model because rent seeking was not facilitated with more than two firms. The model will demonstrate that depending on the degree of the boom, the resource movement effect may occur if there is a colluding duopoly with rent seeking activities in the energy sector. Rent seeking may be facilitated in the duopoly case with a sufficiently small degree of boom. Additionally, the effect of the boom on national income depends on its degree.

2. Literature Review

The term "Dutch disease" comes from a historical event (1959) in the Netherlands, and the discovery of gas reserves that negatively affected the manufacturing sector by appreciating local currency and decreased capital investment in the non-resource sector. Cordon and Neary (1982) analyzed the "Dutch disease" phenomenon and introduced a model to demonstrate the impact of the boom (technological progress) on the economy by explaining the two effects, the spending effect, and the resource movement effect. A boom is seen as an upward shift in the production function of the energy sector through the extent of technological improvement and, hence labor demand (assuming labor is the only mobile factor between sectors) increases. Even increasing global oil prices can have similar effect on manufacturing output due to the real appreciation caused by surging demand for domestic currency. In the dynamic model of Dutch disease (Bruno & Sachs, 1982), the boom can negatively affect the manufacturing sector within an open economy by shrinking the tradable sector. The production

of other tradable goods will decline due to the boom in the energy sector. This impact will depend on government policies on the distribution of energy revenues to the private sector. After the oil discovery, higher wealth induces the increase for excess money demand (Neary & Wijnbergen, 1984). International mobility of capital could assist in protecting the price of commodities and factors before the natural resource abundance (Cassing & Warr, 1985). Van der Ploeg (2011) stated that some negative outcomes of resource abundance are deindustrialization, currency appreciation, and lower economic growth due to the presence of bad institutions and a deficiency in the rule of law in some resource rich countries.

The rent seeking idea was first introduced by Tullock (1967), and he explained the welfare loss of society through a creation of tariffs and subsidies. Firms join rent seeking activities by lobbying government officials and expending resources until the last dollar that is invested will offset the probability of being protected. Their resources would be completely wasted to rent seeking activities. Lane and Tornell (1996) and Tornell and Lane (1999) described that higher productivity may push the rate of return on investment with powerful firms within an economy. Due to higher productivity, the firms will try to obtain a higher portion in production by requiring more transfers. These transfers will increase the tax rate and decrease the return on capital. Afterwards, the redistribution effect will exceed the impact of increased productivity. Lane and Tornell (1996) mentioned that economic growth falls due to decreased savings, but in Tornell and Lane (1999), the economy stagnated since the capital was used in the unproductive informal sector (which is safe from taxation (rent-seeking)). According to Baland and Francois (2000), the rents were formed through import quotas. If a great number of firms engage in rent-seeking within an economy, the result shows that more firms will move to rent seeking. The aggregate income will decrease because the value of an import quota will induce the resources to move into rent seeking activities. Moreover, a higher number of rent seekers will reduce each firm's expected income by allowing the tax rate to increase with the number of rent seekers (Torvik, 2002). The rents will be public sector income which are taxes, bribes, and natural resources. The resource boom will reduce national income in

his paper. In the energy sector's monopoly case (Muradov, 2022), the price was used as a tool for rent seeking to receive attractive rents in the energy sector. The Energy sector's monopoly will engage in rent seeking depending on a political situation. If the situation is favorable, then it will increase the price in the energy sector for increasing its profits. The reason is that monopolies mainly cover their losses (by increasing local gasoline prices) during decreasing global oil prices and gain the surplus as a rent. Table 1 summarizes the above-mentioned studies.

Table 1: Description of the Literature

Models	Rent-seeking	Number of firms
Tullock (1967)	Tariffs and subsidies	Several firms
Tornell & Lane (1996, 1999)	Taxes	Several firms
Baland & Francois (2000)	Import quotas	Several firms
Torvik (2002)	Public sector income	Several firms
Muradov (2022)	Price (energy sector)	Monopoly
This study (rent seeking collusion)	Difference between profits with collusion and no collusion	Duopoly

The conclusions in this research paper about national income, rent seeking, and the resource movement effect in the case of rent seeking collusion are different from the above-mentioned studies. The reason is that this study focuses on a Cournot competition in the energy sector and analyzes the impact of rent seeking and natural resource abundance (the boom) from a duopoly perspective. The firms engage in rent seeking through Cournot competition which is the first analysis under the Dutch disease concept. Another important distinction is related to the formulation of rent in this paper through complete dissipation. It formulates rent as a difference of profits in collusion and no collusion cases. Furthermore, the model demonstrates the direction of labor inputs through the resource movement effect under collusive rent seeking. The Dutch disease phenomenon happens under parameter values since the resource movement effect occurs along with the reduction of outputs in the services sector. Rent seeking is facilitated under the process where a small amount of natural resource boom is necessary. The resources are dissipated by reducing the national income under parameter values. However, the production of energy will occur with a sufficiently large degree of the boom. In this case (large boom), firms will be inclined to profit-seeking

activities to produce energy without wasting the resources (labor inputs). Thus, this paper shows how labor inputs and national income in the energy sector will be affected under the rent seeking duopoly collusion by contributing to the literature of Dutch disease and the political economy.

3. The Model

Let's assume that there are two sectors: services and energy sectors. The input in each sector is labor, and a quantity of labor is supplied in-elastically by workers, which is divided between production of two goods in services and energy sectors. A constant return to scale production is used for the services sector as an assumption, meaning that one unit of labor can produce one unit of output. The cost function $C_S(x_S)$ in the services sector is given as

$$C_S(x_S) = x_S \tag{1}$$

where x_S is the output level of production in the services sector. Profit maximization is given as

$$max_{x_S} P_S x_S - C_S(x_S) \tag{2}$$

where P_S is the price of good in the services sector.

Let's assume there are n firms also producing homogeneous products in the energy sector with following cost functions:

$$C_{E1}(x_{E1}) = \alpha x_{E1} \tag{3}$$
$$C_{En}(x_{En}) = \alpha x_{En} \tag{4}$$

where x_{E1} and x_{En} are the output levels of production in the energy sector, and *α (α>0)* is the parameter about productivity. Linear cost functions are taken for simplicity and obtaining clear results. The parameter *α* is seen as a natural resource boom or technological improvement. Profit maximization in this sector is

$$max_{x_{E1}} P_E x_{E1} - C_{E1}(x_{E1}) \tag{5}$$
$$max_{x_{En}} P_E x_{En} - C_{En}(x_{En}) \tag{6}$$

where P_E is the price of good in the energy sector.

Let's assume that all the output of the firm is sold on the domestic market. The inverse demand function in the energy sector is given by

$$P(x_{E1} + \cdots + x_{En}) = \beta - \gamma x_E = \beta - \gamma(x_{E1} + \cdots + x_{En}) \quad (7)$$

where x_E is quantity of demand in the energy sector. β and γ are the positive parameters. This model focuses on the resource movement effect by removing the spending effect and, hence, consumer behavior is fixed (fixed demand) as an assumption (they do not assume the level of income). The demand curve will not depend on the boom because if demand depends on that, then the spending effect happens.

3.1. Cournot competition case

Commodity market in the energy sector

In Cournot competition, the firms (with non-negative quantities) compete by choosing their quantity levels simultaneously to maximize their profits. Each firm (with full knowledge of the market) choses its quantity by assuming the rivals' quantities as given. The resulting equilibrium will be called Cournot equilibrium (in terms of quantities). It is possible to compute the Cournot equilibrium by solving reaction functions simultaneously. Let $({x_{E1}}^C, \ldots, {x_{En}}^C, {P_E}^C)$ be an allocation of commodity markets of the energy sector at equilibrium under the Cournot competition. From the equations (5) and (6) under profit maximization condition (marginal cost is equal to marginal revenue for each firm) it gives

$$\frac{d{\pi_{E1}}^C}{d{x_{E1}}^C} = \beta - \gamma({x_{E1}}^C + \cdots + {x_{En}}^C) - \alpha - \gamma {x_{E1}}^C = 0 \quad (8)$$

$$\frac{d{\pi_{En}}^C}{d{x_{En}}^C} = \beta - \gamma({x_{E1}}^C + \cdots + {x_{En}}^C) - \alpha - \gamma {x_{En}}^C = 0 \quad (9)$$

Solving the equations yield the following quantity with the reaction function

$${x_{E1}}^C = r_1({x_{En}}^C) = \frac{\beta - \alpha - \gamma({x_{E2}}^C + \cdots + {x_{En}}^C)}{2\gamma} \quad (10)$$

Assuming all firms are symmetric, then the quantity for each firm will be

$$x_{E1}{}^{C} = x_{E2}{}^{C} = \cdots = x_{En}{}^{C} = x_{E}{}^{C} \tag{11}$$

$$x_{E}{}^{C} = \frac{\beta-\alpha-\gamma(n-1)x_{E}{}^{C}}{2\gamma} => x_{E}{}^{C} = \frac{\beta-\alpha}{(n+1)\gamma} \text{ (for each firm)} \tag{12}$$

Total quantity and price will be

$$X_{E}{}^{C} = nx_{E}{}^{C} = \frac{n(\beta-\alpha)}{(n+1)\gamma} \tag{13}$$

$$P_{E}{}^{C} = \beta - \gamma X_{E}{}^{C} = \beta - \frac{n(\beta-\alpha)}{(n+1)} = \frac{\beta+\alpha n}{(n+1)} \tag{14}$$

The profits of the firms will be

$$\pi_{E1}{}^{C} = \cdots = \pi_{En}{}^{C} = \frac{(\beta-\alpha)^2}{(n+1)^2\gamma} \tag{15}$$

$$\pi_{E}{}^{C} = \pi_{E1}{}^{C} + \cdots + \pi_{En}{}^{C} = \frac{n(\beta-\alpha)^2}{(n+1)^2\gamma} \tag{16}$$

Labor market

Suppose that the total number of workers is unity. Let $(l_{E1}{}^{C}, \ldots, l_{En}{}^{C}, l_{S}{}^{C})$ be the labor at equilibrium in each sector. An equilibrium condition of labor market is

$$l_{E1}{}^{C} + \cdots + l_{En}{}^{C} + l_{S}{}^{C} = 1 \tag{17}$$

The wage rate at equilibrium is unity due to the assumption that one unit of labor produces one unit of services. Also, services are the numeraire of the economy, and all prices are in terms of units of the service good, whose price is normalized to one. Second, the paper only considers equilibriums where the economy produces some output of the numeraire sector. The cost of production in this model also is the product of wage rate and the use of labor. By using the equations (3), (4), (10) and (12), the labor in the energy sector is determined as follows:

$$l_{E1}{}^{C} = \cdots = l_{En}{}^{C} = \alpha x_{E1}{}^{C} = \cdots = \alpha x_{En}{}^{C} = \alpha x_{E}{}^{C} = \frac{\alpha(\beta-\alpha)}{(n+1)\gamma} \tag{18}$$

$$l_{E}{}^{C} = l_{E1}{}^{C} + \cdots + l_{En}{}^{C} = \frac{n\alpha(\beta-\alpha)}{(n+1)\gamma} \tag{19}$$

From the equilibrium condition of labor market, the labor in the services sector:

$$l_{S}{}^{C} = 1 - l_{E1}{}^{C} - \cdots - l_{En}{}^{C} = 1 - \frac{n\alpha(\beta-\alpha)}{(n+1)\gamma} = \frac{\gamma+n(\gamma-\alpha\beta+\alpha^2)}{(n+1)\gamma} \tag{20}$$

Commodity market in the services sector

Let $(x_S{}^C, P_S{}^C)$ be an allocation of commodity markets of the services sector at equilibrium. From the equation (1) and first order condition from the equation (2)

$$P_S{}^C = 1 \tag{21}$$

$$x_S{}^C = l_S{}^C = 1 - \frac{n\alpha(\beta-\alpha)}{(n+1)\gamma} = \frac{\gamma+n(\gamma-\alpha\beta+\alpha^2)}{(n+1)\gamma} \tag{22}$$

The formulation of this model does not depend on the services sector. It means if all markets except one are in equilibrium, the last market (services sector) must also be in equilibrium due to Walrasian general equilibrium theory. Hence, the model formulation will concentrate on the energy sector where Cournot competition occurs.

3.1.1. Analysis of the Cournot competition case

The effect of the boom on the labor markets

Decreasing is taken as the boom because it implies decreasing costs due to technological advancement. Differentiating the equations (17) and (18) with respect to gives

$$\frac{dl_S{}^C}{d\alpha} = \frac{2\alpha n-n\beta}{(n+1)\gamma} \tag{23}$$

$$\frac{dl_E{}^C}{d\alpha} = \frac{n\beta-2\alpha n}{(n+1)\gamma} \tag{24}$$

If $\alpha > \frac{\beta}{2}$, then the equation (23) is positive, and the equation (24) is negative. It means that the boom in the energy sector induces the labor inputs to move from the services sector to the energy sector, which is called as resource movement effect (Corden & Neary, 1982).

The effect of the boom on the commodity markets

The effect of the boom on outputs will be determined by following Corden and Neary (1982). The boom increases the output in the energy sector:

$$\frac{dx_E{}^C}{d\alpha} = -\frac{n}{(n+1)\gamma} < 0 \tag{25}$$

Figure 1. Firms in Cournot Competition

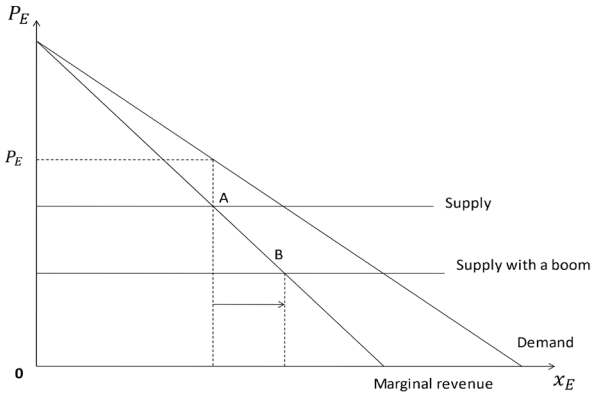


Figure 1 describes the inverse demand curve and supply curve for each identical firm producing homogeneous products with identical cost functions in the energy sector. The boom as a technological advancement induces the inverse supply curve to shift down by increasing the equilibrium quantity as a result and it is consistent with the equation (25). The profit maximization *(MR=MC)* point moves from the point A to the point B.

A marginal effect of the boom on the output in the services sector depends on parameter values:

$$\frac{dx_S{}^C}{d\alpha} = \frac{2\alpha n - n\beta}{(n+1)\gamma} \tag{26}$$

Let $Y^C = x_E{}^C + x_S{}^C$ be the national income in the Cournot competition case with given world prices (Hindricks & Myles, 2013). A marginal effect of the boom on the national income:

$$\frac{dY^C}{d\alpha} = \frac{2\alpha n - n\beta - n}{(n+1)\gamma} \tag{27}$$

The sign of the equation (27) is negative (positive) if

$$\beta > (<) 2\alpha - 1 \text{ or } \alpha < (>) \frac{\beta}{2} + \frac{1}{2} \tag{28}$$

The following Lemma is obtained from the equations (23), (24) and (27):

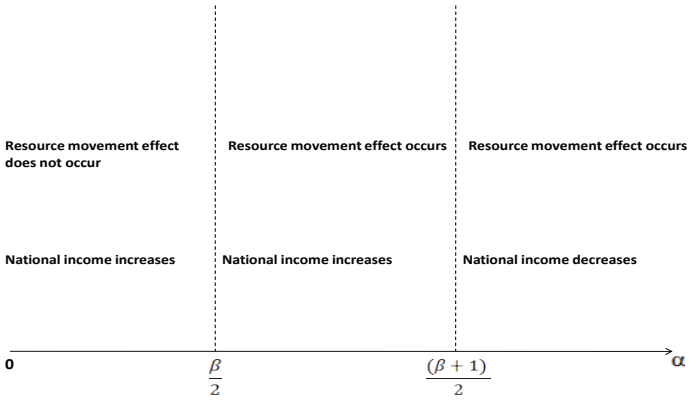
Lemma

If $\frac{\beta}{2} < \alpha < \frac{\beta}{2} + \frac{1}{2}$, then the boom generates resource movement effect and increases national income.

If $\alpha > \frac{\beta}{2} + \frac{1}{2}$, then the boom generates resource movement effect and decreases national income.

If $\alpha < \frac{\beta}{2}$, then the boom does not generate the resource movement effect.

Figure 2. Lemma



The first and the second arguments of the lemma demonstrates the occurrence of the resource movement effect (Figure 2). The equations (25) and (26) show

that the output of the energy sector will increase but the output of the services sector depends on the parameter values. The equations (23) and (27) mean that when n $\alpha > \frac{\beta}{2}$, then the resource movement will occur. If is sufficiently large ($\alpha > \frac{\beta}{2} + \frac{1}{2}$), the national income decreases due to the boom.

Labor inputs in the services sector move from the services sector to the energy sector (under the context of Dutch disease) by decreasing output in the services sector due to the natural resource abundance. This is related to the cost function (1) in the services sector where one unit of labor produces one unit of output (constant return to scale). In the Corunot competition case, the arguments with resource movement occurrence in the lemma together with the income reduction in the services sector should be analyzed for determining the Dutch disease phenomenon. The first and the second arguments of the lemma describe that resource movement effect happens in case of sufficient degree of the boom ($\alpha > \frac{\beta}{2}$). The equation (26) means that if $\alpha > \frac{\beta}{2}$, then the resource movement will occur along with the reduction of output in the services sector. Thus, Dutch disease will happen when the natural resource boom is sufficiently large. The first and the second arguments correspond to the Dutch disease outcomes. The second argument will be more serious because of reduction of national income. Specifically, the national income decreases due to the boom in the case of $\alpha > \frac{\beta}{2} + \frac{1}{2}$, which in turn contributes more to the Dutch disease outcomes. The lemma shows that more natural resources will negatively affect the overall economy by increasing the gap between the energy and services sectors which is consistent with the occurrence of Dutch disease.

Intuitively, the Dutch disease phenomenon in the lemma is related to the sufficient degree of the boom because of the cost function (3 and 4) in the energy sector. Higher costs mean increasing wages in the energy sector and, hence, labor will move from the services sector to the energy sector due to increasing wages. This will cause the resource movement effect and the Dutch disease phenomenon. The gap will increase between the energy and services sector because energy production will increase by attracting the resources (labor inputs) from the services sector.

3.2. Collusion case

Collusion is usually illegal, and firms might tacitly collide by reducing output, which in turn will hike the price by increasing the profits of firms. According to Cournot (1838) the firms are motivated to create a cartel by changing the Cournot model into a monopoly. In this section, the colluding firms will be analyzed for determining commodity market and labor market differences from the Cournot competition case. Furthermore, empirical studies also mention tacit collusion in several studies (Bello & Cavero, 2008; Contı´n, Correlje´, & Palacios, 2009; Garcia, 2010) by describing the Spanish retail gasoline market under colluding firms (Repsol and Cepsa) where they charged higher fuel prices for consumers. Although the energy market was liberalized in Spain, the high market quotas facilitated collusive price equilibrium because Repsol is a vertically integrated company with a huge market share (Garcia, 2010). So, liberalization of the Spanish oil market did not achieve its effective competition goals. This result in Spanish retail fuel market was like the previous empirical study (Contı´n et al., 2009) analyzing the pricing behavior of firms.

The collusion case was studied here because it was necessary to compare it with the previous studies mentioned above and, the collusion case was not mentioned previously in the context of Dutch disease under the Corden and Neary (1982) model.

Commodity market in the energy sector

Let $({x_{E1}}^{cl}, \dots, {x_{En}}^{cl}, {P_E}^{cl})$ be an allocation of commodity markets of energy sector at equilibrium with collusion case. In this case, the costs will be summed up $(C_{E1}(x_{E1}) + \dots + C_{En}(x_{En}))$ together with quantities $({x_{E1}}^{cl} + \dots + {x_{En}}^{cl})$ under profit maximization condition. The reason is that they will share both the costs together with quantities and it gives:

$$\pi_E{}^{cl}({x_{E1}}^{cl}, \dots, {x_{En}}^{cl}) = (\beta - \gamma {x_{E1}}^{cl} - \dots - \gamma {x_{En}}^{cl})({x_{E1}}^{cl} + \dots + {x_{En}}^{cl}) - \alpha {x_{E1}}^{cl} - \dots - \alpha {x_{En}}^{cl} \quad (29)$$

Taking partial derivatives with respect to ${x_{E1}}^{cl}$ and ${x_{En}}^{cl}$ we get

$$\frac{\partial {\pi_{E1}}^{cl}}{\partial {x_{E1}}^{cl}} = \beta - n\gamma {x_{E1}}^{cl} - \cdots - n\gamma {x_{En}}^{cl} - \alpha = 0 \tag{30}$$

$${x_E}^{cl} = {x_{E1}}^{cl} + \cdots + {x_{En}}^{cl} = \frac{\beta - \alpha}{n\gamma} \tag{31}$$

The first order conditions for joint profit maximization are identical due to fact that the colluding firms in the model have same cost curves and, hence, joint profit maximization requires ${x_E}^{cl} = {x_{E1}}^{cl} + \cdots + {x_{En}}^{cl}$. The joint profits of the firms under collusion in the energy sector will be

$${\pi_E}^{cl} = {\pi_{E1}}^{cl} + \cdots + {\pi_{En}}^{cl} = \frac{(\beta - \alpha)^2}{2n\gamma} \tag{32}$$

Labor market

Let $({l_{E1}}^{cl}, \ldots, {l_{En}}^{cl}, {l_E}^{cl})$ be the labor at equilibrium in each sector in the energy sector under collusion case $({l_E}^{cl} = {l_{E1}}^{cl} + \cdots + {l_{En}}^{cl})$. The labor in the energy sector will be

$${l_E}^{cl} = {l_{E1}}^{cl} + \cdots + {l_{En}}^{cl} = \frac{\alpha(\beta - \alpha)}{n\gamma} \tag{33}$$

From the equilibrium condition of labor market, the labor in the services sector is

$${l_S}^{cl} = \frac{n\gamma - \alpha\beta + \alpha^2}{n\gamma} \tag{34}$$

Commodity market in the services sector

Let $({x_S}^{cl}, {P_S}^{cl})$ be an allocation of commodity markets of the services sector at equilibrium. Price and quantity in the services sector will be as follows:

$${P_S}^{cl} = 1 \tag{35}$$

$${x_S}^{cl} = {l_S}^{cl} = \frac{n\gamma - \alpha\beta + \alpha^2}{n\gamma} \tag{36}$$

3.2.1. Analysis of the collusion case

The effect of the boom on the labor markets

Differentiating labor inputs in both sectors with respect to α gives

$$\frac{dl_S{}^{cl}}{d\alpha} = \frac{2\alpha-\beta}{n\gamma} \tag{37}$$

$$\frac{dl_E{}^{cl}}{d\alpha} = \frac{\beta-2\alpha}{n\gamma} \tag{38}$$

If $\alpha > \frac{\beta}{2}$, then the equation (37) is positive, and the equation (38) is negative, which means that the resource movement effect occurs. The result is same with the Cournot competition case due to the equations (3) and (4) showing the same functions.

The effect of the boom on the commodity markets

The boom increases the output in the energy sector:

$$\frac{dx_E{}^{cl}}{d\alpha} = -\frac{1}{n\gamma} < 0 \tag{39}$$

A marginal effect of the boom on the output in the services sector depends on parameter values:

$$\frac{dx_S{}^{cl}}{d\alpha} = \frac{dl_S{}^{cl}}{d\alpha} = \frac{2\alpha-\beta}{n\gamma} \tag{40}$$

Let $Y^{cl} = x_E{}^{cl} + x_S{}^{cl}$ be the national income of the collusion case. A marginal effect of the boom on the national income is

$$\frac{dY^{cl}}{d\alpha} = \frac{2\alpha-\beta-1}{n\gamma} \tag{41}$$

The sign of the equation (41) is negative (positive) if

$$\beta > (<) 2\alpha - 1 \text{ or } \alpha < (>) \frac{\beta}{2} + \frac{1}{2} \tag{42}$$

Generally, both cases show the same results in the analysis of labor and commodity markets because of the cost function for firms (3 and 4). The results in the previous lemma can be applied here as well.

3.3. Collusion case with rent-seeking

This model's main objective is to figure out how colluding firms with rent seeking activities in the energy sector impacts labor inputs and national income.

Previous studies did not mention this type of model under Corden and Neary's (1982) model. Empirical studies (Ogbuabor, God'stime, Charles, & Ifeoma, 2018; Ogbuabor & Onuigbo, 2018, 2019) about Eurozone, Spanish and Italian cases showed that collusion and rent seeking behavior had clear signs in the energy markets of these regions. In case of Eurozone (Ogbuabor et al., 2018), colluding firms in road fuel markets manipulated the tax system to hide long term rent seeking behavior to gain excess profits through collusive pricing which was shown under the analysis of the years of 2004-2016. Rent-seeking and uncompetitive pricing was rampant in the Spanish diesel market as well between the years of 2005-2015 (Ogbuabor & Onuigbo, 2018). The firms practicing collusive behavior in the Spanish automotive diesel market exploited the tax system for concealing their profitable rent seeking activities and charged higher prices in the energy market. In the case of Italy, results indicated that after changes in crude oil costs, short-run collusion and rent seeking was witnessed from the data analysis (2005-2015) (Ogbuabor & Onuigbo, 2019). Although actions of large firms (Eni and Agip) in the oil retail market did show the problem in a short-term period, their dominant positions might lead to long-run rent seeking activities combined with collusion because the industry was deregulated and prices, imports, and exports are determined by the firms in the Italian market. In addition, the anticompetitive behavior of monopolies was widespread in the global retail energy markets according to one study (between 2004-2016) (Ogbuabor, Anthony, & Onyinye, 2020). This empirical paper showed that there was more likelihood of rent seeking and collusive behavior in oil markets, because the firms in the market utilized the tax system for hiding their rent seeking activities and, hence, competition was negatively affected due to irregularities in firms' pricing strategies. In the case of Africa's oil boom, corruption was quite rampant in the oil industry between the years of 2005-2014. National and private oil companies through illicit tactics engaged in corruption for capturing natural resource rents (Gillies, 2020). Oil companies hampered competition and government officials strengthened their political positions through rent seeking activities in the African natural resource industry.

Labor market

Firms created advantageous opportunities through rent seeking for themselves which was detrimental for a society (Hindricks & Myles, 2013, p. 389). The level of resources (labor inputs) which is dissipated during rent seeking is presented as a "time" in this paper. Firms engaged in rent seeking (it is also seen as an additional investment to get rent) use the chance of lobbying government officials for gaining rents. These resources could have been used in production for profit-seeking which in turn would have been beneficial for a society.

Let's suppose that there are several potential colluding firms in the energy market. Firms can collude (act like a monopoly according to Cournot (1838)) and obtain the profit which is mentioned in the equation (32). For one thing, this profit will be attractive for them through rent seeking, because they can receive it by removing others from the market by lobbying. Although collusion might be unstable later due to the incentives to cheat on the agreement, this is usually applicable to collusion without a rent seeking case. Hence, rent seeking (collusion) is advantageous for firms to create barriers to entry in the beginning and to become only firms in the energy market which is evident in empirical studies (Chernova & Ramzanova, 2018; Ogbuabor & Onuigbo, 2018, 2019). In this model, the value of collusion will be a rent which is considered as the additional profit made by collusion. The difference between the profits of collusion and no collusion cases will be equal to the rent. Colluding firms (identical and risk-neutral) in the energy sector simultaneously offer how much money they will burn. Potential firms which will burn the most money will be colluding firms in the energy sector. The whole value of the rent will be dissipated under the equation (44), and it is known as complete dissipation theorem (Hindricks & Myles, 2013, p. 393). For attaining the rent available in the market, the colluding firms in the model burn labor which matches the money mentioned above. Let ${l_L}^l$ be the labor burned for rent-seeking activities, and an equilibrium condition of labor market will be

$$ {l_{Ecl}}^l + {l_S}^l + {l_L}^l = 1 \tag{43} $$

where superscript indicates the collusion under rent-seeking case.

The prize for the colluding firms is the rent and it is the difference between the profits with collusion and without collusion cases (π_E^{cl}), because profits in collusion (π_E^{C}) case is higher than the one without collusion case. The rent and the power in the market will induce them to collude (through rent seeking) to get all the benefits by removing competitors from the market. The labor which is spent for rent seeking can be figured out by applying the complete dissipation theorem which means that "…labor inputs that are used for rent-seeking activities up to the point where additional profit is exactly equal to the resource cost" (Hindricks & Myles, 2013, p. 405). So, the value of labor that colluding firms will spend for rent-seeking is

$$l_L^{\,l} = \pi_E^{\,cl} - \pi_E^{\,C} = \frac{(2n-n^2+1)(\beta-\alpha)^2}{2n(n+1)^2\gamma} \tag{44}$$

From the equilibrium condition of labor market, the labor in the services sector:

$$l_S^{\,l} = 1 - l_{Ecl}^{\,l} - l_L^{\,l} = 1 - \left(\frac{\alpha(\beta-\alpha)}{n\gamma} + \frac{(2n-n^2+1)(\beta-\alpha)^2}{2n(n+1)^2\gamma}\right) \tag{45}$$

Commodity market in the services sector

Let $(x_S^{\,l}, P_S^{\,l})$ be the pair of commodity markets of the services sector at equilibrium:

$$P_S^{\,l} = 1 \tag{46}$$

$$x_S^{\,l} = l_S^{\,l} = 1 - \left(\frac{\alpha(\beta-\alpha)}{n\gamma} + \frac{(2n-n^2+1)(\beta-\alpha)^2}{2n(n+1)^2\gamma}\right) \tag{47}$$

3.3.1. Analysis of the collusion with rent-seeking case

The effect of the boom on the labor markets

Differentiating labor inputs in all sectors with respect to gives

$$\frac{dl_{Ecl}^{\,l}}{d\alpha} = \frac{\beta-2\alpha}{n\gamma} \tag{48}$$

$$\frac{dl_L{}^l}{d\alpha} = \frac{(\alpha-\beta)(2n-n^2+1)}{n(n+1)^2\gamma} \quad (49)$$

$$\frac{dl_S{}^l}{d\alpha} = \frac{n^2(3\alpha-2\beta)+\alpha(2n+1)}{n(n+1)^2\gamma} \quad (50)$$

The equation (48) is negative when $\alpha > \frac{\beta}{2}$. It means that the labor in the energy sector will increase. The equation (49) indicates that during the boom, the labor inputs spent for rent-seeking activities increases under the condition of $\alpha < \beta$ $(n = 2)$. The occurrence of the resource movement effect under the equation (50) depends on parameter values (α, β) and the number of firms.

The effect of the boom on the commodity markets

The energy sector output increases under the boom:

$$\frac{dx_{Tcl}{}^l}{d\alpha} = -\frac{1}{n\gamma} < 0 \quad (51)$$

The effect of the boom on the output of the services sector depends on parameter values:

$$\frac{dx_N{}^l}{d\alpha} = \frac{dl_N{}^l}{d\alpha} = \frac{n^2(3\alpha-2\beta)+\alpha(2n+1)}{2n(n+1)^2\gamma} \quad (52)$$

Let $Y^l = x_{Ecl}{}^l + x_S{}^l$ be the national income of collusion with rent-seeking case. A marginal effect of the boom on the national income is

$$\frac{dY^l}{d\alpha} = \frac{\alpha+n(2(\alpha-2)+3\alpha n-2(\beta+1)n)-2}{2n(n+1)^2\gamma} \quad (53)$$

The following proposition is attained from the equations (49), (50) and (53):

Proposition

Under rent seeking collusion in the energy sector:

- The resource movement effect occurrence depends on the parameter values. In the duopoly case, it is $\alpha > \frac{8\beta}{17}$.
- Rent-seeking is facilitated in the case of $\alpha < \beta$ (in the duopoly case).

- The effect of the boom on the national income also depends on parameter values. National income will decrease if $\alpha > \frac{8\beta+9}{17}$(in the duopoly case).

According to the results of the analysis (proposition (Figure 3)) in the case of rent seeking activities, the Dutch disease has signs because the resource movement effect occurs, and the output of the services sector decreases under the case of $\alpha > \frac{8\beta}{17}$. This argument is supported by referring to the equations (50) and (52). Labor inputs (in the services sector) will join the energy sector to engage in rent-seeking (resource dissipation) and production of energy (profit-seeking). The reason is that the rent seeking duopoly in the energy sector demand labor inputs for making profits (through production), and the other portion of the labor inputs will be used for rent seeking activities (for contacting government officials or lobbying). The firms under Cournot competition (without collusion) with the absence of rent seeking mitigates the phenomenon of Dutch disease. On the other hand, the rent seeking duopoly (with collusion) reduces this mitigation and affects the outcome (facilitates Dutch disease occurrence).

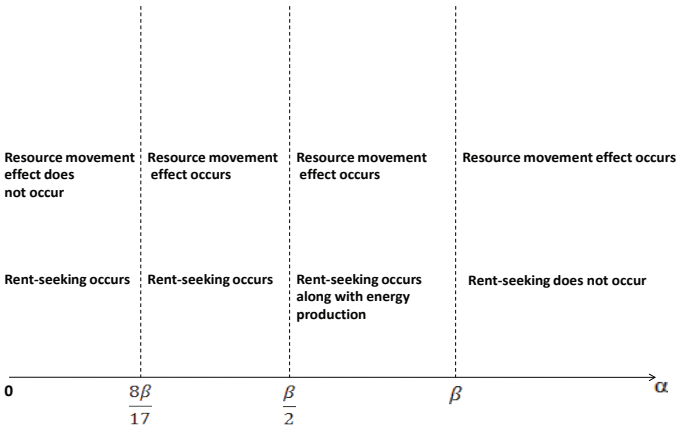
For the first argument of the proposition, the equation (50) shows that the resource movement effect depends on the parameter values in the rent seeking case and labor inputs may move from the services sector to the energy sector. Mainly, the production of energy will depend on the degree of the natural resource abundance. According to the equation (48), the production will occur under the case of $\alpha > \frac{\beta}{2}$, which is preferable for an economy because firms will join profit-seeking activities without wasting the resources. The firms will be inclined to production of energy if the boom is sufficiently large. More natural resources will induce them to maximize their profits through production.

To support the second argument of the proposition, the equation (49) is used, and it shows that the boom facilitates workers to engage in rent seeking in the energy sector in the duopoly case under the condition of α<β. The reason is that ${l_L}^l$ is a variable of degree of rent seeking activities. Unlike profit-seeking activities, this variable will induce the wastage of resources within an economy without participating in production. The rent seeking variable will contribute more to the

Dutch disease occurrence because it will demand more labor inputs from the services sector by worsening the situation (through dissipation). If the boom is small, then it will not be profitable for the firms. Hence, they will join rent seeking activities to get the rent which is available within the energy market. Finally, the resources which the firms will expend for gaining the rent (difference of profits between the collusion and no collusion case) will be completely dissipated according to the complete dissipation theorem.

As for the support of the third argument of the proposition, the equation (53) is shows that national income may decrease depending on the parameter values of (α, β) in the duopoly case. The reduction of the national income adds more to the Dutch disease outcome ($\alpha > \frac{8\beta+9}{17}$). The decline of the national income will be partly related to the dissipation of the resources. Rent-seeking negatively affects the services sector along with the overall economy. This effect is unambiguous on the outputs (services), labor inputs and national income (under parameters) by adding the variable of degree $(l_L{}^{l})$ of rent-seeking into the duopoly collusion. Overall, the rent-seeking variable impacts all aspects of the model, and rent-seeking as a political issue results in more findings under the context of Dutch disease by contributing to the literature of political economy.

Figure 3. Proposition (rent seeking collusion)



4. Conclusion

The model analyzes colluding firms with rent-seeking activities (under the Dutch disease context) in the energy sector and demonstrates how the resource boom impacts national income and movement of labor inputs (resource movement effect). The resource movement effect occurrence or the movement of labor inputs from the services to the energy sector depends on the degree of the boom along with the number of the firms. The boom may also facilitate rent-seeking depending on its degree and the number of the firms. In the duopoly case (n=2), sufficiently small degree of the boom ($\alpha < \beta$) is needed for the rent-seeking facilitation. The national income (duopoly case) may decrease depending on parameter values.

The impact of the boom on the national income and rent-seeking is different from the previous studies because rent-seeking facilitation and national income reduction depends on parameter values as well as the number of the firms. The reason is that the rent-seeking activities of firms in the preceding studies (which are mentioned above) are different from this model, and they focus on various sectors under different assumptions. However, this study focuses on the Cournot competition to analyze the effect of the boom as well as rent-seeking collusion. It calculates the rent as the difference between profits of collusion and no collusion cases which is another key difference from the past studies. In addition, rent-seeking activities of firms (under small amount of boom) will dissipate the resources (by attracting labor inputs from the services sector), and it corresponds to Dutch disease outcome because of resource movement effect along with the reduction of outputs in the services sector. However, the production of energy occurs when there is sufficiently large degree of the boom. In this case, the firms will join profit-seeking activities (production). Decreasing national income (under parameters) is more serious because it happens in addition to the increasing gap (between energy and services). This study is not the alternative to the above-mentioned studies, and it analyzes the effect of the boom on labor inputs and national income under the colluding firms with rent-seeking activities through distinct formulation of the rent.

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