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Natural resources, rent seeking and welfare

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Abstract

A new and very simple mechanism to explain why natural resource abundance may lower income and welfare is developed. In a model with rent seeking, a greater amount of natural resources increases the number of entrepreneurs engaged in rent seeking and reduces the number of entrepreneurs running productive firms. With a demand externality, it is shown that the drop in income as a result of this is higher than the increase in income from the natural resource. More natural resources thus lead to lower welfare. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Why are so many countries poor even though they are rich in natural resources? This puzzle, documented in, for example, Sachs and Warner (1995) and Gylfason et al. (1999), has attracted two different kinds of answers from economists. The 'Dutch disease' literature emphasizes that an abundance of natural resources shifts factors of production out of sectors where production exhibits static or dynamic increasing returns to scale. In van Wijnbergen (1984), Krugman (1987), Matsuyama (1992) and Gylfason et al. (1999), there is learning by doing in one sector, and an abundance of natural resources may shift factors of production away from that sector, pushing down productivity growth. Sachs and Warner (1995) also assume that only one sector generates learning by doing, but assume a perfect spillover to the rest of the economy. An increased amount of natural resources then

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lowers productivity growth in all sectors. Torvik (2001) studies the case where all sectors contribute to learning and there are spillovers between them. Then, an abundance of natural resources may lower growth, depending on the structural characteristics of the economy at hand. Natural resource abundance in a big push model is studied by Sachs and Warner (1999). When one sector has constant returns to scale while the other has increasing returns to scale, more natural resources may lower production if it is the traded sector that has increasing returns to scale. All the Dutch disease papers concur that abundant natural resources may lower production and welfare because the composition of production is changed, and because it is the composition of production that determines the level or the growth rate of productivity.

Another answer to why more natural resources may lower production and welfare is rent seeking. Lane and Tornell (1996) and Tornell and Lane (1999) show that in an economy with multiple powerful groups that each has open access to production, higher productivity may in fact push the rate of return on investment and thus, growth, down. The reason for this is that when productivity increases, each group attempts to acquire a greater share of production by demanding more transfers. In turn, more transfers increase the tax rate and reduce the net return on capital. This redistribution effect may outweigh the direct effect of increased productivity. In Lane and Tornell (1996), growth falls as a result of decreased savings, while in Tornell and Lane (1999), growth falls because capital is reallocated to the less productive informal sector, where it is safe from taxation.[1] Baland and Francois (2000, p. 529) focus on multiple equilibria in a model with rents generated by import quotas. With an increase in the primary factor of production, they obtain the result that: "when a large proportion of individuals are engaged in rent seeking already, such an increase inclines the economy towards more rent seeking and may actually lead to a decline in aggregate income." The reason for this is that with an increase in the primary factor, the value of an import quota increases more than that of productive production, pulling resources out of production and into rent seeking.

To clarify how the present mechanism differs from the Dutch disease literature and from the more recently proposed rent-seeking models, we start out by imposing assumptions that rule out the mechanisms behind the earlier results. First, we assume that the natural resource does not alter the composition of production. The simplest way to do this is to assume that the natural resource consists of the same goods as those previously produced in the economy. Second, we assume a constant tax rate. Then, it is not possible for an increased amount of natural resources to push the tax rate up, leading investors to retain a smaller fraction of the profit from an investment, as in the papers by Lane and Tornell. Third, we assume an economy without external trade, so that no rents can be created as a result of the trade regime. Later, we study effects of relaxing these three assumptions.

Section 2 sets out a simple model with increasing returns to scale and rent seeking, while Section 3 discusses the equilibrium of the model. The main result in the paper, the

[1] An interesting paper on foreign aid and rent-seeking with somewhat related mechanisms is Svensson (2000).

effects on production and welfare of an increase in natural resources, is discussed in Section 4. Furthermore, since the model is set up so that the same experiments as in Lane and Tornell (1996), Tornell and Lane (1999) and Baland and Francois (2000) may be undertaken, Section 4 also compares the model to these related models. It turns out that the mechanisms highlighted in the present paper provide opposite results to both of these approaches. Since we have assumed away the mechanisms leading to the results in these papers, it should be highlighted that rather than being an alternative, the present paper complements these approaches by pointing out some new mechanisms.

The three assumptions in the basic model are then relaxed in Section 5. It is shown that if the tax rate increases with the number of rent seekers, the mechanisms behind the results in the basic model are strengthened. In an open economy version of the model, we study the effects from demand composition, and show that in the present model these generate productivity implications different from traditional Dutch disease models, as well as from the open economy model in Murphy et al. (1989b). The latter suggest that natural resources will increase productivity in the nontraded sector when this is subject to increasing returns to scale in production. Section 6 offers some concluding remarks.

2. The model

There are a given number of goods normalized to one, and an equal number of entrepreneurs. In addition, the economy is populated by L workers. There are four sectors. First, a natural resource sector contributes R units of goods without any input requirements. Second, a backward sector produces with constant returns to scale (CRS). In CRS production, it takes one unit of labor to produce one unit of any good. Third, a modern sector produces with increasing returns to scale (IRS). IRS production requires one entrepreneur and F units of labor. Each additional unit of labor produces $\alpha > 1$ units of output. Fourth, entrepreneurs can engage in political competition, rent seeking or corruption, which for the purpose of this paper will be taken to be the same; seeking to redistribute income in their own favor.

Since the number of entrepreneurs does not exceed the number of goods, there will at most be one IRS firm producing each good. Consumers have Cobb–Douglas utility. Each modern firm sets the highest possible price (since they face unitary demand elasticity), which is equal to one, because this is the price charged by potential competitors in the CRS sector. They pay the lowest possible wage to attract workers, which is also equal to one, since the CRS sector is the workers' outside option. Each modern firm, thus, has a fixed markup $\tau=(\alpha-1)/\alpha$ over marginal cost. A share t of production in modern firms is paid as taxes (or as bribes to be allowed to undertake production). When y is sales, profits π in an IRS firm is then:

$$\pi = (\tau - t)y - F \tag{1}$$

The economy is assumed to lack a strong legal and democratic institutional infrastructure, and the total amount of rents that can be captured by rent seekers is the public sector income, i.e., income from taxes (or bribes) and the natural resource. The number of

entrepreneurs that engage in rent seeking is G, and the number of entrepreneurs in modern production is $(1-G)$.[2] Total rents to be captured, π^{T}, are therefore given by:

$$\pi^{\mathrm{T}} = t(1-G)y + R \tag{2}$$

However, each entrepreneur engaged in rent seeking can only expect to receive a fraction $1/G$ of the total rents. This may be interpreted as the result of rent sharing between all the corrupt tax officials, or as the expected outcome of a political struggle where the winner acquires public sector income. In the latter interpretation, entrepreneurs are assumed to be risk neutral. The expected income π_G for an entrepreneur engaged in competition for the rents is now:

$$\pi_G = \frac{\pi^{\mathrm{T}}}{G} \tag{3}$$

The formulation differs from Lane and Tornell (1996) and Tornell and Lane (1999). There, each rent seeker has open access to aggregate production so that the more rent-seeking activity, the higher the taxes and the more rents are to be distributed. In our case, we have competition among rent seekers, so that the more rent seekers, the lower is each rent seeker's expected income (for any given level of total income). We allow the tax rate to be increasing with respect to the number of rent seekers in Section 5.

3. Equilibrium

Two conditions have to be fulfilled for the economy to be in equilibrium. First, the allocation of entrepreneurs must be such that no entrepreneurs wish to shift between activities. If we do not have a corner solution, this implies that the payoff to entrepreneurs from modern production must equal the expected payoff from rent seeking:

$$\pi = \pi_G \tag{4}$$

Second, total supply of goods must equal total demand of goods. Total supply of goods is given by $y+R$. Total demand for goods equals total income, since there are no possibilities for saving and investing in the model. Total income, in turn, equals the labor income L plus profit income. The supply–demand balance then reads:

$$y + R = L + (1-G)\pi + \pi^{\mathrm{T}} \tag{5}$$

[2] We, thus, assume that rent-seeking requires entrepreneurial talent, and that such talent is in scarce supply. If rent-seeking does not divert entrepreneurial resources away from production, the mechanisms in the model will not go through, because then no scarce resources are used in rent-seeking.

We start out with the latter equilibrium condition. Inserting from Eqs. (1) and (2) in Eq. (5) and solving with respect to y yields:

$$y = \frac{\alpha[L - (1 - G)F]}{1 + G(\alpha - 1)} = y(G) \tag{6}$$

It follows that $y(0) = \alpha(L - F)$ and $y(1) = L$. We assume that F is sufficiently small compared to L to give $y(0) > y(1)$, implying that income is higher in a fully modernized economy than in an economy with only backward production. Then, it can be seen that $y'(G) < 0$ and that $y''(G) > 0$. A higher G means that fewer entrepreneurs engage in modern production. This pushes income down as workers are transferred from IRS production to less productive CRS production. The smaller is G in the first place, the larger the decrease in income from a higher G. A small G means many modern firms, high income and thus, high sales from each firm. The larger the production in each firm, the more income falls when the workers in one firm are transferred from IRS to CRS production, so that $y''(G) > 0$.

Note that neither taxes nor the amount of natural resources enter directly into the expression for y, and can only have indirect effect through G. Taxes do not enter because all tax income as well as other income is spent, so that taxes do not directly affect total demand. Natural resources do not enter into the expression because for a given G, they contribute in equal amounts to total supply and total demand. Then, they do not affect production outside the natural resource sector, and total income $y + R$ increases by the same amount as an increase in R.

Next, we turn to the second equilibrium condition. Inserting from Eq. (6) in Eq. (1) gives profits in modern production as:

$$\begin{aligned} \pi &= (\tau - t)y(G) - F = \pi(G), \\ \pi'(G) &= (\tau - t)y'(G) < 0, \\ \pi''(G) &= (\tau - t)y''(G) > 0 \end{aligned} \tag{7}$$

We assume that $\pi(1) = (\tau - t)L - F > 0$, so that profits with IRS production are positive, even when no other modern firms exist. A poverty trap as the pure result of too small a market, as in Murphy et al. (1989a), then cannot exist.

The profit in modern firms is depicted as the π curve in Fig. 1. If $G = 0$ all entrepreneurs operate modern firms, aggregate income and demand are high, as are profits. As the number of entrepreneurs engaged in rent seeking increases, the number of modern firms decreases. Fewer modern firms imply less income and demand and, thus, lower profits for the remaining modern firms. In this way, the falling π curve is the result of the demand externality.

By inserting from Eqs. (2) and (6) in Eq. (3), we get an expression for the expected profit from rent seeking:

$$\pi_G = \frac{t(1 - G)y(G) + R}{G} = \pi_G(G) \tag{8}$$

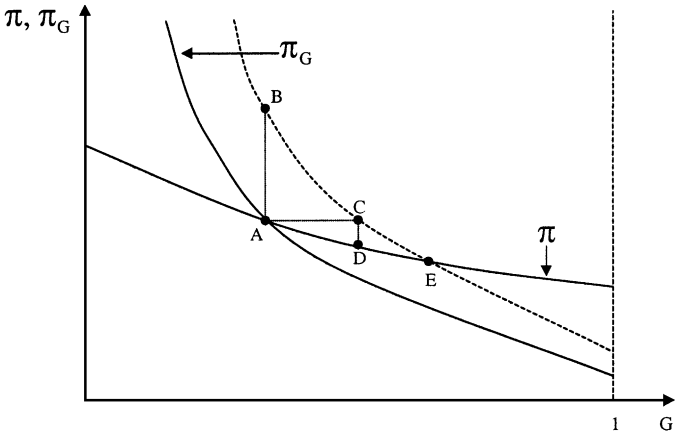

Fig. 1.

where

$$\pi'_G(G) = \frac{-ty(G)G - t(1-G)[y(G) - y'(G)G] - R}{G^2} < 0$$

The profit curve for rent seekers is depicted in Fig. 1. The curve is downward sloping for three reasons. First, a greater number of rent seekers means less of a given rent to each. Second, a higher number of rent seekers means a lower number of modern firms and, hence, fewer from which to collect taxes (or bribes). Third, a lower number of modern firms pushes production in each firm down, decreasing tax payments from each firm. The profits from rent seeking are thus, increasing with respect to the number of entrepreneurs undertaking production. An interesting model with the opposite feature is Baland and Francois (2000). Their result is that because rents are created by import quotas, a greater number of entrepreneurs undertaking production may imply less rents because there are fewer goods that must be imported.

As depicted in the figure, it is assumed that $R < (\tau - t)\, L - F$, so that $\pi\ (1) > \pi_G\ (1)$. Then, the profit curve for the rent seekers must cross the profit curve for modern production from above (at least once), and we have a stable interior equilibrium determining the number of rent seekers and the number of entrepreneurs running modern firms. The equilibrium is denoted as A in the figure. If the curve crosses several times, which is also possible, we have multiple equilibria. In the remainder, we assume that the equilibrium is unique, although all the results to follow will be valid in all stable equilibria. If one jumps from one stable equilibrium to another, however, the results need not necessarily go through.[3] Finally, if $\pi(1) < \pi_G(1)$, $G = 1$ is a stable equilibrium. When it is more profitable to engage in rent seeking even when the rents have to be shared among all the

[3] For multiple equilibria models with productive and unproductive activities, see Andvig and Moene (1990), Murphy et al. (1993), Acemoglu (1995), Baland and Francois (2000) and Mehlum et al. (1999, 2001).

entrepreneurs and the only source of public sector income is the natural resource, modern production will not occur. In the remainder of the paper, we assume a stable interior equilibrium.

4. Natural resource abundance, income and welfare

The effects of an increase in the natural resource is summarized in the following proposition:

Proposition 1. *An increased amount of natural resources decreases total income and welfare.*

The proof of this result is straightforward. The profit curve for modern production in Fig. 1 is not affected by increased R. From Eq. (8), it is easily seen that with a higher R, it becomes more profitable to be a rent seeker at all levels of rent seeking. The profit curve for rent seeking thus, shifts up to the dotted curve in Fig. 1. The new equilibrium in point E involves fewer modern firms and more rent seekers, and lower profits for each entrepreneur. Total income and production $(y+R)$ consists of L workers each receiving the wage one, and one entrepreneurs each receiving the profit income π [that $y+R=L+\pi$ can be verified by inserting Eqs. (3) and (4) in Eq. (5)]. Since the wage income remains the same whereas profit income has decreased, aggregate income and welfare are lower than before the increase in the natural resource. Production in CRS and IRS firms y has thus, decreased more than the increase in the natural resource R.

We now turn to the intuition behind this result. As can be seen from Eq. (2), a marginal increase in the natural resource increases income and total production by the same amount for a given number of rent seekers, since $\mathrm{d}\pi^{\mathrm{T}}/\mathrm{d}R=1$ when G is constant. For a given G, profit in rent seeking is higher than before, while profit in modern production is the same as before. With rent seeking more profitable than modern production, entrepreneurs move into rent seeking. When one entrepreneur closes down a modern firm, the workers are transferred to CRS production. The net decrease in production with the closing of a modern firm thus equals the firm's profit. Because of the arbitrage condition, at the margin the fall in income from this effect equals the increase in income from the natural resource. Through this effect, a marginal increase in the natural resource decreases other production by the same amount, and income is unchanged. However, there is an additional effect, and this is the reason production decreases more than the increase in the natural resource. When production outside the natural resource sector decreases by an amount equal to the increase in the natural resource, one may at first think that demand directed toward firms is not affected since income is not affected. However, this is not the case. The natural resource sector contributes with its own supply, so that even if total income is the same, the demand for goods produced outside the natural resource sector falls. The lower demand for the production from modern firms makes profits fall. After the transfer of entrepreneurs from productive production to rent seeking so that profits are the same from rent seeking as they used to be from modern production, profits from modern production thus, fall. For this reason, even more entrepreneurs will close down and move into rent seeking, demand and profits for the remaining firms will fall further, and so on. This process is not unstable

because when the number of rent seekers increases, profits from rent seeking fall faster than profits from running modern firms.

We have explained a marginal increase in R, but the intuitive explanation can still be recognized as the steps from A to E illustrated in Fig. 1. First, for a given amount of rent seeking, income for rent seekers increases (point B), while profits from modern production are the same (point A). Second, entrepreneurs flow into rent seeking until the profit equals what it used to be from modern production (point C). Third, since demand for goods produced in modern firms has fallen, profits from modern production have now decreased (point D). Even more entrepreneurs flow into rent seeking, and profits from both rent seeking and modern production fall until an equilibrium is reached (point E), where the arbitrage condition is again fulfilled.[4]

The combination of rent seeking and a demand externality is the model's property that yields the result that welfare decreases with more natural resources. If we had rent seeking but CRS with perfect competition, the π curve would be horizontal, and total production and income would have been unaffected by the natural resource. In this case, rent seeking would ensure that production dropped by the same amount as the natural resource increased. If production had decreasing returns to scale, the π curve would be upward sloping, and the decrease in production would be smaller than the increase in the natural resource. Thus, more natural resources would imply higher total income and welfare.

The productive capacity of the economy can also increase by raising productivity in the modern sector, i.e., increased α. This is studied in Lane and Tornell (1996) and Tornell and Lane (1999), and opens up possibilities for reduced welfare in those papers. In the present model, however, we get a very different result, due to the combination of rent seeking and the demand externality. The effects are summarized in the following proposition.

Proposition 2. *An increase in marginal productivity in the modern sector increases income and welfare by more than the effect of increased productivity in each of the existing modern firms.*

Increased marginal productivity in modern production increases profit in both rent seeking and modern production for a given number of G and, thus, shifts both profit curves up; see the dotted curves in Fig. 2. The vertical shift in the π curve is given by:

$$y(G)\frac{\mathrm{d}\tau}{\mathrm{d}\alpha} + (\tau - t)\frac{\mathrm{d}y(G)}{\mathrm{d}\alpha} > 0 \tag{9}$$

while the vertical shift in the π_G curve is given by:

$$\frac{t(1-G)}{G}\frac{\mathrm{d}y(G)}{\mathrm{d}\alpha} > 0 \tag{10}$$

[4] Proposition 1 can also be proved in an alternative way. Although the mechanisms behind the result are more difficult to understand in this way, the proof in itself is simpler. It is now evident that since the wage of workers equals one and profits are the same for productive entrepreneurs and rent-seekers, what happens to income can be found by determining what happens to π (or π_G). Starting out with $y+R=L+\pi$ that was found by inserting Eqs. (3) and (4) in Eq. (5) above, and then inserting for π from Eq. (1) and for $\tau=(\alpha-1)/\alpha$, one gets after solving that $y=\alpha(L-F-R)/(1+\alpha t)$, which contains only exogenous variables on the right hand side. It is then evident that y and thus, π, falls when R increases.

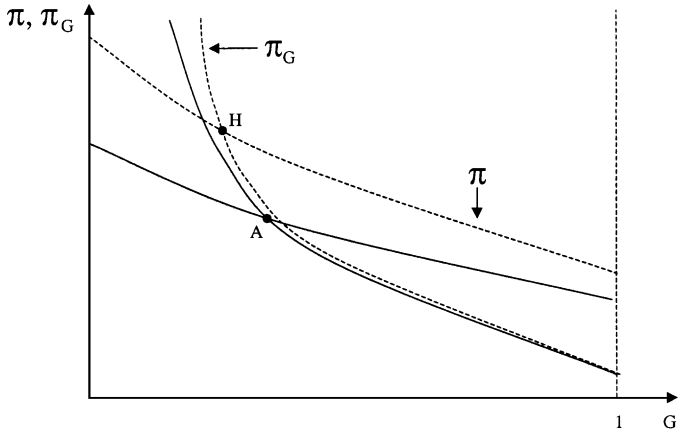

Fig. 2.

By inserting from Eqs. (7) and (8) in the arbitrage condition (4), we get that in equilibrium:

$$\frac{t(1-G)}{G} = (\tau - t) - \frac{F + \frac{R}{G}}{y(G)} \tag{11}$$

By inserting from Eq. (11) in Eq. (10), and comparing this with the expression in Eq. (9), we can verify that from equilibrium, a marginal increase in α shifts the π curve more upwards than the π_G curve. There are three reasons for this. First, the elasticity of profit in modern production with respect to y exceeds one ($F>0$). Second, the elasticity of rent-seeking profit with respect to y falls short of one ($R>0$). Third, the markup in modern production increases with marginal productivity ($d\tau/d\alpha>0$). Consequently, the equilibrium moves from point A to a point such as H in Fig. 2. Increased marginal productivity in modern production thus, decreases rent seeking and increases income. The increase in income is higher than the pure effect of all existing modern firms producing with higher marginal productivity. The reason for this is that fewer entrepreneurs engage in rent seeking and more entrepreneurs engage in modern production. This increases income both as a result of more modern firms, and because demand towards each of the already existing modern firms increases. Rent seeking coupled with a demand externality thus, produces a multiplier effect, where the effect on total income of increased productivity is higher than the direct effect of the productivity increase.

As in the models by Tornell and Lane, the return to rent seeking increases with a higher marginal productivity in the modern sector. In contrast to these models, however, the amount of rent seeking decreases and income increases, because even though profits from rent seeking increase, profits from modern production increase more. Since profits in rent seeking relative to modern production determine the allocation of entrepreneurs in the present model, rent-seeking activity is reduced and income increases. It should be noted, however, that our result does not contradict the one in Tornell and Lane. Their result stems partly from decreased saving and capital accumulation with increased rent seeking, while

no such effect is present in our model. Therefore, rather than being an alternative to Tornell and Lane, the present paper points out some mechanisms that may pull in the opposite direction when production exhibits increasing returns to scale.

Baland and Francois (2000) interpret more natural resources as an increase in the labor force L, and show how this leads to more rent seeking and less entrepreneurship in stable interior equilibria. An increase in the size of the economy increases demand for all goods. With Cobb–Douglas preferences ensuring equal expenditure on all goods, holders of import quotas (rent seekers) benefit more than domestic producers (entrepreneurs). The reason for this is that the quota holders still receive the same quota, so that all of the increased demand channels into higher prices. The domestic producers cannot raise their price, and all of the increased demand channels into increased production. Since it is better to get a higher sales income from increased prices than from increased production (which involves increased costs), rent seekers benefit more than entrepreneurs when the size of the economy increases. Consequently, a larger economy through an increased labor force makes potential entrepreneurs shift from production to rent seeking. When L increases in the present paper, we obtain the opposite result, summarized in Proposition 3:

Proposition 3. *An increase in the labor force means fewer rent seekers and more productive entrepreneurs, and increases income and welfare by more than the direct effect of the increased labor force.*

The proof for this result is analogous to the proof of Proposition 2 (or as in the proof in footnote 4). By differentiating Eqs. (7) and (8) with respect to L, and using the fact that Eq. (11) holds in an equilibrium, we see that from an interior equilibrium, the profit curve for modern production shifts upwards more than the profit curve for rent seekers for two of the same reasons as those behind Proposition 2. That is, the elasticity of modern firms' profits with respect to y exceeds one ($F>0$), while the elasticity of rent-seeking profit with respect to y falls short of one (as long as $R>0$). As in Baland and Francois (2000), the profit for both entrepreneurs and rent seekers increases when the size of the market increases. In contrast to Baland and Francois (2000), however, in the present paper the return to production increases more than the return to rent seeking when the size of the market increases, thus explaining the opposite results with regard to productive entrepreneurship and rent seeking. Note, however, that this does not contradict the result in Baland and Francois, as their result stems from the assumption of import quotas, which is assumed away in the present model.

The shift depicted in Fig. 2 can, thus, also be interpreted as the effect of an increased labor force. With increasing returns to scale in modern production, a larger market represented by a larger L increases modern sector profits more than profits from rent seeking. Entrepreneurs flow out of rent seeking and into modern production, inducing a multiplier whereby the initial effect is strengthened by the demand externality.

All our propositions depend on the increasing returns to scale in production, which create a demand externality. The presence of a market size effect is, thus, crucial for the mechanisms to be of empirical relevance. Empirical evidence on market size effects is discussed in Perkins and Syrquin (1989, p. 1739), who state that: "The higher GDP and productivity growth rate for large countries is an historical fact." However, it is not clear from their study what mechanisms yield this result. Recent developments in 'big push'

theory and endogenous growth theory have led to renewed empirical interest in the question of how market size affects productivity and growth. Backus et al. (1992) find little empirical evidence of a relation between growth and measures of scale. However, looking at the manufacturing sector they find a significant relationship between growth and scale variables. The most influential recent study is probably Ades and Glaeser (1999). By examining two independent data sets, they find support for a positive effect on growth from aggregate demand and size of the market effects, as suggested by the Murphy et al. (1989a,b) models.

5. Extensions

5.1. Endogenous tax rate

In the basic model laid out in Section 2, the tax rate is exogenous and thus, independent of the number of rent seekers. It can be argued, however, that at least for certain forms of rent seeking, more rent-seeking activity implies more redistribution from producers to rent seekers. We now extend the model to take this into account by looking at the alternative assumption that each new rent seeker can extract the same share of production as the previous ones. In this way, our model may be interpreted as one of open access.

When each rent seeker can appropriate a share t of modern firm production, Eqs. (1) and (2) must be reformulated to:

$$\pi = (\tau - tG)y - F \tag{12}$$

$$\pi^T = tG(1 - G)y + R \tag{13}$$

By inserting Eqs. (12) and (13) in Eq. (5), it can be verified that the expression for y is the same as that given by Eq. (6). However, by differentiating Eqs. (12) and (13) with respect to G, it can easily be seen that the slopes of the profit curves are affected. In the profit curve for modern firms, the open access mechanism causes profits to fall faster as G increases, as now more rent seekers not only imply lower profit through the demand externality, but also imply a higher tax rate. Thus, the open access mechanism adds another externality to the demand externality in the basic model. In the profit curve for rent seekers, the open access assumption removes one of the three reasons the profit curve for rent seekers is downward sloping in the basic model. Now it is no longer the case that a higher number of rent seekers mean a smaller fraction of rents from modern production to each one of them. Thus, the open access mechanism pulls in the direction of a less steep profit curve for rent seekers.

When we maintain the assumption of a stable interior equilibrium, it can be verified in the same way as in Section 4 that Propositions 1, 2 and 3 are still valid. Because of the additional externality through the open access mechanism, the multiplier effects behind the propositions are strengthened. With more natural resources the π_G curve shifts up while the π curve is unaffected, as in Fig. 1. However, as rent seeking increases, profits in rent

seeking fall slower, and profits in modern production faster. To reestablish equilibrium there must thus, be a larger reallocation from production towards rent seeking than before.

When the marginal productivity or the labor force increases it is still the case for a given G (and, thus, tax rate tG) that the profit in modern production increases more than income from undertaking rent seeking. The shifts in Fig. 2 are thus, still valid. However, when the π_G curve is flatter and the π curve steeper, more entrepreneurs than in the basic model must reallocate from rent seeking to production for equilibrium to be reestablished, and thus, the positive effect on income is stronger.

5.2. The open economy model

In the basic model of a closed economy, there are no demand composition effects. The natural resource consists of the same goods that are previously produced in the economy. More natural resources then do not translate into higher net demand for goods produced with IRS technology, as they contribute equally much to demand and supply. In contrast, in Dutch disease models it is demand composition effects that drive the results. These may produce additional unfavorable effects compared to our basic model by shifting demand towards goods that contribute less to productivity growth. However, some authors also argue that demand composition effects work in the opposite way, in the sense that more natural resources create income that induces demand towards manufacturing IRS sectors. One example is Murphy et al. (1989b, p. 557), who argue that:

> Although one might expect a productive cash crop or mineral export sector to have the effect of causing the country to import more manufactures and to produce fewer of them at home, the more common consequence of exports is to foster domestic industrialization.

A similar argument is put forward in Krugman (1991, p. 28):

> Paul Rhode (1988) has pointed out that late nineteenth century California was a resource based economy with limited manufacturing, largely because the local market was too small to support much industry. He suggests that the discovery of oil around the turn of the century raised California to critical mass, starting it on a process of explosive growth (and in particular causing the rapid emergence of Los Angeles as a manufacturing center).

Murphy et al. (1989b, Section 5) construct a model where all IRS goods are nontraded to demonstrate their point. Natural resources allow higher productivity and income because demand for IRS goods increases. We now extend our basic model to study the effects when rent seeking is present. To make the best possible case for more natural resources to boost productivity and income, we assume, as in Murphy et al. (1989b), that all goods that can be produced with an increasing returns to scale technology belong in the nontraded sector, and that the natural resource does not contribute to domestic supply.

In addition to the four sectors in the basic model, there is now an export sector exporting a good at a given world market price set equal to one. The export sector

produces with constant returns to scale, and it takes one unit of labor to produce one unit of the export good. Workers then still earn the same wage (equal to one) irrespective of which sector they work in. Furthermore, the natural resource R consists only of the export good, so that it does not contribute to the supply of any good that can be produced with IRS technology. Consumers are assumed to have Cobb–Douglas utility over $1+q$ goods, where the number of nontraded goods equals one and the number of imported goods equals q. The imported goods have a given world market price set equal to one.

When y is now interpreted as nontraded goods demand, Eqs. (1)–(4) in the basic model are not affected. However, Eq. (5) now looks different. Total supply of nontraded goods equals y (instead of $y+R$ as in the basic model). The demand for nontraded goods now is a share $1/(1+q)$ of income, while a share $q/(1+q)$ of income is used for imported goods.[5] The supply–demand balance for nontraded goods then reads:

$$y = \frac{1}{1+q}\left[L + (1-G)\pi + \pi^{T}\right] \tag{14}$$

Inserting from Eqs. (1) and (2) and solving with respect to y yields:

$$y = \frac{\alpha[L-(1-G)F+R]}{1+\alpha q + G(\alpha-1)} \tag{15}$$

In contrast to Eq. (6), we note that R and q now enter the expression. The production of nontraded goods is now not only affected by the amount of natural resources indirectly through G, but also directly through R. For a given G, more natural resources push up income and thus, demand for nontraded goods. In contrast to the basic model, however, the increased demand is not matched by increased supply from the natural resource itself. Therefore, more natural resources contribute to higher demand and production of nontraded goods, as in the standard Dutch disease literature. Also, demand for nontraded goods is affected by the openness of the economy, determined by the consumers' preferences. A more open economy, with higher q, means less demand and production of nontraded goods.

When R enters directly in the expression for y, this in terms of Fig. 1 implies that the profit curve for modern production is no longer unaffected by increased R, but shifts up as more natural resources increase income and thus, demand towards nontraded goods. The higher demand means higher profit in modern production for any given G.

By using the same reasoning as that behind Proposition 2, it is straightforward to show that when R increases, the vertical shift in the profit curve for rent seeking from equilibrium is larger than the vertical shift in the profit curve for modern production. The condition for this reduces to $\alpha(L-F)>20$, which is satisfied. For a given number of rent seekers, G, it thus, also now becomes relatively more tempting to engage in rent seeking than in modern production when the amount of natural resources increases. As a consequence, the number of entrepreneurs engaged in rent seeking increases while the

[5] There is no saving in the model, and trade is always balanced.

number of entrepreneurs engaged in modern production decreases. The effect on productivity, income and welfare is summarized in the following proposition:

Proposition 4. *When (i) only the nontraded sector is subject to increasing returns to scale and (ii) the natural resource consists only of export goods, more natural resources imply increased rent seeking resulting in a lower average productivity in the nontraded sector. This fully offsets the direct income effect of more natural resources. Total income and welfare are thus, unchanged.*

To prove this result, first note that it is still the case that the wage equals one, so that total labor income equals L. It is, thus, also, in the open economy version, sufficient to investigate what happens to π or π_G to determine what happens to income and welfare. Now there are at least two ways to prove the result in Proposition 4. The first is by showing that from the old equilibrium, the horizontal shifts in both profit curves are the same for the given initial level of profit. In terms of Fig. 1, when the π_G curve shifts out to point C at the initial profit level, the π curve now also shifts out and crosses through point C. The new equilibrium is established at a higher G for the same level of profit as before, and income is, therefore, unchanged. However, a considerably easier way to show the result is to note from Eq. (1) that what happens to profits and, therefore, income fully depends on what happens to demand for nontraded goods y. The explicit solution for y can be found by inserting for π^{T} in Eq. (14) from Eq. (3), and then inserting for π_G from Eq. (4), before inserting for π from Eq. (1) and replacing τ with $(\alpha-1)/\alpha$. Solving for y then yields:

$$y=\frac{\alpha(L-F)}{1+\alpha(q+t)} \tag{16}$$

From Eq. (16), it is evident that in contrast to the basic model, the equilibrium value of y is now independent of R. Therefore, even in the case where the export sector produces with constant returns to scale and all goods that can be produced with increasing returns to scale technology belong in the nontraded sector, income does not increase with more natural resources despite these consisting only of export goods.

Since income and all prices are the same with increased R, it follows that consumption of all goods is also the same. Therefore, when R increases with one unit, employment in the export sector decreases with one unit, leaving total supply of export goods unaltered. The unit of labor that leaves the export sector enters the nontraded sector. Therefore, as in Dutch disease models, more natural resources transfer labor from the export sector to the nontraded sector.

Unlike the Dutch disease models, however, the increased nontraded sector labor use does not translate into increased production. The reason is that rent seeking has become relatively more attractive (for a given G), so that more of the production in the nontraded sector is undertaken by CRS technology. Since there are fewer modern firms, average productivity in production of nontraded goods has fallen, which is the opposite result from that in Murphy et al. (1989b). The fall in average productivity equals the sum of the profit for the entrepreneurs that have shifted from production to rent seeking. However, this sum is again equal to the increase in the natural resource. Thus, more natural resources decrease productivity in the nontraded sector sufficiently to keep total income unchanged.

As in the models of the Dutch disease with endogenous productivity discussed in the introduction, more natural resources decrease productivity. In contrast to standard Dutch disease theories, however, in the present model it is the productivity in the nontraded sector that decreases. Viewed in the light of some countries' experiences, especially in Africa, this is an interesting result. As pointed out, for example by Davies et al. (1994), heavy import restrictions have made the manufacturing sector in sub-Saharan African countries a sector with nontraded characteristics, while the agricultural sector is the main traded sector. Interpreted in this light, the present model suggests that more natural resources are likely to stimulate rent seeking that results in fewer manufacturing firms and lower average productivity, rather than harming the productivity in traded sector agriculture as an application of standard Dutch disease theories would suggest, or increasing productivity in domestic manufacturing as Murphy et al. (1989b) suggest. Import substitution policies that were meant to create domestic industrialization deliver deindustrialization with natural resource abundance.

Finally, before we conclude, note that from Eq. (16) it is evident that Propositions 2 and 3 above are valid also in the open economy version of the model.

6. Concluding remarks

A new and very simple mechanism explaining why natural resource increases may decrease welfare and income has been developed. The mechanism is the result of the combination of rent seeking and increasing returns to scale. Although the model is constructed in the simplest possible way to capture the idea that more natural resources may lower welfare, the mechanisms may also apply to other types of exogenous increases in income, such as foreign aid or regional transfers.

In general in this type of model, increased productive capacity may decrease or increase welfare, depending on how it increases profits in rent seeking, relative to profits in modern production. Because of demand externalities, the initial response of entrepreneurs is strengthened, and increased productive capacity induces negative or positive multipliers. In this way, productive capacity not only has different, but also more dramatically negative or positive effects than in most other models.

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