A Note on the Resource Curse - Should Brazil Take a Swedish Medicine for the Dutch Disease?

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Resumo

O que aprendemos com a experiência sueca, em que o avanço industrial foi sustentado por sua demanda doméstica impulsionando a produção interna de matéria-prima? Ao modelar a descoberta de um recurso natural escasso em um simples modelo de Equilíbrio Geral Analítico, oferecemos novos insights que podem ser o ponto de partida para uma teoria que explique as experiências bem sucedidas de industrialização baseadas primeiramente na especialização no uso de recursos naturais. Além disso, o modelo prevê que, independentemente dos efeitos decorrentes do canal de comércio internacional, em geral destacados pela a literatura atual sobre a "Doença Holandesa", a desindustrialização poderia ocorrer em condições especiais.

Palavras Chaves: Industrialização, Recursos Naturais, Doença Holandesa, Analytical General Equilibrium Model

Abstract

What did we learn from the Swedish experience in which the industrial breakthrough was sustained by its domestic demand driving the domestic production of raw material? By modeling the discovery of a scarce natural resource in a simple Analytical General Equilibrium model, we provide new insights that could be the start point of a theory explaining the successful industrialization experiences which started through the resource-based specialization. Furthermore, the model predicts that, regardless the effects arising from the international trade channel, usually highlighted by the current literature on "Dutch Disease", the de-industrialization could take place under special conditions.

Keywords: Industrialization, Natural Resources, Dutch Disease, Analytical General Equilibrium Model

JEL Codes: Q32,Q33,Q43

1   INTRODUCTION

In 1977 the British magazine *The Economist* coined the term "Dutch Disease"to describe the mediocre performance of the manufacturing sector in Netherlands after the discovery of a large natural gas field in 1959. Ever since, the term has been widely used to designate the negative relationship between the exploitation of natural resources and the industrial sector production. By exporting a considerable amount of natural resources, a country may end up with an overvalued currency, which may reduce the internal and external competitiveness of manufacturing goods produced domestically and then result in the shrinking of this sector.

On the other hand, the less discussed path of Sweden suggests that it is not necessarily the case. As one of Europe's poorest countries in the 19th century, the exploitation of its natural resources led the country to manage a successful industrialization process. Blomstrom and Kokko (2007) argue that the key point was the role played by its domestic market along the intermediate stage of its industrial development. Here, we provide some insights regarding the channels by which it could take place.

Corden and Neary (1982) developed the workhorse "Dutch Disease"model, which modeled the booming sector as the result of an exogenous increase in the price of energy and checked for its effect on a small open economy. Hence, the international trade was the driving force of a reallocation process that would lead to changes in the output of the manufacturing sector. Surprisingly, cases by which the exploitation of natural resources happened to be pro-industrialization were treated as "counter-intuitive results". In their model, the industrial sector as a capital intensive sector would benefit from the boom just if the reallocation of capital in the economy compensates the unambiguous negative income effect that would decrease the demand for manufactures. As can be noted, the model seems limited on explaining the Swedish experience in which the manufacturing sector were resource-based specialized and by which the domestic demand contributed positively to it.

2   THE MODEL

Consider a closed economy with two sectors, Manufacturing (M) and Energy sector (E).[1] They should be seen as per capita consumption or production. The production of Manufacturing good is a function of a composite factor (K_M), which includes capital and labor, and Energy (E_M). The production of the latter is a function of the composite factor (K_E) and a sector specific factor (Q), which could represent the limited reserves of fossil fuel. Strictly speaking, the production functions are represented by:

$$M = M(K_M, E_M) \tag{1}$$
$$E = E(K_E, Q_E) \tag{2}$$

The discovery of natural resource will be modeled as an increase in the quantity of the

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[1]The choice of a closed economy is to highlight the special features of the Swedish experience by which in an intermediate stage the domestic demand was the key point for the industrialization

specific factor Q. By allowing the household to own the limited amount of Q, we can find both substitution and income effect. For the sake of simplicity, also assume perfect competition and Constant Returns to Scale (CRS). For the energy sector the CRS assumption combined with to the limited amount of a sector specific factor (Q) will in fact present decreasing returns to scale with respect to the composite factor good (K_E).

Regarding the production factors, the resource constraints can be represented by:

$$\bar{K} = K_M + K_E \tag{3}$$
$$\bar{Q} = Q_E \tag{4}$$

Assume each consumer presents a homothetic and twice continuously differentiable utility function given by:

$$U = U(M, N) \tag{5}$$

where $\frac{\partial U}{\partial M} > 0$ and $\frac{\partial U}{\partial N} > 0$

The individual budget constraint will be given by:

$$P_M M + P_E E_C = P_K \bar{K} + P_Q \bar{Q} \tag{6}$$

where E_C represents a quantity of energy directly consumed by households.

The market clearing condition for the energy sector is given by:

$$E_M + E_C = E \tag{7}$$

3 SOLUTION STRATEGY

In this section we derive a general solution for small changes in $\hat{Q}$. Therefore, we shall find equations for outcome variations, $\hat{M}$ and $\hat{E}$, for any exogenous shock represented by a small $\hat{Q}$. Following the same strategy as Fullerton and Metcalf (2002), the problem is solved by using the log-linearization method of Harberger (1962), i.e. by totally differentiating the equations and solving for the linearized system. The results will be quite general since the linearization only requires differentiability of the production and utility functions used here, nevertheless it shall be limited to the analysis of small changes around an initial equilibrium condition.

By totally differentiating the production functions and by invoking the perfect competition assumption we have:

$$\hat{M} = \theta_{MK} \hat{K}_M + \theta_{ME} \hat{E}_M \tag{8}$$
$$\hat{E} = \theta_{EK} \hat{K}_E + \theta_{EQ} \hat{Q}_E \tag{9}$$

where θ_{ij} represents the factor share of j in sector i, i.e. $\theta_{ij} = P_j j_i / P_i i$.

The total differential of the factor constraints and market clearing conditions yields:

$$\lambda_{KM}\hat{K}_M + \lambda_{KE}\hat{K}_E = 0 \tag{10}$$

$$\hat{Q}_E = \hat{Q} \tag{11}$$

$$\lambda_{EM}\hat{E}_M + \lambda_{EC}\hat{E}_C = \hat{E} \tag{12}$$

where λ_{ij} is the fraction of factor i used in the production of j, for instance $\lambda_{KM} = K_M/\bar{K}$.

With perfect competition and constant returns to scale, we have the zero profit condition for each of the two production sectors. By total differentiating the equality between revenue and total cost we get:

$$\hat{P}_M + \hat{M} = \theta_{MK}(\hat{P}_K + \hat{K}_M) + \theta_{ME}(\hat{P}_E + \hat{E}_M) \tag{13}$$

$$\hat{P}_E + \hat{E} = \theta_{EK}(\hat{P}_K + \hat{K}_E) + \theta_{EQ}(\hat{P}_Q + \hat{Q}_E) \tag{14}$$

The elasticities of substitution of production factors (σ_i, for $i \in \{M, E\}$) and the consumer elasticity of substitution between M and E (σ_U) can be formally represented as:

$$\hat{K}_M - \hat{E}_M = \sigma_M(\hat{P}_E - \hat{P}_K) \tag{15}$$

$$\hat{K}_E - \hat{Q}_E = \sigma_E(\hat{P}_Q - \hat{P}_K) \tag{16}$$

$$\hat{M} - \hat{E} = \sigma_U(\hat{P}_E - \hat{P}_M) \tag{17}$$

Finally, by total differentiating the individual budget constraint we have:

$$\theta_{IM}(\hat{P}_M + \hat{M}) + \theta_{IE}(\hat{P}_E + \hat{E}_C) = \theta_{IK}\hat{P}_K + \theta_{IQ}(\hat{P}_Q + \hat{Q}) \tag{18}$$

where θ_{Ii} represents either the share of income spent by or earned from sector i, i.e. $\theta_{Ii} = P_i i/I$ and $I =$ Income. In fact, $\theta_{IM} + \theta_{IE} = 1$ and both parameters represent the share of income allocated by consumers on the consumption of M and E. On the other hand, $\theta_{IK} + \theta_{IQ} = 1$ and they represent the share of different sources of income, θ_{IK} is the share of income earned form the composite good while θ_{IQ} is the share of scarcity rents on the household income.

In the system, we have 11 variables: $\hat{M}$, $\hat{E}$, $\hat{K}_M$, $\hat{K}_E$, $\hat{E}_M$, $\hat{E}_C$, $\hat{Q}_E$, $\hat{P}_M$, $\hat{P}_E$, $\hat{P}_K$, $\hat{P}_Q$; and 11 equations (eq(8)-eq(18)). However, though it is good to have the budget constraint explicitly represented, it is linearly dependent in this system. Therefore, the system presents 10 linear independent equation and 11 variables. Our strategy for solving is to use M as the numeraire and then $\hat{P}_M = 0$.

4 EFFECTS ON THE MANUFACTURING SECTOR

In this section we use the closed form solution found for $\hat{P}_M$ and $\hat{M}$ when solving the log-linearized system. The expression for the effect of small changes in Q on the price of M is given by:

$$\hat{P}_Q = \frac{D}{A_1\sigma_E + A_2\sigma_M + (1 - \theta_{IE})A_3\sigma_U + A_5}(\theta_{IQ} - A_4)\hat{Q} \tag{19}$$

where D, A_1, A_2, A_3, A_4 and A_5 are all positive, as can be checked in the appendix.

As can be noted, the expression can assume either positive or negative values and the sign depends solely on θ_{IQ} and A_4. [2] The interpretation of a positive $\hat{P}_Q$, however, is a bit trick. Though an increase in the quantity of Q available shall decrease its price, the positive $\hat{P}_Q$ means that it decreases less than P_M.

The solution for real changes in the output of the manufacturing sector, M, caused by small change in Q and P_Q is given by:

$$\hat{M} = \frac{1}{D}\left[A_1\sigma_E + A_2\sigma_M + A_3\sigma_U\right]\hat{P}_Q + A_4\hat{Q} \tag{20}$$

Therefore, since A_4 is unambiguously positive, the negative effect would arise through $\hat{P}_Q$.

Proposition 1 If $\theta_{IQ} > A_4$ then $\hat{M} > 0$.

If $\theta_{IQ} > A_4$ then $\hat{P}_Q > 0$, which implies $\hat{M} > 0$. Hence, no Dutch Disease. Intuitively, if the share of income earned by scarcity rent is very high, the Dutch Disease is unlikely to happen since the increasing in Q has a strong income effect. Assuming M to be a normal good this effect would be translated in more consumption of manufacturing goods. Turning to A_4, if the manufacturing sector is energy intensive, i.e. if it presents a low θ_{KM}, it may directly benefit from the low prices of energy and lead to a decrease of its price and higher production.

Proposition 2 If $\sigma_U = 0$ then $\hat{M} > 0$.

If $\sigma_U = 0$ then $\hat{M} = \theta_{IQ}\hat{Q}$. Given $\hat{Q} > 0$, then $\hat{M} > 0$. In this case, households do not change their consumption of energy, which would be the same as assuming that households do not consume energy directly. As a consequence, the energy sector produce just for the manufacturing sector and then the two sectors can be treated as only one sector. The increase of Q would then increase the production of this sector since it would be consuming the same quantity of capital as before, $\bar{K}$, but more of Q.

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[2]As an example, one may assume that $\lambda_{KM} = 0.6$, $\lambda_{EM} = 0.5$, $\theta_{KM} = 0.5$ and $\theta_{IQ} = 0.9$, which would imply $\theta_{IQ} - A_4 = 0.1$. Hence, positive values can in fact be obtained

Proposition 3 $\hat{M} < 0$ only if $\theta_{IQ} < \theta_{IE}A_4$

By substituting the expression of $\hat{P}_Q$ as a function of $\hat{Q}$ on the expression for $\hat{M}$ we have:

$$\hat{M} = \left[\frac{\theta_{IQ}(A_1\sigma_E + A_2\sigma_M) + A_5A_4 + (\theta_{IQ} - \theta_{IE}A_4)A_3\sigma_U}{A_1\sigma_E + A_2\sigma_M + (1 - \theta_{IE})A_3\sigma_U + A_5}\right]\hat{Q} \tag{21}$$

then, $\theta_{IQ} < \theta_{IE}A_4$ is a necessary condition for the existence of Dutch Disease, otherwise everything would be positive. It means that not only $\hat{P}_Q$ need to be negative, i.e. $\theta_{IQ} < A_4$, but also the share of household's income directly spent on energy must be high enough. In the extreme, assuming θ_{IE} close to zero the Dutch disease would be very unlikely. It would be the same situation as the one discussed in proposition 2. If just a very small part of income is used to buy energy it means that the household behave similar to one who just consume manufacturing goods.

5 CONCLUSION

We have illustrated here a model that predicts, under some conditions, the resource based specialization and the increase of manufacturing production occurring simultaneously. Similar to the Swedish case, in our hypothetical economic model if a significant part of income comes from scarcity rents and the industrial sector consumes a great part of the raw material then the industrial sector shall increase as we increase the use of the scarce natural resource. The resource-based industry would ended up better off after the discovery/exploitation of the natural resource. Despite its simplicity, the channels discussed here shall remain important ingredients in a more complex study on the topic.

Future research may extend the limited features of this static model and check, in a dynamic setting, the transitional dynamics of this process. By doing so, we would start the discussion on the path by wich such successful experience was achieved, i.e. looking at the capital accumulation path, on the output growth in different sectors and so on. A model that explicitly embeds these dynamics could shed some light on the reasons for the different paths experienced historically, such as the Dutch and Swedish cases.

For the Brazilian current circumstance, a better understanding of the instances in which the exploitation of natural resources had pro-industrialization effects can enrich the discussion of public policies, which have been mostly concentrated on the international trade side of the issue.

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7   APPENDIX

Here we provide the closed form solution for $\hat{M}$ and the description of its parameters.

$$\hat{M} = \left[\frac{\theta_{IQ}(A_1\sigma_E + A_2\sigma_M) + A_5 A_4 + (\theta_{IQ} - \theta_{IE}A_4)A_3\sigma_U}{A_1\sigma_E + A_2\sigma_M + (1 - \theta_{IE})A_3\sigma_U + A_5} \right] \hat{Q}$$

where

$$D \equiv \theta_{MK} + \theta_{EK}\theta_{ME}$$
$$A_1 \equiv \frac{\theta_{EQ}\lambda_{KM} + \lambda_{EM}\lambda_{KE}}{\lambda_{EC}\lambda_{KM}}$$
$$A_2 \equiv \frac{\lambda_{EM}\theta_{EQ}}{\lambda_{EC}}$$
$$A_3 \equiv \theta_{MK}\theta_{EQ}$$
$$A_4 \equiv \frac{\lambda_{KM} + \lambda_{EM}\lambda_{KE}}{\lambda_{EC}\theta_{KM}}$$
$$A_5 \equiv \theta_{IE}A_3 + \theta_{IK}\theta_{ME}\theta_{EQ} + \theta_{IQ}D$$

Since all the parameters are real numbers in the interval $[0, 1]$, we can conclude that D, A_1, A_2, A_3, A_4 and A_5 are unambiguously positive.