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Discovery of natural resources: A class of general equilibrium models☆

Paulo Henrique Vaz

Department of Economics, Universidade Federal de Pernambuco, Brazil

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ABSTRACT

When is the discovery of natural resources a curse for a country's industrialization and when is it a blessing? A large literature on economic development has collected evidence on both directions. This paper discusses a class of general equilibrium models that deals with natural resource discoveries and evaluates its potential to accommodate both successful and unsuccessful resource-based industrialization experiences, under different model settings. Particularly, it analyzes the importance of disentangling price and quantity effects. It illustrates that in closed model economies (or large open economies), with vertical integration between manufacturing and energy sectors, the long-run effect on the production of manufacturing goods will depend mainly on the equilibrium price of the natural resource good. Moreover, the strength of the vertical integration, even for small open economies, determines the limits to accommodate blessing or curse type of theories.

1. Introduction

Not every country that experienced a major discovery in natural resources experienced also a decline of its manufacturing sector. In other words, not all of them came down with a case of resource curse; Wright and Czelusta (2007), Van der Ploeg (2011) and Van Der Ploeg and Poelhekke (2016) list several counterexamples when surveying the literature. In this paper, an analytical general equilibrium model is used to discuss model economy features that could incorporate the channels by which the rise of economy's endowment of natural resources could be pro-industrialization or against it. The exercise can be interpreted as discussing a class of general equilibrium models dealing with the discovery of natural resources and its ability to accommodate both curse and blessing type of argument.

Previous studies have discussed several channels by which resource booms could be associated to the decline of manufacturing production and/or the slowdown of economic growth. Among the leading hypotheses, one could classify them into the agendas of institutional quality or structural change. This paper focuses on the latter, emphasizing that no clear consensus has been reached, that induces a deeper investigation on the mechanism driving contrasting experiences.[1]

The so-called "Dutch Disease" is perhaps the more widespread example of resource curse from the structural transformation literature. In 1977, *The Economist* coined the term to describe the mediocre performance of the manufacturing sector in Netherlands following the discovery of a large natural gas field in 1959. Henceforth, it has been widely used to designate the negative relationship between the dependency on natural resources and industrial sector production. Intuitively, after the discovery of natural resources or an increase of its international price, the country may end up with an overvalued currency after exporting a considerable amount of its natural resources, which may reduce the internal and external competitiveness of its manufacturing goods and result in the shrinking of this sector.

The workhorse dutch disease model, introduced by Corden and Neary (1982), considered the booming sector as the result of an

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E-mail address: paulo.vaz@ufpe.br (P. Vaz).

[1] For the discussion on institutional aspects of resource curses, see Alexeev and Conrad (2009), Brunnschweiler and Bulte (2008), Boschini et al. (2007), Mehlum et al. (2006) and Van Der Ploeg and Poelhekke (2016). For the structural changes triggered by resource boom, see James (2015), Michaels (2011), Peretto (2012), Van der Ploeg (2011), Sachs and Warner (1995, 1999 and 2001),Matsuyama (1992) and Corden and Neary (1982).

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exogenous increase in the price of energy to study the effect of an increase in the price of energy on a resource ruled small open economy. In this conjuncture, the international trade is the driving force of a reallocation process that leads to production decline in the manufacturing sector. In their model, the industrial sector, say capital intensive, benefits from the resource boom only if the capital reallocation compensates the unambiguous negative income effect that decreases the demand for manufactures.

The less discussed path of successful resource-based economic development suggests counterexamples to the resource curse theories. For instance, for Sweden, 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. That is, the manufacturing sector has developed as resource-based specialized and the domestic demand contributed positively to it. Another well known contrasting example would be the United States. As emphasized by Wright and Czelusta (2007), on its way to became the world leader in manufacturing production, at the beginning of the 20th century, the country relied heavily on its leadership on mineral economy. As in the case of Sweden, the linkages and complementarity between manufacturing and resource source were essential to its success.

The divergent empirical evidence led to refinements on theoretical formulations. The first Dutch Disease models were limited on explaining the path observed in Sweden and United States. The cases in which the discovery of natural resources (or resource booms) happened to be pro-industrialization were treated as counter-intuitive results. Van Wijnbergen (1984) presents one of the first attempts to incorporate into those models some mechanism to avoid the "disease", the introduction of learning-by-doing was crucial. Sachs and Warner (1995) also develop endogenous growth model to deal with the issue. Most recently, Torvik (2001) and Peretto (2012) propose endogenous growth models in which the rise of the economy's endowment of natural resource could, under some conditions, expand manufacturing production.

Therefore, this paper is driven by the question: what features in the model economy facilitates the incorporation of resource-based industrialization episodes? or, more specifically, which channels in the model economy will determine whether the manufacturing production increases or decreases after the discovery of natural resources? For this purpose, it discusses a class of general equilibrium models that deals with natural resource discoveries.

Two types of analytical general equilibrium models are discussed. A generic closed economy model and its small open economy version. The former might be interpreted as the extreme case of a large open economy, in which the discovery of natural resources will certainly have price effects involved. Nonetheless, the closed economy environment can be used to study the cases in which domestic demand for manufacturing goods is an important channel and international trade is limited. The small open economy version resembles most resource curse models, by either studying the effects of natural resources discovery with no price effect or by modeling natural resource booms as an increase of its international price. In both versions changes in the long-term equilibrium are discussed, although questions related to economic growth process shall remain open to the modeler. For instance, in cases we find that manufacturing production will increase in equilibrium, endogenous growth models may be designed to link this to higher economic growth, through more investments in R&D due to increase of sectoral production.

The closed economy version of our analytical general equilibrium model, without assuming a particular functional form for utility and production functions, incorporates features considered important by Peretto (2012), such as the vertical integration and the explicit inclusion of a primary sector that competes on inputs with the manufacturing sector. It highlights the primary role played by the endogenous price of the natural resource after the discovery. As opposed to Peretto (2012), our conclusions for closed economies were reached in a less restrictive environment and shall, therefore, be interpreted as a generalization of important features of model economies used to study the resource curse and as paving the road for future general equilibrium modeling on this topic.

In the small open economy scenario, the discovery itself has no price effect and its effect is straightforward, domestic production of manufacturing goods declines. Nonetheless, when resource booms are modeled as an increase in the price of natural resources, the blessing or curse will depend mainly on the share of manufacturing goods imported but other model economy features will determine its ability to accommodate each story. For instance, in a general equilibrium model in which vertical integration between energy and manufacturing sector is important and the energy sector depends a lot on natural resources, we show it is easier to associate the discovery of natural resources to resource-based industrialization experiences.

The paper is structured as follows. First, we describe the model economy for closed economies (or extremely large open economies). Second, we define our solution strategy. Third, we discuss the insights from the closed form solutions. Forth, we repeat the analysis for small open economies. Finally, concluding remarks are made.

2. The baseline closed model economy

Consider a closed economy with two sectors, Manufacturing (M) and Energy sector (E). 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).[2] 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 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

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

[2] A composite factor K_M is used to facilitate the analysis without compromising the insights from the links connecting manufacturing sector, energy sector and natural resources.