ARTICLE IN PRESS

Resources Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Does mineral development provide a basis for sustainable economic development?

John Dobra[a,d], Matt Dobra[b,*], Abdoulaye Ouedraogo[c]

[a] University of Nevada, Reno, United States
[b] Methodist University, United States
[c] World Bank, United States
[d] Fraser Institute, Canada

ARTICLE INFO

JEL codes:
Q3
Q5
D7
04

ABSTRACT

The extraction of non-renewable resources is broadly viewed as an unsustainable activity. After 60+ years of examining the role of non-renewable resource development in broader economic development, and its implications for economic welfare, there is little consensus on its effects–or even its desirability. This paper examines the issue of sustainability in the context of non-renewable mineral resources which, we argue, is entwined with the mineral extraction industry‘s "boom-bust" and "resource curse" images. We present a standard Solow-style economic growth model that integrates mineral endowment and uses the model to examine the mineral blessing or curse question empirically with a cross-section of countries. The model is tested using several econometric techniques that generally support the mineral blessing hypothesis. On the question of sustainability, we contrast the applicability of the concept in the contexts of renewable and non-renewable resource development. In the former case, the concept of sustainable yield is relatively straightforward. In the latter, the concept is much more difficult to apply. Sustainable development of non-renewable resources depends on factors beyond physical rates of production, such as governance and investment in human and physical capital.

1. Introduction

Sustainability in its various manifestations is a major concern for many in both academia and the public at large. These concerns range from climate change and its numerous and far-ranging implications to more focused issues like forestry and agriculture. In the latter case, that of renewable resources, the concept of sustained yield is well known and relatively simple in principle. Yet, when it comes to non-renewable resources like minerals, the concept of sustainability becomes much more difficult to formulate. In fact, to most people the concept of the sustainable use of non-renewable resources appears downright paradoxical at first glance.

In a historical context, humanity has typically leapt from one set of unsustainable practices to another. The hunters and gatherers of our distant past were engaged in an unsustainable activity: they over-hunted and over-gathered. They eventually learned how to domesticate animals to eat instead of hunting them and to cultivate crops instead of randomly foraging for edible plants, ushering in an agricultural revolution. Along the same lines, the Stone Age was not sustainable. But, as Sheikh Zaki Yamani's immortal saying goes, "the Stone Age did not end for lack of stone." On the contrary, it was because there were metallurgical revolutions that led to bronze, and later iron, that provided more useful materials for satisfying human wants. From this perspective, human socio-economic and technological evolution has consisted of a long series of unsustainable models that have been abandoned–not necessarily because they were unsustainable, but because our ancestors found better ways of achieving human survival. Indeed, the very process of sustainable progress may ultimately be societies lurching from one unsustainable system to another via price adjustment and technological progress in response to that which is unsustainable.

In this paper, we address the issue of whether mineral extraction provides a basis for sustainable development. To do so requires examining several initial and intermediate concepts; ranging from a very broad inquiry into the very nature of sustainability to a narrow focus on what it means for non-renewable natural resource extraction to be sustainable. Other authors have examined these questions, and their findings are reported and discussed in Section 2. Regarding the specific issue of the sustainability of non-renewable resources, most authors have focused on the relationship between mining or mineral resource extraction employment, or output, and dependent variables such as migration, education, and linkages to other industries like

* Corresponding author.
E-mail address: mdobra@methodist.edu (M. Dobra).

https://doi.org/10.1016/j.resourpol.2018.03.013
Received 31 December 2016; Received in revised form 20 March 2018; Accepted 20 March 2018

Please cite this article as: Dobra, J., Resources Policy (2018), https://doi.org/10.1016/j.resourpol.2018.03.013

manufacturing and services. Ultimately, the question in the literature is whether commercial mineral development, i.e., extractive industries like mining, benefits or hurts the economy: Is there a resource curse or a resource blessing??

In Section 3 we take a more macro view and examine the implications of mineral endowment for general well-being (measured by GDP per capita) in the context of a Solow growth model with a modified Cobb-Douglas production function. We then test the model using multiple econometric techniques including ordinary least squares estimates and simultaneous equation models to test hypotheses derived from the model. This analysis is presented in Section 4. In the context of the model we generally find that mineral potential has both positive and negative effects on a cross-section of nations but more generally supports the mineral blessing hypothesis.

2. Literature review

Two common themes in the discussion of the minerals producing industry are "boom and bust" and the "resource curse" (or "Dutch Disease"). Both of these observations about the industry have a basis in facts that are readily observable. For instance, there have been numerous mineral price cycles because of changes in demand and supply, and these cycles have had profound impacts both on the natural resource based industries and communities dependent upon them (see, for example, Tilton and Guzmán (2016) for a theoretical, or Stuermer (2016) for an empirical, examination of the nature and causes of mineral price cycles). There are also numerous examples of resource dependent economies that have failed to achieve broader economic growth and development. Compounding these themes is the legacy of the mining industry (before reclamation laws where they exist) leaving wasted landscapes and unusable land.

Perspectives about mining among the general public and academics reflect these themes and have evolved over time. For example, studies in the 1950s and 1960s on economic development based on natural resource development, e.g., Hirschman (1958) and Seers (1964) focused on supply and demand shocks in commodity sectors and their destabilizing impacts on employment and incomes. These supply and demand shocks resulted in the "boom and bust" cycles associated with natural resources industries.

The general assumption, based on the experience in Western countries like the U.S., Australia and Canada, was that resource abundance would stimulate economic development. Resource development, after all, leads to growth in exports, foreign exchange earnings and rising personal incomes. The classic export-led growth hypothesis found in North (1966) is, perhaps, the template for this view. Yet, during the 1960s and 1970s when commodity prices were generally rising, the evidence showed that many resource rich countries–countries ranging from Nigeria to Peru, Venezuela, and Indonesia–did not experience significant economic development (Mikesell, 1997). The term Dutch Disease was apparently coined by the editors of *The Economist* in The Economist (1977) to describe how expansion of the natural resource based sector of an economy restricted growth in other sectors because of adverse foreign exchange movements, thereby restricting more diversified economic development and exports of other goods. Following this lead, others, e.g., Sachs and Andrew (1995) and Sachs and Warner (2001), have argued that a large natural resource export sector retards development in other sectors such as manufacturing. A large natural resource sector also distorts labor markets by increasing demand for relatively unskilled labor in some cases, reducing incentives for individual educational attainment (Hajkowicz, 2009).

More recently, however, the focus of the development literature has shifted to institutional and demographic factors such as educational attainment and political institutions. Pegg (2006), for example, starts with the assumption that a natural resource endowment is a potentially significant source of wealth creation for poor countries but that wealth never materializes in many cases because of governance issues, i.e., factors like corruption. Along the same line of inquiry, Hodler (2006) argues that a connection exists between resource abundance and wealth and political instability. Similar arguments have been made by Collier and Hoeffler (2005), Ross (1999), and others. The literature on resource abundance and economic development, over more than five decades, has evolved from supply and demand shocks and price cycles, to a more subtle and complex inquiry.

The latter perspective focusing on governance and human capital has likely been gaining currency because of the obvious exceptions based on casual observation. We see nations with little in the way of natural resource endowments, e.g., Hong Kong, Singapore and Switzerland, with dynamic developed economies, and countries like the United States, Canada, Australia, and Chile with significant natural resource endowments and also with dynamic developed economies. So, if there is a "curse" that inhibits economic development, it does not appear to be a result of the abundance of natural resources. Rather, as the more recent literature suggests, institutional and cultural factors appear to be the determinants of whether resources are a blessing or a curse.

This apparent paradox also has implications for those concerned with the sustainability of industries and economies based on natural resource development. As Wellmer and Becker-Platen (2002) note, the concept of sustainability is not a physical or even scientific concept. They refer to the Brundtland Report Brundtland (1987) which holds that "sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Sustainability of non-renewable resource use presents a particular conundrum for some who view it as an oxymoron. Advocates of so-called "peak" theory, e.g., peak oil (Hubbert, 1956), peak copper (Leherrere, 2010), etc., take the view that, since we are running out of non-renewable natural resources, this kind of resource extraction is non-sustainable by definition. This view has significant problems. Dobra and Dobra (2014) argue that available reserve data are not capable of demonstrating a "peak" in the production of any commodity because of the nature of the data and the inability to predict future use and technologies. However, Wellmer and Becker-Platen (2002) avoid this problem by defining sustainability as "[t]he consumption of non-renewable resources should not exceed the amount that can be replaced by functionally equivalent renewable resources or by attaining a higher efficiency in the use of renewable or non-renewable resources."

This formulation appears reasonable but has several practical problems with one of the most significant being the fact that at any given point in time we cannot know if a non-renewable resource could be replaced by a "functionally equivalent" renewable resource. If we had known, for example, that millions of miles of copper telephone lines could be replaced by the electromagnetic spectrum, telephone lines would probably never have been built. But, of course, the people who built the telephone lines had no way of knowing that cellular telephones would be invented. Indeed, perhaps the invention of cellular phones might have required the prior use of wired telephony. Alternatively, if the builders of the telephone lines knew that straw was functionally equivalent to copper, which of course it is not, why would they have bothered to incur the cost of mining copper?

Still, the idea of sustainability has broad appeal. And it makes good sense when applied to renewable resources like forests, fisheries and other renewable resources. Ultimately, definitions of sustainability suffer from the problem of being impossible to apply to non-renewable resources because of information limitations. The ability to identify whether the use of a non-renewable resource is sustainable depends critically on information that is unavailable to contemporary observers–future technological innovations, future reserve discoveries, etc. Logically, this biases the identification of any non-renewable resource toward being unsustainable, regardless of that resource's true sustainability. Applied to non-renewables one has to ask if sustainability is anything more than a platitude. In this context Boudreaux