SUNK COSTS, RESOURCE EX extractive INDUSTRIES, AND DEVELOPMENT OUTCOMES

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ABSTRACT

Sunk costs are a key feature of extractive industries that profoundly shape regional economic development outcomes. In this chapter, we argue that sunk costs do so by influencing both the investment behavior of firms and the organization, as well as the performance, of extractive industries in ways that often deviate substantially from traditional neoclassical models of competitive markets with resource mobility. Sunk costs are defined, and the features that give rise to such costs are identified, followed by an analysis of the impacts of sunk costs on firms, regions, and economies. Sunk costs are shown to underlie two important phenomena associated with the economic experience of resource extraction—“Dutch Disease” and the “resource curse”. The chapter concludes with a discussion of the need for development policy to incorporate often overlooked sunk cost considerations into efforts to promote economic development in extractive economies.
1. INTRODUCTION

Few sights are as impressive as the massive port works, open-pit mines, and 500-mile railways developed to tap the natural resources of frontier regions, or so bittersweet as the relic landscapes left behind in the wake of resource booms. Abandoned mines, idle processing facilities, vacant warehouses, empty ports, disused railroads, boarded-up buildings, and underemployed residents in once vibrant regions speak not only to the capricious nature of resource economies but also to the salience of "rigidities" in investments in extractive industries. Stripped bare of all that could be profitably moved, the remaining specter of idle physical and human resources in once booming areas provides a poignant reminder that investment patterns profoundly affect industrial and regional development paths.

A basic, but often overlooked, feature of extractive investments is that they are predominately sunk, giving rise to the phenomena of ghost towns and idle capital and human resources; once they are made, their salvage value for alternate uses in situ or in other locales is less than the costs of transfer. This "sunkness" of extractive investments fundamentally shapes the investment decisions and actions of firms and governments, influences the subsequent industrial organization of the sector and its connections to the regional economy, and thus holds major implications for economic development, especially in economies with high levels of dependence on natural resources. This chapter, inspired by Stephen Bunker's work on natural resources, develops an integrated view of sunk costs in extractive industries, one that stretches from the micro level of the spatial, biophysical, and basic market features of the resource to the intersection of extractive industries with national development outcomes and the global political economy. It also aims to provide a firmer microeconomic foundation for the recent flurry of writing on the "resource curse" (Sachs & Warner, 1995, 2001; Gylfason, 2001; Neumayer, 2004; Atkinson & Hamilton, 2003), and the Dutch Disease (Corden & Neary, 1982), which explore the hypothesis that resource abundance contributes to low growth rates and thus to divergence in development performance between resource-rich and resource-poor economies.

Inspired by the seminal work of Harold Innis on the role of primary commodity industries in Canadian economic development, the theme of investment rigidities, or "sunk costs," in extractive industries is prevalent in this volume. For most scholars since Innis, sunk costs create "path dependence" for regional development: future prospects for growth and structural change are contingent upon the characteristics of industries that propelled the regional economy in the past. Where few options are available
for making use of the related fixed investments once the boom begins to wane, prospects for economic development are likely to be limited; as such, the fortunes of the region remained tied rather strictly to those of the original boom activity. Given the often irreversible nature of investments in extractive industries, the resulting path dependencies are especially important to understanding development outcomes in resource-rich regions.

The potential of extractive activities to produce highly problematic development outcomes reaches beyond those captured by the notion of Innisian path dependency. Sunk costs fundamentally shape both the investment behavior of firms and the organization and performance of industries in ways that can deviate substantially from neoclassical models of competitive markets with resource mobility. In particular, a high degree of sunk costs can generate investment levels that are lower, or paradoxically even higher, than optimal levels predicted by conventional models. If the extractive industry is important to the region, the inefficiencies and inequities that result from these investment patterns can limit the industry's contribution to regional economic development, both during its heyday and thereafter. In addition, sunk costs in a leading extractive sector can act to distort investment patterns of both private and public agents in the surrounding regional economy, again in ways that limit the leading sector's contribution to development. This tendency for regional economic distortions to arise in the presence of extractive industries can be especially important if the leading sector undergoes a major boom era of high returns, which when combined with sunk costs in the extractive and perhaps surrounding sectors can set the economy on an unsustainable course. In that respect, this chapter provides much needed microfoundations for the "resource curse" and "Dutch Disease" literature by identifying the deeper logic of distorted investment patterns that tend to be associated with extractive industries.

We begin our presentation with an overview of the nature and causes of sunk costs. In Section 2, we explore the wide range of factors that can make investments sunk, and conclude that sunk costs are far more pervasive than is commonly recognized. In Section 3, we build on Innis (1930, 1933, 1956) and our work elsewhere (see Barham, Chavas, & Coomes, 1998; and Barham & Coomes, 1994a, b) to explain further why sunk costs are of special significance in extractive industries. We do this by exploring the potential degree of sunk costs associated with investments of capital, labor, and information in different extractive industries and in the various stages of the extractive process. We then examine in Sections 4 and 5 the effects of sunk costs on the efficiency and equity of industry and economy-wide performance. We identify four major ways that sunk costs lead to problematic
development outcomes. In the conclusion, we discuss the need for an improved understanding among scholars and policy-makers of the broad implications of sunk costs in natural resource industries, and the potential value—in this era of market liberalization, free trade, and liberalized foreign direct investment—of well-managed regulation for promoting economic development in resource-rich regions.

2. THE NATURE AND CAUSES OF SUNK COSTS

2.1. What are Sunk Costs?

All economic activities involve some degree of investment, which the investor anticipates will generate a flow of favorable returns. In considering investment in extractive industries, observers tend to focus most attentively on the more obvious setup costs; e.g., outlays necessary to secure rights to the resource and to construct (or purchase) the physical infrastructure for the extraction, processing, storage, and transportation of raw materials and their byproducts. Other forms of investment, however, are also important. Substantial expenditures are made to acquire information on the resource’s location and characteristics, to recruit, screen, hire, and train workers, to comply with government regulations and registration requirements for initiating extractive activity, and to form contracts and business relations with input suppliers and buyers. Generally, as long as an expense incurred by a firm is undertaken with the intention that it will bring value over time (i.e., because it generates a stream of future returns), then that expense can be thought of as an “investment.”

Sunk costs refer to those investments that, once undertaken, cannot be fully recovered through their transfer or sale. The “irreversibility” of investments is frequently viewed as resulting from their firm- or industry-specific nature (Dixit, 1980; Spence, 1977). However, sunk costs can arise even when investments are transferable to other economic activities or sectors; such is the case where transfer costs make a certain portion of the value of the original investment essentially unrecoverable. To estimate sunk costs, therefore, an analyst would find the difference between the value of the original investment and its salvage value (i.e., the value if sold or transferred to another use). Where the salvage value of an investment is high, the sunk costs by definition will be low. Thus, for any given investment a wide range of reversibility can exist: from “full reversibility,” where sunk costs are zero because the salvage value equals the original investment, to “full
irreversibility”, where sunk costs equal the full value of the original expenditure because there is no salvage value to the investment.

The extent of sunk costs in a given investment also can vary over time and place. Through time, the salvage value will fluctuate with changes in the activity’s expected net revenue stream (independent of the original investment costs) or with the value of alternative uses of the investment. Thus, a price shock, an input cost shock, or changes in the viability of alternative uses of the investment can affect the salvage value. The extent of sunk costs also vary with place, in that the actual location of the investment can affect the prospects for its sale or transfer and hence the salvage value. A more precise measure of sunk costs would also incorporate, at any given time, a value to reflect the physical-economic depreciation of the investment, which would be deducted from the original investment cost (Dixit & Pyndick, 1994). A fully reversible investment under this modification would have (at any given time) a salvage value equal to its original cost less the physical-economic depreciation that has occurred during its lifetime.

So far, our attempt to define sunk costs has been in terms of the extent of sunk costs associated with a particular investment. However, any given investment activity is likely to involve a set of distinctive yet interrelated investment expenditures (e.g., locating the valuable resource, acquiring rights, building the physical infrastructure for its extraction, hiring the workers, and so on). Thus, the extent of sunk costs associated with a set of investments may not simply be the sum of the sunk costs of each distinctive form of investment, treated separately. The salvage value of different forms of investment could well be affected by the sale or transfer of other interlinked investments, so that the salvage value of the set of investments must be analyzed jointly. The contingent and conjunctural nature of sunk costs means that generally no single measure or estimate can be identified at the moment of original investment decision that will apply over the entire life of the investment. Instead, the sunk cost measure must be continually updated with information about the evolving salvage value of the investment in order to have a proper evaluation of the worth of the assets in question.

2.2. What are the Causes of Sunk Costs?

2.2.1. Physical Characteristics of Investment
Perhaps, the most commonly understood cause of an investment being sunk is that the physical characteristics make the installation costly to set up, remove, and relocate or industry-specific in its potential use. For example,
the task of extracting, separating, and moving large volumes of raw materials will require sturdy, secure facilities with high installation and deinstallation costs. In addition, these investments, especially in the mining and energy sectors, must often be quite large to achieve a minimum efficient scale. Large investments in secure removal, separation, and transport equipment and infrastructure characterizes many extractive activities.

2.2.2. Investment Specificity and Remoteness
Sunk costs are also caused by the specificity of investment to a firm or particular activity, even if the investment does not involve physical capital. Of course, expenses that are not inherently firm- or industry-specific also can be sunk. Investments can have alternate uses to other industries or firms, yet their transferability may be limited by the physical costs of moving them from their original location, the transaction costs of arranging for their sale or transfer, or by the economic conditions in other sectors of the economy which might be most likely to use them. Any factor that increases the transfer costs of an investment to an alternative use can raise sunk costs by reducing its potential salvage value. Of particular importance here is the location of investment, or more specifically its remoteness.

Remoteness contributes to raising sunk costs in two fundamental ways. First, the actual cost of the original investment is likely to be higher, the more remote is the locale; indeed the notion of “remote” reflects such access costs. Second, remoteness will also tend to reduce the salvage value of investments—in several ways described later below—thereby heightening the associated sunk costs. In particular, to move such investments from remote areas, or transfer them to other uses in situ, will tend to be expensive, thereby lowering the salvage value. Although perhaps somewhat counterintuitive, remoteness can increase sunk costs even for such seemingly mobile investments as human resources. People are mobile and many will recoup what they can and seek out new economic opportunities when local opportunities fade. However, in a remote location undergoing a major industry decline, the salvage value for local fixed investments by its residents (e.g., housing, woodlots, piers, not to mention social ties and community) will be low. As a result, many residents may choose to stay, despite the prospect of low returns on their labor and business capital, because the consumption value of their local material and social investments remains greater than the value they could salvage upon moving. In this way, the remote locale potentially imbues an otherwise nearly fully reversible investment of human resources with a significant degree of sunk costs as well.³
2.2.3 Transaction Costs
Informational (or transaction) costs also create sunk costs. Specifically, the transfer of an investment entails certain costs which, in turn, reduce the potential salvage value of the investment. Such transaction costs arise from a variety of sources (see Williamson, 1985), including the process of negotiating the terms of the transfer, informational asymmetries between the buyer and seller concerning the real value of the transferred asset, adjustments the buyer will have to make in terms of hiring or retraining labor and management or reorganizing the operation’s human resources, and developing specific relations with input suppliers and buyers that may not be perfectly transferable. All such transaction costs reduce the potential salvage value of the investment and thereby increase sunk costs.

Of the various sources of transaction costs, the relationship between informational asymmetries and sunk costs is perhaps least obvious. A resale problem arises for many types of equipment, Akerlof (1970) argues, because of the asymmetry in information between what the seller knows and what the buyer does not know about the condition and effectiveness of the item under consideration. Because of the difficulty (or costs) of evaluating the quality of second-hand equipment, buyers will tend to offer a price that corresponds to what they perceive to be the average quality of goods in the market. This, in turn, makes sellers reluctant to sell equipment of above-average quality, because they are unwilling to take the loss in salvage value associated with selling equipment of above-average quality for average prices. Thus, the asymmetry of information between seller and buyer tends to lower the average quality, and hence the price of resale markets for many types of equipment and services. When otherwise transferable inputs are subject to the “Market for Lemons Effect,” and are therefore more costly to transfer, investors face sunk costs in these expenses.\(^4\)

Other types of informational asymmetries also create sunk costs. Uncertainty or inexperience on the buyer’s side with the technological processes involved in equipment use, or the underlying market conditions, can open gaps in beliefs between sellers and buyers about the value of physical or organizational capital. Where buyers have more uncertainty about the degree of down-side risk in the market or more doubts about the efficacy of the technological processes, then sunk costs for the original investor will also tend to be higher than they would be in the absence of information asymmetries. Again, sunk costs associated with informational asymmetries may be more likely to occur in remote locales, where because markets are thinner, information about key features of distant markets may be less available.
2.2.4. The Investment Package and Same Boat Effects

Two final features make investments more sunk than they would otherwise appear—what Barham, Chavas, and Klemme (1994) refer to as the "Investment Package Effect" and the Same Boat Effect. The Investment Package Effect arises where investments are made that are essential to the continuing operation of a facility, and hence in preserving the value of other sunk investments. The "Same Boat Effect" occurs when simultaneous efforts by firms (or individuals) to sell off similar investments drives down salvage values, thereby increasing the level of sunk costs. Such conditions are most likely to arise when down-side risk is realized (e.g., a sharp price drop) and widely felt across an industry or across an economy, prompting firms to sell off their investments and secure their salvage value. To the extent that the shock occurs in a specific industry, the magnitude and scope of impacts will depend on the size of that industry relative to the economy as a whole and the potential utility of sunk investments to other industries. Still, the many sellers of similar investments, essentially all in the same boat of seeking to reduce their down-side losses, can drive down resale prices and hence salvage values, as purchasers of the transferable equipment find themselves in a buyers market filled with many prospective suppliers. A similar effect may be experienced with non-industry specific investment goods when related sectors are also suffering reduced demand for goods and hence create a buyers' market.

All such effects are likely to be heightened in remote regions. When adverse conditions are confined to a locale or region, then prospective relocation of physical and human capital will force net resale prices downward. In more remote areas, transportation costs to relocate capital will reduce resale value, but so will the fewer options to offset the Investment Package Effect, and the greater potential for the Market for Lemons Effect of a product in a distant market. Moreover, the "Same Boat Effect" will be magnified in isolated regions as the pool of potential buyers is smaller than they would be in a well-integrated area. Thus, once more, the remoteness of the original investment becomes important in reducing the potential salvage value of investments, even if such investments are not inherently "sunk" by their actual physical nature.

3. EX extractive INDUSTRIES AND SUNK COSTS

The task of assessing the potential for sunk costs in a specific extractive activity is deceptively difficult. Sunk costs vary substantially not only across
industries, but also within industries over space and time. In some cases, the presence of sunk costs is quite apparent and difficult to dispute, as in a mineral processing facility in a remote locale. In others, though, the variety of causes of sunk costs and their potential variability over space and time make the actual identification of sunk costs a major challenge. Moreover, within particular extractive industries, sunk costs will be highly activity-specific and contingent, both geographically and historically. Such complexity suggests that the task of developing a comprehensive, systematic analysis of the occurrence and causes of sunk costs across extractive industries lies well beyond the scope of this chapter. Instead, we focus in this section on exploring the causes and pervasiveness of sunk costs in extractive industries.

### 3.1. The Stages of Extractive Activity

Sunk costs arise in each of four basic stages in extractive activity: discovery and appropriation of the raw material, extraction, processing, and transportation. Initially, firms invest capital, labor, and managerial effort in finding the natural resource of interest; discovery costs can be substantial, as can investments needed to secure ownership rights to the raw material. Labor investments can include not just the wage bill in this stage but also the costs of recruiting, training, and monitoring labor. Second, investments are made to extract the raw material from nature. Such investments include not only equipment and labor for extraction but also for information and technology management, and for long-term cleanup costs that are not compensated by future use or regulatory authorities. Finally, investments are made to process the raw material and transport it to markets. Clearly, processing and transportation can occur in either order, depending on whether some or all of the processing is handled more economically near the site of extraction or the market. Again substantial costs are incurred in these last two stages for physical capital, labor, information, and clean up.

### 3.2. Investments in Extractive Industries: Specific, Remote and Lumpy

Extractive industries are also prone to sunk costs because of the particular nature of investments. In each stage of extraction, investments tend to be rather activity-specific due, in part, to the unique physical features of raw materials, their specific geographical location, and the large-scale technologies involved in their discovery, extraction, processing, and
transportation. Most exploration for rich concentrations of raw materials involves the use of equipment and personnel oriented toward a certain resource; such specificity in orientation may reduce the prospects of discovering prime reserves of other materials. Depending on the resource in question, a considerable portion of the total costs can be incurred at this early stage, and such costs are quite likely to be sunk, especially when the investment yields no significant discovery.

In the extraction stage, the infrastructure used to remove the resource from nature is engineered to extract the material from the locale as efficiently as possible. Extractive equipment often is designed to conform precisely to the material properties of the particular raw material and its natural setting; consequently, both the capital and technology used are highly specific to the industry and sometimes even to the site of extraction. The costs of dismantling major installations usually make it cheaper to buy and install new infrastructure and equipment than to relocate extant installations. As such, both the installation and de-installation costs involved in the extraction stage reduce the salvage value of these investments and hence increase the potential level of sunk costs.

Refining and initial processing also often require technologies designed to conform to the physical and chemical characteristics of the extracted material. Thus, the processing equipment is also likely to be highly specific to the material at hand, which further increases the potential for sunk costs in the activity. In the case of certain raw materials, such as bauxite, the specificity of design in the processing equipment is so closely linked to the chemical features of the raw material that the processing equipment is designed to handle the resource from a single site or source (Stuckey, 1983). In these cases, the extreme specificity involved in the processing investment makes likely a high degree of vertical integration between the raw material site and the processing firm (in the form of a long-term contract or direct purchase). Either way, such a commitment can mean a higher level of sunk investment for the economic agent involved.

Transportation and storage facilities may also be designed around the particular physical characteristics of a resource in a way that promotes more sunk costs. Different resources have particular "volume to value ratios" and thus require quite distinctive transport and storage systems. Thus, the transport and storage infrastructure developed to serve one type of extractive activity in an area may not be suitable for what turn out to be reasonable alternatives (Priest, 1995, 2003). In this manner, investments in a stage of extractive activity which may not seem to entail much in the way of sunk costs can actually be highly prone to sunk costs.
Because raw materials are fixed spatially by their occurrence in nature, only by chance are they likely to occur near important markets or other industries that may serve as potential alternative users of the inputs employed for raw material extraction and transport. As much of Stephen Bunker's work suggests, increased isolation of many raw materials is also a socially constructed phenomena to the extent that the more proximate reserves have been exhausted, and so extraction moves to more remote locales (see Bunker, 1994a, b). This remoteness tends to make investments in extractive activity more sunk than otherwise would be the case for the reasons explored in the previous section. Remoteness may especially deepen the sunkness of investments in transport and storage facilities which inherently might have alternative uses, but no such options are available when the infrastructure serves a remote site.

A third reason why sunk investments are pervasive in extractive activity is that investment requirements, particularly in minerals and non-mineral energy resource developments, often tend to be "lumpy" — that is, investments are only economical at a relatively large scale requiring tightly coordinated and integrated stages (Bunker, 1994b; Priest, this volume). This is so, in part, because of the scale economies that arise in mining or extracting and refining of raw materials. Transport infrastructure requirements also tend to promote larger scale operations, because there is a substantial fixed cost imposed by these installations which can be minimized on a per unit basis by increasing the volumes of materials transported. The lumpiness of extractive investments also occurs in another sense, in that investment in the different stages of the operation have to be tightly coordinated to avoid having investments in one stage generating no revenue as they wait for other investments to be completed. As Bunker (1994b) demonstrates, this need for timeliness in extractive industry investments can make them even larger in their initial costs, which for the reasons given above (and below) are also likely to be sunk.

4. SUNK INVESTMENTS, INDUSTRY ORGANIZATION, AND DEVELOPMENT OUTCOMES

Sunk costs can influence development outcomes in extractive industries in several ways that are distinct from the predictions based on neoclassical models of competitive markets with resource mobility. Two effects of sunk costs occur at the microeconomic level of industry organization and
performance. First, sunk costs create the potential for firms to engage in strategic behavior aimed at influencing the actions of other participants or potential entrants and hence the degree of competition within the industry. Second, sunk costs, when combined with uncertainty about future net revenue streams, can lead to socially inefficient investment outcomes, i.e., either too little or too much investment, depending on the interactions of markets and public policies in these industries. Sunk costs thus constrain competitive and flexible resource allocation at the industry level, which in turn can undermine both efficiency and equity outcomes in developing countries where many extractive industries play major roles in regional and national economies.

4.1. Sunk Costs and Strategic Behavior in Extractive Industries

In terms of strategic behavior, sunk costs essentially represent a form of commitment to participate in an industry that would not be present if the costs could be readily reversed. The higher is the portion of sunk costs to total costs, the less the firm has to lose by choosing to stay in business once the sunk costs are incurred. Sunk cost commitments thus hold strategic value to the incumbent firm by creating barriers to entry. Erstwhile competitors, who have yet to sink their costs, may be deterred from entering the industry because of the prospect of making losses once their output and sunk cost capacity commitment are added to those of the incumbent. If an incumbent firm faces zero costs in the future, entrants face a firm with nothing to lose. If, in fact, entry is deterred because of existing sunk cost investments, incumbent firms gain some degree of market power, which can then be used to raise prices and profits above competitive levels.

Research by Krugman (1985), Auty (1993, 1994), Barham (1994), Woo, Glassburner, and Nasution (1994), Mikesell (1997), Barham et al. (1998), Davis (1997), and Aggarwal and Narayan (2004) show why sunk costs and strategic behavior are likely to be of special importance to the industrial organization and performance of extractive activities in developing countries. One fundamental mechanism highlighted by Krugman and Barham, Chavas and Coomes is how sunk costs help firms, which by luck or design can secure a first-mover advantage, to invest strategically to raise rivals costs and thus to limit or deter future entrants.

Extractive industries, especially minerals and energy resources, are strong candidates for this type of preemptive sunk cost investment strategy. This preemptive strategy is most likely to be viable for natural resources with
certain physical features: specifically, where the variation in the quality of the appropriated resources is sufficient to create major cost differences across sites, where the prime reserves are concentrated in a few sites, and where the resource can be readily and relatively cheaply appropriated as private property. These features are shared, for example, by mineral ores; grades vary spatially, are often highly concentrated, and are more readily appropriated than other inputs, such as information or skilled labor for other economic activities. In such cases, the incumbent firm(s), by securing a small number of strategic purchases or concessions, can deter potential rivals by pushing them toward inferior reserves of key inputs. Whether incumbents actually accomplish this in a given industry depends on the cost and feasibility of securing a first-mover advantage.

In the early stages of such a strategy, establishing a first-mover advantage is likely to require some imbalance in the bargaining position of the original holders of the prime reserve sites (say, a national government) and the firm seeking to establish its strategic position in an industry, with the imbalance favoring the firm. Without this type of bargaining advantage, the original holder would be in a position to play off rival firms against one another, as each sought to establish control over the prime sites. The resulting increase in the cost of capturing the prime resource sites would quickly obviate the viability of a preemptive strategy aimed at capturing control over reserves of the scarce input.

First-mover advantages can originate by accident, luck, innovation, asymmetric information, or entry barriers (for example, patents and state licenses). Historically, prime reserves of scarce natural inputs often have been located in isolated regions of developing countries; a paucity of domestic information about their extent and market value combined with relatively weak states and other local institutions may have increased the prospects for this sort of asymmetry to arise, and thereby favor strategic capture of key sites by well-informed and well-capitalized foreign (multinational) firms (O’Hearn, 1994). Moreover, the fact that many innovations and the resulting patents for the refinement and processing of raw materials were made by these firms in more developed countries also may have conferred on them an initial bargaining advantage.

An initial advantage captured in one or two prime locales, as Krugman (1985) points out, tends to feed on itself, providing the firm with an even more advantageous market position. The incumbent firm becomes willing to pay a higher price than a later entrant for a prime source, because it can capitalize into the purchase price some portion of the value of the market power protected by the additional capacity investment in scarce reserves. If,
as a result of this or other advantages, rivals drop out of the bidding, initial holders of the prime reserves (such as national governments) may actually find themselves on the long side of the market, bargaining with the dominant firm to have their reserve purchased ahead of other holders of prime reserves.

The development implications of sunk costs and strategic capacity efforts in extractive industries therefore depend on several factors. Certain features of extractive industries historically have favored domination of prime reserves by multinational corporations based in more developed countries. Multinational firms have been able to exploit, to their advantage, initial asymmetries in information about markets, technologies, and resources; to establish initial monopoly positions in the major consuming economies by technological advantages, mergers, or other factors present in those stages of the market; and to outmaneuver and outbargain weak states in remote regions, at times with the help of their home country or international institutions.

Just as sunk costs and capacity investments offer strategic opportunities for foreign firms, so might they also do so for host countries. The flip side of the strategic side of concentrated reserves would, for example, seem to be the opportunity afforded developing countries to acquire market power. Indeed, this prospect certainly has been a motivating force behind a large number of strategic initiatives by resource-rich countries during recent decades. Several factors seriously limit this potential, not withstanding the broad historical trend of recent decades toward rising national ownership and control of mineral and energy reserves. One well-recognized limitation is the problems that developing country industry managers face in trying to stay competitive in discovery, extraction, and transport technologies, product development, and marketing and distribution. Perhaps a more fundamental constraint on host countries realizing strategic advantage is that of location or jurisdiction. Even in those cases where prime reserves are concentrated in a few sites, they are rarely contained within one nation or region of a nation. Compared with a multinational company that can strategically integrate within a single organization the use of reserves across many regions and countries, whatever private, public, or quasi-public domestic institution might control the prime reserve in a given resource-rich region will have much less capability to act strategically in the industry. Coordination with other similar bodies in other countries or jurisdictions will run directly into conflicting objectives, not the least of which will be the basic contradiction that arises when attempting to agree on which sites will be assigned a reserve or underutilized status in an excess capacity strategy.
Historical evidence of this fundamental limitation in coordination among prime exporting countries in resource industries abounds, as revealed in the difficulties associated with recent supply management efforts in bananas, bauxite, coffee, cocoa, copper, and tin. Only those cases—such as oil and diamonds—where a single, low-cost producer (Saudi Arabia) or a deeply inventoried producer (De Beers of South Africa) has notable capacity to discipline the rest of the industry, have we seen “coordination” proving to be more durable. Otherwise, the capability of developing countries to build strategic advantage over scarce reserves seems inherently hamstrung by coordination problems.

Sunk cost and strategic capacity investments continue to be dominated by multinational firms. Therefore, the efficiency and equity implications associated with sunk costs and strategic capacity in extractive industries tend to be highly negative for the host region. On the efficiency side, if a viable excess capacity strategy is achieved via initial first-mover advantages enjoyed by a multinational corporation, then output can be restricted well below competitive levels. The extent of under or even non-utilization of a given locale, the so-called “captive mine,” will depend significantly on how prime its reserves are relative to the rest of the company’s holdings, the extraction, refining, and processing capacity originally installed by the firm, and relatedly the production or export levels which the firm perceives to be necessary to maintain its property rights to the resource. Given that the strategy calls for excess holdings somewhere, clearly some, if not all, host regions could have output levels reduced below levels than would prevail in a more competitively organized industry. Although the remoteness of the extractive industry may limit the spillover effects of reduced output levels on the national economy, where the extractive activity’s role is significant, restrictions in output would have important local and regional impacts.

On the equity side, the terms of the concession (i.e., the original purchase price of the reserve and accompanying taxes or trade duties) will determine the share of the benefits captured by the firm and host country of controlling prime and strategic reserves. If the multinational is (or was) able to exploit historical conditions that enabled the firm to secure control over these resources at low cost, the equity impacts on the host country can be quite adverse. Both the strategic rents arising from market power and the resource rents due to the prime nature of the resource are at stake (Barham, 1994). Clearly, without regulation both the equity and efficiency impacts of sunk costs in extractive industries can be strongly negative.
4.2. Sunk Costs, Uncertainty, and Investment in Extractive Industries

Somewhat paradoxically, sunk cost commitments also create the potential for major losses and thereby make strategic investments quite risky. If a firm or its industry experiences an adverse price or cost shock, the firm may find itself forced to abandon a major capital investment; alternatively, the firm may be in position to cover variable costs but not recover the costs of the original sunk investment. Thus, by restricting the incumbent’s exit option, sunk costs can evoke either market power or major down-side losses, depending on industry and market conditions. How then do uncertainty and sunk costs influence the industrial organization and performance of extractive activities?

Microtheoretic research in economics on sunk costs (Lambson, 1991; Dixit & Pyndick, 1994; Chavas, 1994; Lambson & Jensen, 1995, 1998) has examined how uncertainty (and especially downside risk) discourages investment and distorts entry and exit decisions, where investments are less than fully reversible. Such effects are probably more common than the strategic capacity issues raised in the previous section, because the interaction of sunk costs and uncertainty is likely to affect a much broader class of economic activities. Whereas strategic capacity models can require significant first-mover advantages, limited prime reserves, and/or significant cost differences across prime reserves, the prospect of meaningful down-side risks (such as price, output, or cost shocks) is all that is needed in an industry with significant sunk costs to create under- or possibly over-investment by limiting resource mobility. The mere presence of sunk costs and down-side uncertainty about future industry outcomes is sufficient to ensure that firms will not allocate or reallocate resources flexibly or smoothly according to price signals.

The economic logic of the interaction of sunk costs and uncertainty is relatively simple (Chavas, 1994; Dixit & Pyndick, 1994). Taken together, sunk costs and uncertainty create two potentially important investment considerations to incorporate into profitability analyses; first is the option value in exiting, which decreases with the extent of sunk costs, because greater sunk costs limit the ability of investors in bad times to avoid losses by selling off investments for a good salvage value; and second, is the option value to enter later, which arises because by delaying investment in a sunk cost activity, the potential investor is able to acquire additional information about future industry conditions before sinking capital. Interestingly, both options are generally overlooked in standard long-term profitability analyses, yet they are potentially influential.
For participants who have already invested, the more sunk the investment, the more difficult it is to sell off and avoid down-side losses, if industry profitability erodes. On the other hand, this exit constraint provides the incentive for investors or entrants to choose a flexible, "wait-and-see" strategy. The value in waiting arises to the extent that industry conditions permit the investor to enter if long-term profitability conditions improve, or otherwise to avoid the bad times, if industry prospects deteriorate or continue to have large down-side risks. By taking a wait-and-see approach, the investor can earn an overall higher return, cashing in on the good prospects while avoiding the bad. The result of these two effects is that private investment in industries with sunk costs and uncertainty is discouraged, yielding socially sub-optimal levels of investment and entry. More efficient levels could be achieved if the uncertainty facing individual investors is reduced via social insurance or other risk-reducing mechanisms; however, these private or public institutions are not established without costs, and thus will not necessarily emerge. Both the investment and entry–exit depressing effects of sunk costs under uncertainty may be highly salient for extractive industries in developing countries (Hum & Wright, 1994; Garland, Sandefur, & Rogers, 1990).

Without measures aimed at reducing the interactive effects of sunk costs and uncertainty, private investment patterns in extractive industries will tend decidedly toward underinvestment. Private and public institutions serve to mediate this result when they reduce uncertainty or subsidize sunk cost investments, but there is no assurance these conditions will arise in a given situation without public intervention. If institutions are created to reduce uncertainty or subsidize sunk cost investments, there is of course the distinct possibility that the subsidy involved could induce the contrary outcome: too much investment in the sector (Dixit, 1991). Over-investment appears to have occurred recently on an international level in many extractive industries. In their book, Bunker and Ciccantell (2005) show how Japan seems to have succeeded in achieving an advantageous outcome for their consumers of raw materials by encouraging several resource-rich regions (Brazil, Australia, Canada, and South Africa) to invest in superports sized to fit Japanese ships. For encouragement, Japanese firms supported by their government typically offered initial seed-money investments for the infrastructure with medium- or long-term guarantees to purchase large volumes of raw materials from the countries. Cumulatively, these inducements resulted in major capacity commitments by governments in these regions, and the unique fit between the efficient scale of operation of their superports and large Japanese ships has helped to assure Japan a steady, low-cost supply of prime raw materials.
The susceptibility of resource-rich governments to this arrangement arises, in part, from the hesitance of private investors to move into an industry with sunk costs and uncertainty. Thus, in many developing countries, the state moves to invest heavily in these extractive industries, either directly through state agencies or indirectly through the provision of funds and special support to quasi-state enterprises. In so doing, their actions can combine to produce the reverse problem of over-investment, especially when these government-sponsored efforts do not account for the actions of participants in other regions and countries, so that extractive industry expansion occurs in several places simultaneously. In such a case, the sunk cost nature of these projects leads paradoxically to industry-wide over-investment and depressed prices, because the sunk costs involved act to slow subsequent adjustments to depressed prices.

Either way, under the free market or by government intervention, inefficient levels of investment in extractive activities are likely to arise unless careful attention is paid to the interactive effects of sunk costs and uncertainty. Choosing the most efficient forms of intervention—from government sponsored investments for select price stabilization techniques to promotion of private-sector based, risk-mitigating institutions—would depend on a much deeper understanding of these interactions than is available in the current literature. Given the scale of many extractive industry investments in minerals and non-mineral energy resources, advances in this area of research could be of significant value to governments around the world, especially those banking on extractive industries for development.

5. SUNK COSTS AND THE STRUCTURAL EVOLUTION OF THE ECONOMY

Sunk costs can also influence development outcomes at a macroeconomic level by constraining the future options available to the overall economy of a locale, region, or country. This influence may be felt in terms of the “path dependencies” established by the sunk cost industry, which guide the economy toward certain futures and away from others that would otherwise be more attractive. In the extreme, a sunk cost industry can become important enough in the overall economy that the patterns of investment in the booming sector and other non-tradeables can alter radically the entire economic structure. The resulting economic structure is less flexible and less responsive to price shifts than conventional economic theory would suggest,
which creates the potential for major economic decline when the boom sector declines or fails. In this sense, it may be the sunk cost nature of investments in the booming sector that underpins the kinds of deleterious outcomes predicted by the "resource curse" hypothesis and "Dutch Disease."

5.1. Sunk Costs and Path Dependency in Extractive Industries

Much of Stephen Bunker's research on resource industries (Bunker, 1994b; Bunker & Ciecantell, 2005) demonstrates how extractive industries tend to generate ephemeral development episodes, in which a region's economic fortunes rise and fall with the rhythm of the leading resource sector. To some readers perhaps, these outcomes may seem to be a direct and inevitable product of the remoteness of extractive activities, which by accident of geography and natural surroundings are often too far from the resources, technologies, and markets needed to stimulate alternate economic activities.

However, "remoteness" per se does not make regional economic development outcomes depend on the fortunes of extractive activities. Rather, remoteness reflects both the cost of the access and the lack of alternate options, which influence the level of sunk costs in local investments, and thereby development outcomes. Moreover, sunk costs limit future options even in regions where remoteness does not limit alternative options. Indeed, the negative impact on economic development, or the path-dependence created by sunk costs in extractive industries, is quite commonplace in the less extreme cases where regional economic alternatives are locationally possible but circumscribed by the specificity of the original investments. In these cases, the key issue lies in the degree to which existing investments in the sector, and other ancillary activities, can be reallocated toward new activities when opportunities change; the more sunk the existing investments, the less readily they will be transferred, and the more dependent the local economy will be on the original investments.

The key features which lend themselves toward path-dependent development outcomes in extractive industries are:

1. Sunk costs tend to be high, both because of the inherent nature of the activity and other factors explored above;
2. Where extraction is the economic core sector of a region, ancillary infrastructural and institutional investments, including the investments of workers in their homes and firms in supporting sectors, tend to be
strongly oriented toward and often specific to the core sector's needs; and,

3. Regional policies of economic diversification are thus often difficult to prosecute because of the inherent limitations of sunk investments, the political-economic resistance that fundamental change might elicit from those private agents for whom the salvage value of their investments hinges (or seems to hinge) on the core sector, and the collective action challenge of pursuing a self-insurance scheme aimed at diversification in what are often frontier-oriented communities.

The factors which account for the first two features should be relatively self-evident from our earlier discussion. The last feature, concerning the challenge of economic diversification, is discussed below.

5.2. Sunk Costs and Dutch Disease Effects in Extractive Economies

Resource booms often generate intersectoral investment and resource allocation patterns that beget rather fragile paths of economic development, a phenomena widely referred to as the "Dutch Disease" (see Corden & Neary, 1982). High economic returns in a booming resource sector (such as natural gas in the Netherlands during the 1970s, hence the expression) tend to attract capital and labor into that sector as well as into the production of non-tradeable goods and services. If investments can flow smoothly back into the production of other tradeable goods after the boom, then the Dutch Disease effects of intersectoral resource allocation on longer-run development possibilities would be largely inconsequential, albeit useful in explaining temporary structural shifts in the regional economy. If, however, investments in these favored sectors exhibit a high degree of sunk costs, then the resulting structure of the economy becomes quite rigid and vulnerable to future shifts in the price of the boom resource relative to other tradeable goods.

The Dutch Disease phenomena thus helps account for why regional economies tend to become so hypertrophied and dependent on extractive industries. Boom sectors tend to arise, and in turn propel significant capital and labor flows across sectors in the economy, where the potential is greatest for large gaps to arise between the price and the cost of the good. Extractive industries are prime candidates for large price-cost gaps for two reasons: first, they have the potential for certain high-quality reserves to be exploited at significantly lower cost than at other sites; and second, extractive industries often face a high inelasticity of demand in consumer markets which can
generate large price rises. Furthermore, the sunk costs of expanding production in new areas, when prices change abruptly, is often high enough to delay rapid entry from areas that are not currently in production. This retarding effect on supply affords extant exporters longer periods of large price-cost gaps and high returns.

When high returns are realized by industry participants, fresh capital and labor are pulled strongly into the booming sector, thereby deepening the local reliance on that sector. In addition, the effect of the boom on other economic sectors is highly uneven. Local spending generated by increased incomes during a boom stimulates the production of more non-tradeable goods and services, where local producers can raise their prices to ensure the necessary returns to the factors employed there. Labor and capital are thus drawn both directly (via re-investment) and indirectly (via income increases) into the non-tradeables sector and away from the production of (non-boom) tradeable goods and services. The other tradeables sectors (e.g., agriculture or manufacturing) cannot pay the higher returns now demanded by labor and capital because of the price discipline they face from imports (tradeables), and are forced to reduce production in an attempt to match the more generous returns now available elsewhere in the booming economy.

In terms of maintaining a flow of regional exports that can support the rising consumption of imported tradeables and vibrant production activity in the non-tradeable sector, the regional economy becomes even more reliant on the booming sector. If the boom lasts long enough, the local economy can become almost entirely dependent on the prospects of the booming sector, with virtually all of its tradeable exports coming from that sector. If the investments which directly and indirectly gave rise to this unbalanced economic structure are not easily reversible, because of the high degree of sunk costs in investments in the booming extractive sector and the non-tradeables sector, and/or because there are substantial learning costs to re-entering production of other (non-boom) tradeable goods that were abandoned previously, then the Dutch Disease effects caused by the boom can result in an economic structure that is exceptionally vulnerable to a price decline in the boom sector.

The Amazon Rubber Boom provides a quintessential historical case of the Dutch Disease phenomena with sunk costs (Barham & Coomes, 1996; Barham et al., 1998). But, by no means does the historical case of the Amazon Rubber Boom stand alone as an example of the Dutch Disease phenomena. In the 1970s and 1980s, numerous resource-rich countries, including Cameroon, Costa Rica, Colombia, Indonesia, Mexico, Nigeria, and Venezuela experienced Dutch Disease episodes of varying degrees of severity, as coffee and oil prices boomed. The consistent difficulties experienced by regional and
national governments in coping with resource booms and overdependence on a booming sector suggest perhaps that the significance of sunk investments in extractive industries and economic development may be underestimated, a result, in part, of the lack of emphasis given to sunk costs in conventional microeconomic and macroeconomic theory. If investments are not recognized as sunk (in the fuller sense implied above), then the resulting economic structure could be viewed as more supple and resilient than is the case. Also, if the implications of sunk costs are not fully understood, then sunk investments will not be seen by policy-makers as being particularly problematic for longer-term economic development. Again, it is in this sense that sunk costs are potentially a key microfoundation of what has recently been labeled as the “resource curse.”

Even with a heightened awareness of sunk costs, however, powerful political-economic forces come into play during resource booms that may make it difficult for regional and national economic policy-makers to avoid succumbing to the Dutch Disease. The realization of high economic returns by those groups linked specifically to the booming and non-tradeables sector enable their rapid ascendance and the advancement of their interests in political spheres. As such, even prescient government officials, political leaders, or civil organizations would experience difficulties in securing broad-based support to follow a “go slow” or “save for a rainy day” approach to economic development. Rather, state officials, particularly, are likely to be under considerable pressure to eliminate infrastructural or institutional obstacles that may be slowing down the expansion of the booming sectors, driven by the promise of new and easy wealth. Furthermore, if the state is capturing a share of the boom’s rents through taxation, trade duties, or other measures, these burgeoning fiscal resources would attract considerable pressure from various other groups in society to have outstanding social and economic needs addressed, to say nothing of the opportunities created by these rents for improving the status and living standards of government officials and of workers. In such a milieu, state expenditures will probably do more to encourage further sectoral shifts in the economy toward the booming sector and the non-tradeable sector, deepening in the process the future vulnerability of the region to price shocks in their leading sector.

The ability of governments to pursue diversification policies during extractive resource booms is also constrained by the remoteness and “frontier” character of resource-rich locales. In remote areas, fewer economic alternatives will appear to be viable, even in an economy with radically different relative prices than one undergoing a boom. Moreover, the relatively low returns in almost any investment oriented toward longer-term diversification
into the production of tradeable goods will also make it harder to justify the expenditure when much more money can be made in the near term in the booming sectors. Concerned individuals or groups who may advocate economic diversification, pointing to the risks associated with sunk cost investments in the boom sector, are likely to earn reputations as “naysayers” and would be hard pressed to garner significant support for their initiatives.

The other problem with forging broad support for economic diversification lies in the limited stock that the population may put in collective social action. Where resource-rich regions are frontier regions, rugged individualism and fortune-seeking behavior among residents, most of whom have migrated recently to the region, are more likely than in areas with long-standing and durable community institutions and social ties. Forging collective responses in “boom town” environments to pursue diversification or savings for some distant “rainy day” will be difficult, especially given the economic and political forces that would tend to rise up against such efforts. The lure of immediate private fortunes, or at least higher returns, will hardly be outweighed by the vague promise of long-term “social well-being.” Moreover, the pursuit of such a longer-term goal would require a level of individual investment in social outcomes that is unlikely to be seen until the boom is over. Then, with the value of everyone’s sunk capital investments riding on alternatives or subsidies from external sources, collective action may become much more accepted as an appropriate response to a common predicament.

Sunk costs in extractive industries can thus evoke notably negative development outcomes at both industry and economy-wide levels. Such outcomes stand in stark contrast to the common expectations that follow from “free market thinking,” which rests on the presumption of the optimality of markets, where competition and factor mobility yield first-best welfare outcomes. In extractive industries, sunk costs are pervasive and act to undercut competition within the sector and factor mobility in the economy as a whole. For this reason, policies surrounding the development of extractive industries must fully incorporate the notion of sunk costs if outcomes are to coincide with basic efficiency and equity goals.

6. POLICY AND RESEARCH IMPLICATIONS FOR EX extrative Industries WITH SUNK COSTS

The broad policy implication of our conclusion – that sunk costs matter in extractive industries and thus the process of resource-based development – is
essentially straightforward. Regulatory mechanisms, institutional innovation, and other measures aimed at overcoming the negative development outcomes associated with sunk costs in extractive industries are needed to complement any such measures that may be delivered by private markets. For example, some combination of private and public institutional innovation may be needed to reduce the uncertainty that private investors confront in extractive industries with sunk costs if underinvestment is to be avoided. Similarly, at the economy-wide level, state policies may be needed to encourage both private and public agents to include the option value of flexible economic investments to avoid over-reliance on a currently lucrative activity with attendant high levels of sunk costs.

The real challenge for policy comes in the specific practice—that is, in designing appropriate policies that will not over-adjust or create even worse distortions. Our analysis suggests that the economic performance problems created by sunk costs cannot all be remedied by the same prescription. This type of challenge is common to a wide range of economic issues, where markets do not work efficiently because of market-level distortions (see Carter & Barham, 1996 on policy challenges of agro-export development models). In the case of sunk costs, even the task of identifying the presence or extent of sunk costs for a given activity is a challenging undertaking, one that cannot be simply completed by examining the physical properties of the invested capital, or by referring to a "once and for all" chart of sunk costs associated with different activities or stages of extraction. Sunk costs are both contingent and conjunctural; they can vary substantially over time, space, and even within a specific activity, depending on all of the various causes outlined in Section 3. To take the next analytical step, which involves assessing how the extent of sunk costs in a given extractive activity may influence industry and economy-wide outcomes, also represents a significant undertaking. Both tasks need to be completed before specific policy prescriptions can be identified.

The task of pursuing the effects of sunk costs on development outcomes promises to be challenging for at least four reasons. First, sunk cost measures are inherently dynamic (the reader will recall that estimating the salvage value of investments requires an assessment of possible future net revenue streams in current or alternative uses), and are therefore challenging to generate because they must rely on forecasts of contingent price and cost outcomes. Second, the effects of sunk costs on firm behavior and hence on industry organization and performance also are not static outcomes; consequently, the conceptualization and measurement of these outcomes also will be difficult. Third, because private and public agents may act
strategically to take advantage of the commitments offered by sunk costs or attempt to reduce the uncertainty that may hamper sunk investments, there is room for considerable agency and adjustments over time, which can in turn influence contingent price and cost outcomes in ways that subsequently affect the sunk cost measures. Fourth, attempts to relate features of an extractive industry and the attendant investment patterns that result in path dependence to the overall economic structure will represent a complex undertaking in many cases, especially in those cases where no single sector is “booming” and thus, in some sense, “overdetermining” outcomes in the regional economy. Given the magnitude of the challenges posed for ex ante analyses, we believe that more in-depth ex post empirical studies are much needed to advance our understanding of the nature and role of sunk costs.

Because of the prevalence of sunk costs in extractive industries, and the continuing importance of extractive industries to many resource-rich developing areas, research and policy directed toward improving development outcomes is a crucial and urgent task. No hyperbole about the “magic of markets” can finesse the efficiency and equity problems that sunk costs create in extractive activities. The sooner the importance of sunk costs is recognized, and the fact that they are geographically, historically, and socially constituted, the sooner economic analyses and policy proposals will approach a “real-world” economics of resource-based development. By getting on with the difficult task of understanding sunk costs, we advance the day when policy-makers can design and implement appropriate economic development policies to deal with their distortionary effects.

NOTES

1. There are a variety of strands to the sunk cost literature, and several terms are used including asset fixity, irreversible investment, rigid investments, and fixed capital, with sunk costs and irreversible investment being the two most common at present. Asset fixity is a terms used by some agricultural economists, as discussed in Chavas (1994).

2. Depreciation here is taken to reflect the physical life of the investment, taking into consideration normal wear and tear and periodic maintenance, and technological obsolescence that occurs as newer, more efficient vintages are introduced.

3. In particular, among lower and middle income families, most of their wealth investment is likely to be in their homes and the land surrounding that home. Even though the market value of that home may fall dramatically following the collapse of a one industry town, the consumption (and psychic) value provided by maintaining the home and the remaining local connections to family, friends, and community may help to explain why families will accept much lower returns to labor and capital
than they might be able to earn elsewhere. The sunk nature of the investment in housing and community is a fundamental component of this decision.

4. The moral hazard problem of not being able to observe the buyer’s use often prevents the seller from issuing a warranty or some other signal which guarantees quality. This "Market for Lemons effect" is often used to explain why the resale value of almost new equipment, such as a recently purchased automobile or truck, are often well below the purchase cost.

5. Although the site of processing has been a major issue for developing countries and academic analyses of the role of primary commodities in economic development, the ordering of these two stages is not a key issue in understanding the basic pervasiveness of sunk costs in extractive industries. That said, the desire to avoid the sunkness of a processing investment next to a mine, and the associated strategic and stochastic risks, may actually play a major role in the decisions of firms about where to locate the processing stage of the operation.

6. Barham et al. (1994) explore the limitations on resource nationalism in raw material industries, with primary emphasis on the international aluminum industry. The issue is explored in more general terms in the book’s epilogue.

7. The potential interaction between strategic behavior and uncertainty is not explored here, though they are potentially flip sides of the same coin and together could be quite influential in shaping industry organization and performance. The theoretical complications that may arise by combining these two microeconomic effects are quite complex (Bresnahan & Reiss, 1993 offer an early attack on this issue. More recently, this issue has been given attention in the industrial organization literature associated with deregulated electricity generation). These analyses require more analytical and numerical exploration than can be provided in this presentation.

8. Barham et al. (1994) offers a simple example that demonstrates this attribute of industries with sunk costs and uncertainty where participants make decisions in an atomized, competitive environment. Chavas (1994) and Dixit and Pyndick (1994) also demonstrate this outcome more formally.

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REFERENCES


Sunk Costs, Resource Extractive Industries


