Mineral exploitation – regional development in a historical perspective

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With falling costs of transport and communication, and with changes in the technology of mineral exploitation, there has been a tendency for mineral projects to become detached from the region in which they are located. Hence, the experiences of regional development brought about by turn-of-the-century mineral projects, have lost much of their relevance, as the twentieth century draws to a close. The major regional development impact of contemporary mineral projects in outlying areas is of a fiscal nature. Such an impact is dependent on the regional authorities' ability and power to retain some of the fiscal revenue for the region, but policies to attain this objective raise both political and economic problems.

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This paper attempts to answer two questions: (a) how does mineral exploitation contribute to economic development in the region where it is located? And (b) how has this development impact been altered over time, in consequence of falling transport costs and changing technology employed by the mineral industry?

The issue of regional development has not received much attention in the recent literature on mining and its contribution to economic progress. The "mineral enclave" analyses of the 1950s and 1960s including contributions by Baldwin (1966), Meier and Baldwin (1957), Myrdal (1956) and Seers (1959), amongst others, provide interesting insights about the development impact of mineral projects on the areas adjacent to the location of such projects. In more recent works, e.g. Bomsel (1990), Sideri and Johns (1980) or Tilton (1992), attention usually centres on the national benefit from mineral exploitation, and dwells at length on how that benefit could be increased. The regional consequences of mining and mineral processing are typically kept in the background.

Systematic analyses of the development implications, regional and national, following from ongoing technological change in mineral industry activities, are also rare. Most of the literature dealing with the contribution of mineral exploitation to economic development, has a strong focus on the present. Only seldom does it provide an historical perspective.

Since the issues under investigation have obtained only limited attention in the literature[1], the present paper has, by necessity, an exploratory character, and the conclusions must be regarded as tentative.

The first section discusses the nature of the development effects that mineral activities exert on the economic environment in which they are situated. The second examines the long-run changes in mining and mineral processing technology, to clarify why and how the regional development impact of mineral projects has changed over time. A final section identifies policies that would increase the regional development impact of mineral activities, and discusses their appropriateness.

Mineral projects and economic development

Mines and mineral processing plants have a variety of impacts on the economic development process. Some of these arise internally within the mineral firms, others consist of external economies and diseconomies[2].

The direct, internally generated contribution to development consists of the value added generated by the mineral venture. The value added is expended to compensate labour, capital and the entrepreneurial effort, or to satisfy the fiscal agents. A marginal mineral venture will provide no more than "normal" revenues to these parties. In a non-marginal project, a mineral rent will emerge, and will be shared by the above parties in proportions which depend on their respective bargaining positions.

A number of indirect or external development effects will also ensue. The discussion of these can be instructively organized around the concept of linkages[3].

The mineral venture will give rise to backward linkages through its requirements for inputs. The prospects for production of capital goods, supplies and services, needed for investments and operations, will be enhanced through the venture's demand for such inputs. The expanded demand for housing and food, resulting from the addition to employment and to the wage bill, will constitute an incentive for increased agricultural and construction activities.

The forward linkages of a mineral venture facilitate the setting-up of forward processing, refining and fabricating the crude ores and concentrates. This comes about by the ready availability of the raw material output. In mining, the forward linkage chain is much more extended than the backward linkages. The product from the mine commonly has to undergo several transformations before final consumption.

Hence, the forward linkages can have a very large impact on development, if they give rise to the establishment of downstream industrial activities.

A third type of linkage is related to the infrastructural facilities which form part of the mineral venture. Unless the project site is situated in an economically and industrially well-established area, a part of overall investments involves infrastructural installations. Only seldom can these facilities be reserved for the exclusive use of the mineral enterprise. Outsiders can commonly benefit from e.g. the power supply, road facilities and hospitals, that are an integral part of the mineral investment. Industrial or agricultural activities quite unrelated to the mineral venture can become economically feasible as a result of the availability of such infrastructural installations.

The mineral economics literature sometimes refers to the "fiscal linkage". In the present conceptual framework, however, fiscal revenue is seen as an integral part of the mineral activity, and not an external development effect.

The emergence of linkage effects provides an incentive to establish subsidiary activities, but does not automatically ensure that such activities will in fact be set up. The availability of unemployed factors of production, or the willingness of factors to move out of other occupations is an important precondition for subsidiary activities to emerge.

Three common negative external effects also have to be discussed. The first arises if the factors of production engaged by the mineral venture were already employed elsewhere in the economy. The negative development impact will equal the value added lost in the old activity when these factors move into their new occupation. The second negative external effect is commonly referred to as the Dutch disease (Neary and Van Wijnbergen 1986). It arises from the diffusion of the above-average wages that profitable mineral projects can usually afford to pay. The increase in wage levels in the surrounding area diminishes the competitiveness of all economic activities, and reduces the advantage of the linkages that emerged in the first place.

The third negative external effect is the environmental damage caused by mineral activities. This too, will weaken the developmental impact of linkages, by increasing the costs of subsidiary activities. The negative impact of environmental deterioration will not be limited to the subsidiary activities of the mineral venture, however. Independent activities like agriculture or fishery may be harmed, with a resultant reduction in output and employment. A deteriorating environment can in itself be regarded as a reduction in output - of the welfare-creating services or fresh air, clean water etc.

The above discussion of the development effects of mineral activities has had a general and unspecific character, insofar as space is concerned. The different consequences have been listed without any indication of the geographical area that is involved. This shortcoming is rectified in the following section.

Change of "technology": a 100-year perspective

This section begins by listing the major changes in the technology of mineral exploitation during the 20th century. Technology is defined in a broad sense. The changes so identified are then used to compare typical mineral projects at the turn of the century with those characterized by the technology of the 1980s, in terms of the geographical spread of their development impact.

Technological change

Eight major changes affecting the mode of production in the minerals industry during the course of this century are identified below. For completeness, they are separately listed, but several of them are strongly interdependent.

1. There has been a revolutionary reduction in transport costs for bulk materials. The following examples are all expressed in constant 1985 dollars. According to Bairoch (1965), the freight cost per ton of wheat between New York and Liverpool went down from 42.6 USD in 1900 to 18.6 USD in 1962. According to the World Bank (World Bank 1979, 1980, 1988 and 1990), the freight cost per ton of grain from North America to the Netherlands declined from 31 USD in 1955 to 12 USD in 1962 and 10 USD in 1988, while the cost of transporting one ton of sugar from Australia to the UK went down from 80 USD to 41 USD and 15 USD in the same years. The transport cost of petroleum from the Persian Gulf to Northern Europe shrank from 33.8 USD per ton in 1955 to 21 USD in 1962 and 5.5 USD in 1988 (Scandinavian Shipping Gazette 1988). These examples are fully applicable to bulk non-fuel mineral materials. Freight costs for manufactured products and for transport insurance have also experienced substantial declines (Bairoch 1975).

2. The efficient size of mineral ventures has increased over time. This has led to a substantial increase in the average size of operating units. Herfindahl (1959) and McMahon (1965) provide evidence of these trends for the early part of the century. Continued size increases in the period since the second world war are noted in Bosson and Varon (1977), and in Mining Magazine (1978 and 1981).

3. The minerals industry has grown more capital-intensive over time, both in absolute terms and in comparison with other sectors in the economy (Borenstein 1954; Manthy 1978; Mineral Policy Series MR 158,1976 and Radetzki 1980).

4. The combination of scale economies and capital intensity has greatly increased the investment capital requirements of the average individual project over time.

5. The inputs into contemporary mineral projects must satisfy very high technological standards. The management and organization of production, too, must be highly sophisticated for efficient operation. The supply of such high-quality physical inputs and managerial services is subject to important scale economies, and has consequently become quite concentrated. Condi-

tions were very different at the turn of the century, when the corresponding inputs were less sophisticated, and could be supplied economically from decentralized sources.

6. Over time, the minerals industry has become more environment intensive. This is partly related to scale, and the thresholds in terms of environmental damage, exceeded by the large units. New chemical methods brought into use in the course of the present century have increased the air and water pollution per unit of mineral output (for a review see UNEP 1984). Since the 1970s, the long-run trend towards greater environmental intensity appears to have been reversed, as a result of the environmental pressures in industrialized countries (Warhurst 1992). Nevertheless, the average end-of-the-century mineral ventures would appear to harm the environment far more per unit of output than the projects of 100 years ago.

7. The location of mineral projects has gradually become more marginal in relation to the major industrial centres and demographic agglomerations. At the turn of the century, the industrializing areas were still highly self-sufficient in minerals (Landes 1980). At that time, the typical mineral project was located in Europe, Japan or North America. Eighty years later, more than one half of overall mineral investments of the noncommunist world were located in developing countries (Radetzki 1981). Several factors explain this change. First, there has been a relative depletion of the rich mineral deposits located close to major consumption centres. Second, the far-away locations have become less disadvantageous on account of falling transport costs. And third, detrimental environmental impacts have increased the costs of mineral projects in densely populated areas.

8. Over time, national governments have tended to appropriate increasing shares of the surpluses generated by mineral activities. This has been a general consequence of public sector growth worldwide. The government share of the mineral surpluses leapt upwards in the 1960s and 1970s when newly independent developing country administrations asserted their rights by strongly increasing the fiscal impositions on the mineral companies in their territories (Radetzki 1981).

The enumerated changes, and in particular the falling transport costs, have integrated the geographically limited markets for most raw materials and manufactured products, typical of former times, into global ones. From a different angle, the changes reflect a move from societies heavily dependent on physical resources, implying a strong advantage from nearby location of such resources, into societies dependent on human capital, where location of physical resources matters less. An important ensuing consequence has been an overwhelming reduction of the development impact exerted by mineral ventures on the region where they are located. In essence, the changes imply that, over time, the development effects of mineral projects have been spread across ever wider geographical areas. Not only regions within countries, but even entire national economies have tended to lose increasing proportions of the developmental benefits generated by mineral activity.

Characteristics of turn-of-century mineral venture

The typical mineral project at the turn of the century was a relatively simple and not very large enterprise, commonly established to cater to the industrial demand of nearby communities. Its capital and entrepreneurial needs could ordinarily be satisfied within the region. Local labour was employed, and since the mineral sector was not exceedingly capital intensive, the employment effect was considerable. Under these circumstances, and with a relatively low level of national taxation, a high proportion of the value of output accrued to the local community.

The equipment needed to establish the project and the supplies required for operations could in large measure be procured in the area - either from industries which already existed, or from ones set up for the particular purpose of supplying the mineral venture. The reliance on local supplies was supported both by the high cost of transport, and by the relative simplicity of the required inputs. Hence, the local advantage of the backward linkages was strong.

Forward linkages, too, were reaped in considerable measure within a limited geographical region. In numerous cases the chain of causality was reversed. Thus, mines were commonly located in the neighbourhood of industrial centres precisely because there was a local market for the output. The high level of transport costs gave a strong competitive advantage to local processing of the product. For instance, the heavy costs of transporting coal and iron ore extracted in Western Pennsylvania was a key factor in attracting the iron and steel industries into this mining area (Spooner 1981). Given the small size of the mines in this period, only marginal quantities, if any at all, had to be sold to far-away consumers.

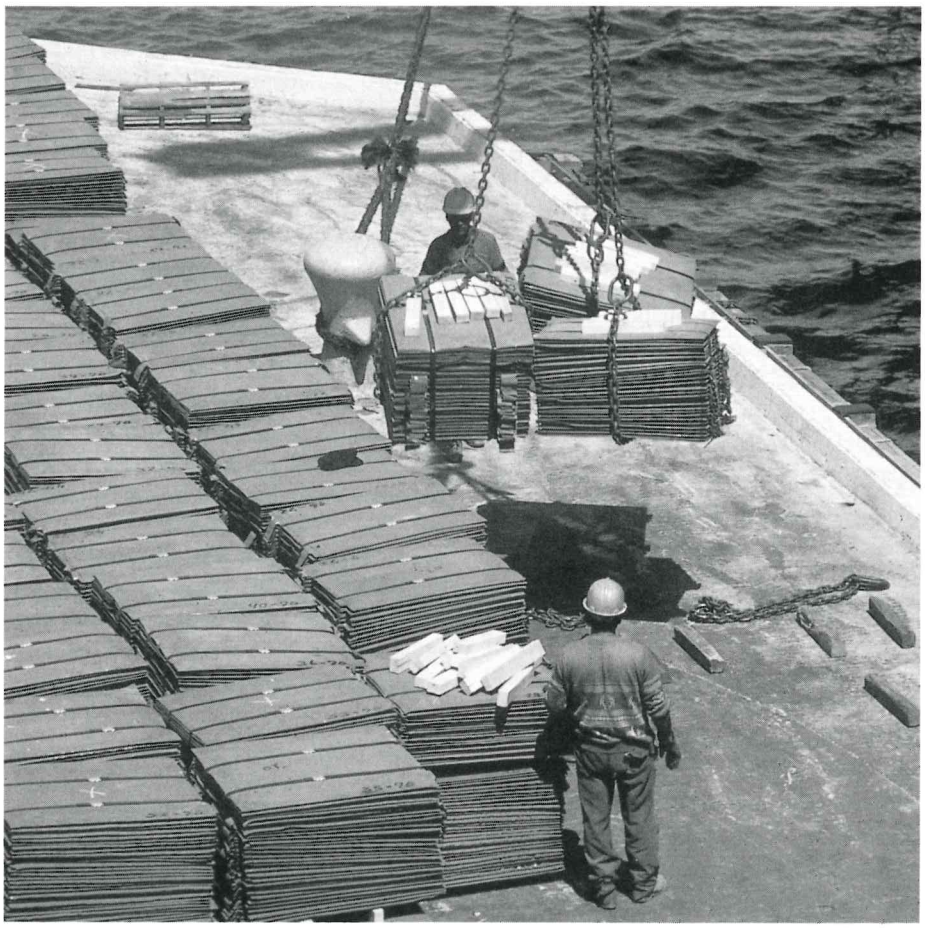
The symbiosis between the mineral ventures and other economic activities in a region frequently gave rise to virtuous circles. The initiative to establish a mine might have been prompted by the local mineral needs. Once established, the mine not only satisfied the existing mineral demand, but became, both through its supply of output and input requirements, a pole of regional industrial growth and diversification.

Contemporary mineral projects

Circumstances have changed considerably in the course of the 20th century. In the 1980s and 1990s, the typical mineral projects accounting for a major proportion of additions to current world supply are huge, complex and capital-intensive operation, frequently located far away from major population centres, dependent on key inputs from a few leading industrialized countries, and serving the entire world market.

The investment capital of such a project commonly runs into a billion dollars or

Copper cathodes ready for shipment, Chile.



more. Examples of more spectacular mineral development ventures in the most recent decade include the Carajas iron ore venture in Brazil, with investment costs of 4 000 MUSD and production start-up in 1986 and the Ok Tedi copper and gold project in Papua New Guinea, costing 900 MUSD and start-up in 1988 (Bomsel 1990); the El Cerrejon Norte coal mine in Colombia costing 3 000 MUSD, start-up in 1988 (Mining Annual Review 1990); the Olympic Dam copper and uranium project in Australia, costing 700 MUSD, start-up in 1989 (Mining Annual Review 1989); and the Escondida copper mine in Chile, with total investment costs of 1 000 MUSD billion and production start-up in 1991 (Mining Annual Review 1991). Such sums are completely out of reach of local financial institutions. The compilation of financial packages for such projects invariably requires a global approach.

As a consequence of these characteristics of modern mineral projects, most of the returns to capital and to entrepreneurship flow not only out of the region, but often out of the country as well. A large part of the surplus generated by contemporary mineral ventures is appropriated as fiscal levies by the national government, and redistributed throughout the nation. Remuneration of local labour is the major positive direct development impact that accrues to the region.

Even though the mineral industries can commonly afford high wages, the local wage bill is restricted by the need to bring in skilled personnel from outside, and by the capital-intensive methods of production. Data contained in the annual reports of mineral companies suggest total labour compensation at 10-15 per cent of turnover. The local wage costs in far-away projects would be considerably lower.

The regional linkages, both backward and forward, of large-scale modern mineral projects are weak. One general factor explaining this weakness is the decline in transport costs. Another is that with increasing capital intensities, mineral projects can easily afford high wages, while the movement to peripheral locations results in a more pronounced wage leadership role for the firm. The typical result is a considerable increment in the regional wage level. Both factors weaken the project's linkages by reducing the comparative advantage of nearby production activities. However, other factors are also at work.

As noted, the entrepreneurial and technical expertise required to develop and run such projects is highly specific and not often available outside the multinational mining firms. The equipment needed to develop a mineral venture and the supplies required for its operation are highly specialized and sophisticated. Potential local suppliers, if any exist, can seldom compete with the established international manufacturers of such products. Hence, most physical inputs are obtained from outside the region. The same is true for the housing and consumption requirements of the labour force. Residential dwellings are constructed from prefabricated elements brought in from far away, and even a large part of the food is frequently imported from outside the region.

A similar pattern applies to the output of the mineral venture. Large mining projects regularly have the entire world as their market. Processing of the mineral typically takes place close to the mine only in instances where there is a substantial weight reduction and an ensuing saving in transport costs.

In summary, the regional development effects of large contemporary mineral projects consist of the local employment that they create; of the stimulation of local ac-

tivities; and of that share of the fiscal revenue obtained from the mineral sector that the central government returns to the region. However, the employment effects will be limited, the stimulation through backward and forward linkages weak, and the government spending only a fraction of what was extracted as fiscal dues in the first place. Hence, most of the development effects resulting from a modern large-scale mineral venture will commonly be reaped outside the region where it is located. In contrast, the environmental damage caused by mineral projects, continues to be heavily concentrated in their immediate vicinity.

The comparison presented above has been between a mineral project at the turn of the century, located in an industrial country like France, Sweden or the USA, and a large-scale mineral project of the 1980s, in an unindustrialized area, on the other. This comparison has a twofold rationale. First, the two types of mineral projects appear typical of their respective time periods. And second, the comparison helps to clarify the limited relevance of the old experiences of minerals industries for assessing the development effects of modern mineral projects.

It should be clear that other comparisons might lead to different conclusions. For instance, a comparison of mineral projects in developing countries might reveal that the regional development impact has increased over time. In isolated enclave circumstances characteristic of the 1950s and before, most of the surplus from such projects disappeared abroad. In recent years much of it has been reaped as fiscal revenue by the national government, which spends at least a part of it in the mineral producing region.

Conclusions and suggested policies

The above analysis has pointed to the stark change in the regional development impact of mineral resource ventures over time. At the turn of the century, mineral projects commonly provided a substantial boost to the economic development of the area where they were situated. In contemporary circumstances, the development impact tends to be dissipated world-wide. This is true both of new, modern projects, and of old ones, for the latter have had to assume the latest technologies in order to survive.

The large benefits lost by the mineral region provide an explanation of the demands for secession made by, for instance, Shaba in Zaire, Bougainville in Papua New Guinea, Biafra in Nigeria, Scotland in the UK, and most recently by the oil producing areas of Russia. Sovereignty for the resource-rich region is seen as a measure to keep the benefits otherwise dissipated throughout the nation within the regional boundaries.

A concomitant conclusion is that there is little relevance in using the old development experiences of mining regions, to assess what can be expected in areas of contemporary mineral expansion. In the absence of very forceful policy directives, the new mining regions are unlikely to succeeded in building up a diversified economic structure similar to those which exist in many areas of old mineral exploitation.

The appropriateness of energetic regional development policies financed by a diversion of the mineral revenue, will clearly depend on the nature of the region where mineral exploitation takes place. If the mineral area is situated in an uncomfortable and formerly uninhabited environment - for instance in the desert or arctic zone (uranium mining in Niger's part of the Sahara desert, and gas production on the Yamal Peninsula in Northern Siberia provide examples) - the rational policy may be to accept from the beginning that the social costs of a diversified regional development effort are too high and to adjust the mineral venture to the fact that the area will be deserted once the resources have been exhausted. The rationale for special policies to promote regional development is stronger in areas such as Amazonia in Brazil and Lappland in Sweden, where population agglomerations and agricultural or industrial activities (or at least the potential for such activities) already exist.

Development policies for mineral-rich regions can take a variety of forms. One natural direction for such a policy would consist of measures to strengthen the regional linkage effects of the mineral ventures. Thus, the mineral company can be required to expand those of its activities which have an especially important positive external impact on the surrounding geographical area. Vocational training and the establishment of a widespread electricity grid are two pertinent examples. Alternatively, the mineral company could be obliged to expand its local procurements. For instance, imported food, could be replaced by local produce. The company could also be asked to start its own local manufacture of some inputs, or to support the establishment of independent local producers of such inputs. Where there is little former industrial tradition, the criteria for selecting the products for local manufacture would commonly comprise relatively simplicity of production technology and limited economies of scale. Steel balls for milling the ore and assembly of explosives and detonators fit these criteria. The purpose and end result of the requirements for local production would be an increase in regional value added. It may be noted that this is akin to the frequent requirements of government administrations in many developing and industrialized countries, that the national content of industrial output, especially in plants owned by foreign investors, be high and rising.

A second approach to promoting regional development in marginal areas with important mineral exploitation would involve capturing a larger share of the fiscal revenue from the mineral sector. For instance, regional authorities could impose a local tax over and above that taken by the national government. Alternatively, a larger share of the central government's receipts from the mineral activity could be ear-marked for the region from which they originate. The additional fiscal revenue so

captured could then be used to promote non-mineral industrial projects. Various arguments can be advanced to justify a fiscal reallocation of this kind. For instance, the additional regional revenue could be seen as a compensation for the depletion of natural wealth, or for the environmental damage caused by the resource exploitation activity.

Three problems are bound to emerge in the formulation of regional development policies as outlined here. The first is that the imposition of enforced regional linkages may hamper the efficient operation of mineral enterprises. Mineral investments will be discouraged in consequence. The second is that competing fiscal claims between regional and national authorities may have detrimental effects on the subjects who carry the burden. In the 1970s, many mineral ventures in British Columbia, a province of Canada, came close to bankruptcy, because of the imposition of heavy provincial taxes, without consideration of the national fiscal dues. The third problem concerns the distribution of fiscal revenues between the region of mineral exploitation and other regions of the country. The national government will typically face a quandary: discontent and threats of secession if too little of the mineral revenue is returned to the region it originates from; and the possibility of widening regional income disparities if the resource-rich area is allowed to keep a disproportionate share of large tax incomes derived from mineral exploitation. These problems require careful consideration before a regional development policy is launched.

The historical perspective offered in this paper should broaden the vista of policy makers and mineral investors, and provide them with a better understanding of the regional dilemmas posed by modern mineral projects.

Notes

[1] However, see Radetzki 1982, from which the present paper derives much of its inspiration.

[2] For a general classification of external economies see Scitovsky 1954.

[3] This concept was first used in a systematic way by Hirschman 1958.

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