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Labor productivity, costs, and mine survival during a recession☆

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Abstract

The ability of a mine to survive cyclical downturns depends, according to economic theory, largely on its variable production costs. Since labor accounts for a sizeable share of the variable costs of mining, a mine that enters a recession with relatively high labor productivity and that manages during the recession to raise its labor productivity should be more likely than other mines to avoid cutbacks and closure.

The US copper industry over the 1975–90 period provides empirical support for this expectation. But surprisingly, it also suggests that mine survival depends (a) more on labor productivity than variable costs, and (b) more on the ability of a mine to increase its labor productivity once in a recession than on a high level of labor productivity at the start of a recession. An important factor affecting the extent to which mines increase labor productivity once in a recession is the life expectancy of their reserves.

Keywords: Copper mining industry; Labor productivity; Competitiveness

In 1975 the world copper mining industry fell into a deep recession that persisted for over a decade. As shown in Fig. 1, the average annual copper price on the LME (London Metal Exchange) in 1997 dollars dropped to 1.49 dollars a pound in 1975 from 2.72 dollars the previous year. It then stayed at this relatively depressed level for the next several years. After a modest increase at the end of the 1970s, it plunged to new lows. By 1986, the bottom of the decline, the real price of copper was nearly 70% below the 1974 high. During the latter half of the 1980s, the price of copper recovered, and by 1990 was at roughly the same level in real terms as in 1975.

The United States with many of the world's marginal copper mines was particularly hard hit by this severe downturn in the global copper market. Profits fell sharply, and by the early 1980s nearly all US mines were losing money. Many were not even recovering their variable costs of production. The US industry petitioned the government for protection against imports in 1978 and then again in 1984. On both occasions its request was denied.

Nevertheless, the US industry did survive. As described elsewhere (Tilton and Landsberg, 1999), the industry greatly reduced its costs and increased its labor productivity. As a result, when the price recovered in the late 1980s, it once again was profitable. Chile, it is true, had become the world's largest copper mining country, a distinction the United States had held since the beginning of the century. Still, the US industry accounted for 22% of Western world copper production in 1990, and its output was above its 1970 level and considerably above its 1975 level.

Aggregate figures, however, paint an incomplete and somewhat misleading picture. Not all the US copper industry survived to enjoy the market recovery and the price increases during the latter half of the 1980s. As Table 1 shows, some 24 US mines produced 10,000 t or more of copper in concentrate in 1975. By 1990, five of these mines had ceased production completely, and another six were producing very modest tonnages (under 4000 t). The other 13 mines remained important producers—three had cut back their output (from 2 to 29%), while ten had expanded their production (from 4 to 590%).

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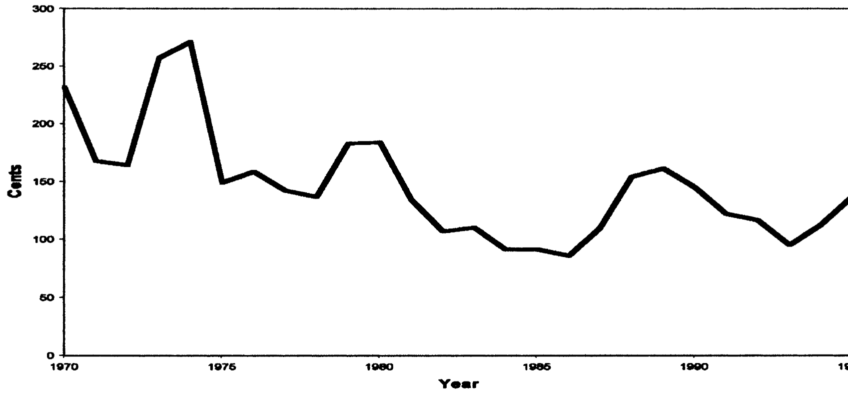

Fig. 1. Average annual LME copper price in real (1997) US cents per pound, 1970–95. Source: US Geological Survey.

Why did 13 mines manage to survive—a number even to grow—over the 1975–90 period, while others failed? Here we focus on the contribution of labor productivity in answering this question. The next section considers why we expect labor productivity to affect a mine's ability to survive a recession. The third section then examines empirically the relationship between labor productivity and changes in mine output over the 1975–1990 period. The fourth section turns to production costs, presumably the critical link between productivity and output. The fifth section focuses on the role of reserves and mine size in explaining why some mines greatly improved their productivity (and in turn their prospects for survival) while others did not. Finally, the sixth section highlights the major findings and examines a few of their implications.

Labor productivity and survival: theory

According to conventional economic theory, a profit maximizing or net-present-value maximizing firm without any market power should remain in operation as long as the market price remains at or above its average variable costs of production.[2] Variable costs cover all those expenses that rise and fall in the short run with output, in contrast to fixed costs associated with buildings, equipment, and other long-run investments.

This means that a copper mine should remain in operation as long as the price of copper equals or exceeds its variable costs. In the real world, of course, a mine may deviate from this expected behavior as a result of government pressures or incentives, shut down and start up costs, management's expectations about future price movements, and other discrepancies from the simplifying assumptions of economic theory. Still, as the price of copper falls during a recession, we normally expect those mines with relatively high variable costs to shut down before mines with low costs.

Conventional economic theory is the basis of comparative cost analysis, a technique widely used by mining companies, consulting firms, and government agencies to construct short-run supply curves for metal and other mineral commodities.[3] The analysis entails estimating average variable costs of production and capacities for individual mines, and then ordering or ranking mines according to their variable costs. It normally assumes a mine will close whenever price falls below its variable costs, and then reopen when price rises back to or above its variable costs, though in some cases closure costs and other considerations that may cause mines to deviate somewhat from the predicted behavior are taken into account. While most comparative cost studies are proprietary, some are available to the public (see, for example, US Bureau of Mines, 1987; Torries 1988, 1995).

Comparative cost analysis is used to assess the competitiveness of undeveloped mineral deposits and the survivability of existing operating mines. Like conventional economic theory, it assumes that the costs of the marginal producer, whose output is needed to satisfy prevailing demand, determines the market price.

Experienced analysts of the metal industries, however, have for some time noted that the cause-and-effect relationship between costs and price is not just one-way

[2] Where mining firms exploit a fixed stock of mineral resources, variable costs should include user costs, that is the net present value of the profits lost in the future as a result of producing one more unit of output this period, rather than saving the nonrenewable resource required for that unit of output for use in the future (Hotelling, 1931). In the copper industry, however, there is little to suggest user costs are positive, or that firms consider them in determining their copper output. As a result, they are not considered further here.

[3] Comparative cost analysis can also estimate intermediate to long run supply curves. This, however, requires estimates of average total costs for both existing mines and known but undeveloped mineral deposits. Moreover, the resulting supply curve is not truly long run, since it cannot take into account the future discovery of new deposits or the effects on costs of new technological developments.