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Exit Barriers in the Steel Industry

by Mary E. Deily

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Introduction

The U.S. steel industry seems perennially afflicted with overcapacity Even after numerous plant closings, and despite recent high capacity-utilization rates, analysts suggest that another 15 to 20 percent of current capacity should close. Why has overcapacity been a chronic ailment of steel firms during the 1970s and 1980s? Why haven't firms closed plants more quickly since continued operation of these plants depresses profits for the entire industry?

The persistent survival of excess capacity is not inexplicable. In theory, a market system reallocates resources from activities yielding lower-than-normal returns to activities with higher returns. In practice, however, firms can be locked into a low-profit activity if large losses are incurred when capital is transferred to new activities. These potential losses form an exit barrier, delaying plant closings, depressing profits, and prolonging adjustment for the entire industry[1]

The primary purpose of this paper is to examine the nature and size of exit barriers in the steel industry First, the necessity for contraction in this industry is summarized. Then basic exit theory is reviewed, and several types of exit barriers that seem most pertinent to the steel industry are described. The potential size of these barriers in the steel industry is assessed. Finally, the possible effects of current trade-protection and pension-insurance policies on the size of exit barriers in the steel industry are discussed.

This paper argues that high exit barriers have significantly slowed the industry's contraction by delaying plant closings. These barriers explain why capacity has fallen slowly even though industry profits have been subnormal since the late 1950s. They also help to explain why the industry failed to modernize some plants, even though these increasingly inefficient plants continued to operate into the 1980s.

I. The Necessity for Contraction

The U.S. steel industry has performed poorly during the last 25 years. Profits for the industry have been low compared to the average manufacturing return in virtually every year since

1 The term "exit barrier" is perhaps unfortunate, as it carries the connotations of inefficiency attached to the phrase "entry barrier." Such is not the case: exit barriers are the various cost conditions that make lengthy exit a rational response by firms.

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1958.[2] And despite the industry's recent buoyant performance—part of which appears to be due to trade protection—long-run trends in steel demand and steel supply point to continued low profits in the future.

Structural changes in steel demand have greatly reduced the growth of the market. These changes, which include increased use of steel substitutes such as aluminum and plastic, and reductions in the amount of steel used in consumer durables, particularly cars, have reduced the U.S. economy's need for steel. The average annual growth rate of U.S. apparent steel consumption has fallen from from 4.1 percent during 1960-1969, to 1.9 percent during 1970-1979, to 0.2 percent during 1980-1986.

Not all steel firms have fared the same, however. The industry basically consists of two parts: integrated mills and minimills. The integrated mills, which produce steel from iron ore, are the traditional steel industry, while the minimills, which produce steel products by recycling steel scrap, are relative newcomers. It is the integrated portion of the industry that has performed so poorly; minimills have flourished, increasing their market share from about 3 percent in 1960 to 18 percent in 1985.

As their name suggests, minimills produce steel on a much smaller scale than integrated plants, reducing the size of the required capital commitment considerably3 The mills also benefit from employing workers at lower wages. Though their costs are extremely sensitive to the price of scrap, minimills have become very competitive in the product lines in which they specialize, drastically reducing the integrated mills' sales in these markets.[4]

In addition, integrated firms in the U.S. faced tough new competition from imports for a share of the market, as fundamental changes in input costs during the 1950s and 1960s altered the comparative advantage in steelmaking. Two studies, by Crandall (1981) and by Kawahito (1972), examine the changes in the relative cost of materials in the U.S. compared to other countries, particularly Japan. Formerly, abundant supplies of coal and iron ore assured U.S. producers of a materials cost advantage that, along with greater U.S. productivity, more than compensated for higher U.S. wage rates. However, the discovery of rich iron-ore sources in several parts of the world and the decreased cost of ocean shipping began to reduce the traditional U.S. advantage.

Also, as Barnett and Schorsch (1983) point out, countries like Japan experienced phenomenal growth in steel consumption after World War II. Their steel industries were able to build entirely new, large-scale plants, since their rapidly expanding markets could easily absorb the output of the additional capacity These new plants incorporated the latest technology into an optimal plant layout, resulting in high productivity growth. Increased productivity growth, combined with lower wage rates, reduced the unit cost of labor further below U.S. levels. This advantage, added to the favorable changes in materials costs, made foreign steel very competitive with U.S. integrated production.5

The result has been a decline in the market share of integrated steel firms in the U.S. from more than 90 percent in 1960 to less than 65 percent in the 1980s. Given the slow growth of the market, these figures translated into a need to cut integrated steel capacity by closing plants. And, in fact, the industry has closed plants. From its height in the early 1970s of approximately 155 million tons, annual raw steel capacity has fallen to about 112 million tons.

But the contraction of the industry has taken a long time, even though capital has been earning subnormal profits for many years.[6] Rather than moving into other activities, firms appear to be clinging tenaciously to capacity by nursing along aging plants, as if the growth in demand for steel might miraculously increase to pre-1970 levels. But as the discussion in the next section shows, this response may well be optimal for firms facing high exit barriers.

■ **2** See Crandall (1981), p. 29, for the rate of return on equity after taxes in steel versus all U.S. manufacturing for the years 1954-1978. See U.S. Department of Commerce, Bureau of the Census, Quarterly Financial Reports for Manufacturing Corporations, various issues, for subsequent years.

■ 3-Minimills typically consist of an electric steel furnace, a continuous billet caster, and some kind of finishing mill, usually for bars. See Miller (1984) for a good description of this technology.

■ **4** Minimills have a cost advantage over all integrated mills, whether domestic or foreign, in the products they can produce. See Barnett and Crandall (1986) for a detailed comparison of minimill to integrated mill production costs.

■ **5** In fact, Crandall (1981) concludes that a totally new integrated plant would be a poor investment in the United States, given his estimates of the possible reductions in labor and energy savings attainable.

■ **6** The first major plant closings, those of Youngstown Sheet & Tube and the United States Steel Corporation at Youngstown, did not occur until the late 1970s, and the next episode did not occur until 1982. In addition, because capacity is usually measured as the ability to produce raw steel, estimates of capacity reductions may be somewhat overstated. The introduction of continuous casters has increased the yield from raw steel by 10 to 15 percent.

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II. A Model of the Plant Closing Decision

The neoclassical prediction for a competitive industry facing an inward-shifting demand curve is that high-cost plants will exit, leaving the lowest-cost plants to produce in the long run. However, as long as variable costs are covered, a firm will continue to operate an exiting plant that has fixed costs, since doing so minimizes the firm's losses.[7] During this period the firm will not make any major reinvestments; instead, it will disinvest from the capital in place.

Because most production processes do involve fixed costs, the decision to close a plant usually will involve a period of operation and disinvestment before shutdown. The optimal closing point will not occur until the net revenue, which is the return to continued operation of the capital in place, equals the return that could be earned on the salvage value. Thus, the speed with which a firm closes a plant depends on how quickly net revenues decline and on the amount of capital that can be salvaged once the plant is shut down.

Clearly, one important factor that will affect the timing of plant closings is the general level of economic activity When sales decline during recessions, they increase the probability of plant closings by reducing net revenues. This is especially true for a cyclical industry like steel.

Other factors are also important, however. Since the firm will not replace the aging capital with new equipment, one determinant of a plant's net revenues is the amount of maintenance the capital in place requires in order to operate (in other words, its durability). The firm will continue to bear maintenance expenditures as long as the capital generates enough revenue to cover both the additional expense and other variable costs. Obviously, the larger the maintenance expenditures, the more they reduce net revenues, and the less likely they will be worth making.[8]

A low salvage value may also delay a plant's closing. The salvage value is the net amount of money the firm will realize when the plant closes. A large positive value means that much of the capital can be extracted without loss from the plant, thus shortening the time to shutdown. A negative value extends the time before exit, causing the plant to be operated even though total variable costs are not covered. In this situation, the firm would actually borrow to pay the uncovered variable costs in order to avoid the greater loss of closing.[9]

In general, the salvage value is determined by a plant's resale value minus costs incurred during closing. The resale value of the capital depends on its specificity to the production process and on output growth in the industry The closing costs include the resources necessary to gather the information to make the closing decision and the time spent planning and executing it. The firm may also face employee-related closing expenses, such as severance pay, early retirement pay, and pensions, depending on previous contractual agreements or on local plant-closing legislation. Increases in these costs, by raising closing costs, will delay shutdowns.[10]

Thus, in a contracting industry with durable and specific capital and high closing costs, firms will delay closing plants. The plants exit eventually, but only after a long period of disinvestment. The result of selective and drawn-out disinvestment is a gradual increase in the average age of the industry's capital stock and a slowing of productivity growth.

Two things are vital to remember, however. First, in an industry with high exit barriers, a slow decline is the optimal rate of closure, despite years of poor earnings by the industry Resources are always being utilized in their highest return activity during a contraction. Second, although an industry may appear to be failing because of lack of reinvestment, the antiquated plants are the result of exit barriers' prolonging exit and are not the cause of the industry's decline. While some plants will be modernized, those that are exiting will receive little investment.

In sum, an important consequence of allowing the market to reallocate resources from an industry with high exit barriers is that capacity will contract slowly, with old capacity lingering on and plants closing in bunches during downturns that lower revenues.

7 In this context, fixed costs refer to costs that must be paid whether the plant is open or closed.

8 See Lamfalussy (1961) for a discussion of these issues.

9 The cost of going bankrupt, instead of continuing to pay uncovered variable costs, would be an upward bound on the amount the firm would be willing to borrow in this situation.

10 This conclusion depends on the simplifying assumption made here that closing costs do not increase over time. As pointed out by Littman and Lee (1983), if employee-related closing costs rise quickly with the seniority of the work force, then a firm might accelerate closing to avoid the greater future liability.

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III. The Size of Exit Barriers in the Steel Industry

Clearly, the magnitude of exit barriers in an industry depends on three factors: how long gross revenues are expected to cover variable costs, how specific and durable the capital is, and how high closing costs are.[11] This section presents some information about these factors in the steel industry which suggests that exit barriers are large.

TABLE 1

	1976	1986
Total Variable Cost of Raw Steel Materials, Energy and Labor (per net ton)	$217.00	$206.00
Total Variable Cost of Finished Steel Materials, Energy, and Labor (per net ton of finished product)	310.28	348.00
Total Cost of Finished Steel (per net ton of finished product)	361.38"	449.00

a. The number cited here is slightly lower than the figure reported by the Council on Wage and Price Stability, but is calculated as they describe in the text.

SOURCES: U.S. Council on Wage and Price Stability (1977), p. 60; Wharton Econometrics (1987), p. 4.5.

A rough idea of the likelihood that gross revenues will cover variable costs—the costs of all variable inputs to production—can be obtained by comparing the average variable cost of a ton of steel to the prices of various steel products. This cost is conventionally measured as the sum of labor, energy, and materials. The U.S. Council on Wage and Price Stability calculated that the average total variable cost per net finished ton of steel in 1976 was $310.28. Wharton Econometrics estimated that this cost equaled $348.00 in 1986. These estimates include the cost of producing raw steel, as well as the average industry cost of finishing it. Both of these studies also include estimates of the financing costs of steel production, taken here to be the average fixed cost of production (see table 1).

Table 2 compares estimates of average variable cost and average total cost for selected steel products to the average realized price per net ton of those products in 1976 and in 1986. In most cases, product prices were above the average variable cost. On the other hand, almost all of these prices were well below the total cost of finished steel. (Product prices do vary cyclically, causing the size of this shortfall to change over time. See table 3.) Overall, the data indicate that product prices may fall considerably below the average total cost without making immediate shutdown a firm's loss-minimizing alternative.

How long does a plant that is not covering total cost continue to operate? As stated above, unless prices dip or variable costs rise unexpectedly, a plant's closing would depend on the durability of its capital, on its resale value, and on the amount of closing costs.

Of these three, the high cost of closing appears to be the most important exit barrier currently in the steel industry When closing a plant, a firm records a charge for the costs of dismantling the mill, for the operating loss until closing, for losses involved with contract terminations, and for a write-down of the assets. It also records the estimated liability for current and future payments to employees for pensions and insurance benefits.

The payments due to the work force when an integrated steel plant closes are substantial. For instance, by the provisions of a typical labor contract, qualified union members on layoff because of a permanent closing are eligible for severance pay, supplemental unemployment benefits, pension payments and, in some cases, supplemental pension payments.[12] Severance pay for union members with at least three years of seniority equals four to eight weeks' wages, depending on their years of service. A firm continues to pay life- and medical-insurance premiums for six to 12 months for workers with at least two years of continuous service. Workers may also be entitled to supplemental unemployment payments for up to two years.

One of the largest parts of the employee-related closing costs is the estimated liability for future pension payments. Of course, the portion of closing costs represented by the pension liability is not caused by closing, since the firm

■ 11 See Caves and Porter (1976) and Porter (1976) for an exhaustive list of various possible exit barriers. The types of barriers discussed here are those that seem particularly pertinent to the steel industry.

■ 12 The contract described here became effective in 1980. Terms of contracts made in later years appear to be quite similar.

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owes retiring workers their pensions if the plant stays open. Nor are all of these charges out-of-pocket expenses. But they do represent payments that the firm must fund from some new source, since the cash flow from the plant will cease. This places an increased burden on a firm's remaining mills.[13]

TABLE 2

1976

	Average Variable Cost	Average Realized Price	Average Total Cost
Hot-Rolled Sheets	*$282.30*	*$229.43*	*$333.40*
Cold-Rolled Sheets	*328.94*	*288.43*	*380.04*
Hot-Dipped, Galvanized Sheets and Strip	*356.92*	*368.59*	*408.02*
Hot-Rolled Bars	*286.96*	*311.14*	*338.06*
Structurals	*272.97*	*358.94*	*324.07*

1986

	Average Variable Cost	Average Realized Price	Average Total Cost
Hot-Rolled Sheets	*$305.00*	*$273.04*	*$406.00*
Cold-Rolled Sheets	*376.00*	*418.21*	*477.00*
Hot-Dipped, Galvanized Sheets and Strip	*419.00*	*537.93*	*520.00*
Hot-Rolled Bars	*313.00*	*360.03*	*414.00*
Structurals	*291.00*	*321.57*	*392.00*

Note: The cost data from table 1 were adjusted for variation in finishing costs among products using data from Wharton Econometrics (1987), p. 4.7. Estimates are industry averages; costs are bound to be higher in exiting plants.

SOURCE: Bureau of the Census, *Current Industrial Reports: Steel Mill Products,* various issues.

In addition, because of the terms of pension agreements in this industry, the pension payments are actually higher if workers retire from a closing plant rather than from an operating mill. Under normal circumstances, union members are eligible for pensions after *30* years of service, or at age *65* (with *10* years of service), or at age *60* (with *15* years of service). But for workers laid off by plant closings, the eligibility requirements are eased. For instance, workers over *55*, whose age plus years of service equal at least *70*, become eligible. Also, some workers receive supplemental pension payments of *$400* per month until they reach age *62*, if they are laid off by a shutdown.

By the terms of this typical labor contract, it is clear that the size of the payments depends crucially on the age of workers and on their years of service. A firm might be able to reduce the work force somewhat by attrition before closing a plant, but under a seniority system, the remaining workers would tend to be older, with more years of service, which would drive up closing costs.[14]

These claims raise the cost of closing steel facilities enormously In *1979*, the United States Steel Corporation shut down a variety of mills and parts of mills, laying off more than *11,000* workers. According to the company's annual reports, the total cost of the closings was approximately *$650* million, of which about *$415* million represented labor-related expenses, implying a cost per worker of more than *$37,000*. Bethlehem Steel reported similar figures in its annual report, recording a *$700* million liability in *1982* when about *18,000* workers were laid off during a restructuring that dealt principally with steel facilities.

More recent estimates show that these costs may be higher. One study indicates that the total cost per employee of closing a mill is *$75,000*, of which *$54,000* represents employee-related closing costs (Wharton Econometrics [1987]). Using these figures, the Bethlehem Steel restructuring would currently cost *$1.35* billion.

Firms cannot depend on high resale values to cover the large closing costs. The capital is quite specific to the industry and is of little value for any purpose other than steelmaking. Nor are other steel firms particularly interested in buying these plants; most integrated firms are reducing their capacity, and minimills are building new plants. Furthermore, the equipment in a closed plant is usually in need of major investment, since the former owner has disinvested from it before closing.[15]

13 The problem is similar to that of Social Security when future generations are smaller. While in 1977 there were 2.3 workers for each retiree, currently there are two retirees for every steelworker.

14 It is difficult to evaluate how these employee-related costs change over time. The severance payment formula does not appear highly sensitive to the seniority profile of the plant: the maximum severance payment is earned by workers with 10 years of experience. The supplemental pension payment is more complicated. The liability would increase if the number of qualifying workers rose over time (workers qualify if their combined age and years of service is over a certain minimum), and would fall if the number of qualifying workers fell over time (workers receive the payment only until age 62).

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TABLE 3

Year	Hot-Rolled Sheets	Cold-Rolled Sheets	Hot-Dipped Galvanized Sheets & Strip	Hot-Rolled Bars	Structurals
1976	$229.43	$288.43	$368.59	$311.14	$284.46
1977	254.15	320.51	392.72	337.23	293.41
1978	281.10	354.31	430.35	364.26	326.98
1979	314.87	388.78	468.76	403.38	372.02
1980	317.30	395.42	487.64	415.90	408.03
1981	350.12	436.77	532.31	445.83	428.82
1982	338.79	433.87	525.84	414.94	421.90
1983	325.53	437.93	525.87	387.38	362.64
1984	326.01	453.18	560.16	393.49	358.52
1985	310.35	437.97	536.75	366.89	332.57
1986	273.04	418.21	537.93	360.03	321.57

SOURCE: Bureau of the Census, ***Current Industrial Reports: Steel Mill Products,*** various issues.

During the industry's contraction, there have been few examples of closing plants sold for continued operation as integrated steel mills. (One notable exception is the plant in Weirton, West Virginia. The employees purchased this mill from National Steel and have continued integrated production.) When sales do take place, the purchasers are generally interested in the rolling and finishing facilities, and keep steel furnaces closed. For instance, California Steel now imports semifinished steel for finishing at a (formerly integrated) plant in Fontana, which it purchased from Kaiser Steel.[16]

There are few opportunities to sell individual pieces of equipment. One company reportedly auctioned off some equipment when it went bankrupt, and some used equipment has been sold abroad, but no steelmaking operations have been sold for movement. Inventories of raw materials and parts can be distributed to other plants, but beyond that, the equipment is likely to sit until the price of steel scrap rises enough to pay the junk dealer for dismantling it.

The last exit barrier, the durability of steel industry capital, also works to delay plant closings by allowing the continued operation of aging equipment without major reinvestment. Furnaces and mills are depreciated over *15* to *20* years, but may operate for longer. For example, table *4* indicates that the ***average*** ages of various pieces of capital were more than *10* years in *1979*, and that a significant percentage of the equipment had been operated for more than *20* years.

Of course, operation of the equipment still involves noncapitalized maintenance and repair expenditures. In addition, the blast furnaces, which provide the flow of hot metal to the steel furnaces in an integrated plant, require periodic relining. Blast furnaces basically operate on a continual basis for two to eight years, depending on their rate of utilization. But eventually the refractory material that prevents the hot metal from destroying the furnace must be replaced. Figures cited for a somewhat short-term repair process, called gunning, range from *$14* million to *$18* million. Actual replacement of refractories may cost anywhere from *$20* million to *$100* million, depending on the extent of the replacemenr and furnace rebuilding, though on average the cost will probably fall into the *$20* million to *$50* million range.

Frequently, firms will postpone a reline and leave the blast furnace idle, provided they have another operating furnace. But there are some limits to their ability to escape both operating losses and closing costs by idling entire plants. For instance, after being laid off for two years because of idled equipment, workers eligible for

■ **15** From 1960 to 1981, the average annual investment per ton of capacity in major pieces of steelmaking equipment was $34.08 in plants whose closing was announced before 1984, compared with $128.27 for plants remaining open (Deily [1988]). See Deily also for evidence that steel firms channeled investment away from plants that were least able to compete with imports and minimills, particularly during the period 1971-1981.

■ **16** See Wharton Econometrics (1987), p. 1.8, and J. Ernest Beazley, "Big Steel's Push to Extend Import Quotas Draws Debate," *Wall Street Journal*, December 30, 1987.

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pensions may claim them. Also, laid-off workers are eligible for supplemental unemployment benefits for up to two years.

In sum, integrated steel firms appear to face sizable exit barriers. High closing costs, consisting principally of payments to employees, currently appear to be the largest barrier. Durable capital and low resale values also work to delay plant closings.

TABLE 4

	Average Age of Capacity (years)	Capacity Over 20 Years Old (percent)
Coke Ovens	17.3	46.9
Basic Oxygen Furnaces	11.0	2.3
Electric Furnaces	14.3	25.3
Hot Strip Mills	19.0	31.5
Aggregate[b]	17.5	33.3

a. As of January 1, 1979.

b. Includes data on open hearth furnaces, plate mills, wire rod mills, cold strip mills, and galvanizing lines.

SOURCES: American Iron and Steel Institute (1980), p. 21. Based on data from *The World Steel Industry Data Handbook,* vol. I, and the American Iron and Steel Institute.

IV. Implications for Public Policy

The data presented here suggest that the decline of the steel industry has been painful and prolonged because of large closing costs and high exit barriers created by the technology of the production process. Although these barriers have delayed closings, resulting in lower profits and antiquated capital stocks in some plants, the necessary reduction of U.S. integrated steel capacity has been taking place, albeit slowly

Is there any need for policies aimed at raising or lowering exit barriers? Although different firms, workers, stockholders, and communities could gain or lose, it is not at all clear that the economy as a whole benefits from either hastening or delaying plant closings. However, public policy in at least two areas of recent concern may have a strong impact on the steel industry's exit barriers.

First, the pension-insurance program affects exit barriers in the steel industry by altering the cost of closing plants. The Pension Benefit Guaranty Corporation (PBGC), a federally chartered agency that insures all workers with defined-benefit pensions, has already assumed some of the industry's plant closing costs and may ultimately assume more. As stated previously, pension liabilities are a major part of the cost of closing. A firm that desires to close plants, but that cannot afford to do so, may find that declaring bankruptcy is the cheapest way to reduce capacity, because the PBGC becomes responsible for the firm's pension liabilities.[17]

Thus, at least potentially, the PBGC could end up paying the pension liability portion of some firms' closing costs, thereby speeding up plant closings by lowering this particular exit barrier.[18] The situation has become more uncertain, however, because of the recent and still-unresolved differences between the PBGC and LTV Steel over responsibility for the latter's pension liabilities. Since this uncertainty makes it more difficult for firms to evaluate plant-closing decisions, it is important for policymakers to clarify who will ultimately pay these liabilities.

Policies to protect the industry from imports, on the other hand, may raise the exit barriers that steel firms face. The industry is currently protected by five-year Voluntary Restraint Agreements that the Reagan administration has negotiated with a number of steel-exporting countries. In the short run, the effect of the quotas may be to delay plant closings if the protection causes the industry to upwardly revise the expected revenues of its plants.

The long-run effects of the legislation are less clear. Firms are unlikely to reverse their long-run disinvestment from marginal plants unless they are convinced that the profitability of these plants has increased permanently Such an assurance would require at least that the government make a long-term commitment to trade protection for the industry But such a commitment would be expensive for domestic industries that use steel, and would by no means rule out further capacity reductions, since the mini-mill sector will continue to grow

17 See Buynak (1987) for a description of the limits on the amount of the firm's assets that the PBGC can claim to cover unfunded pension liabilities.

18 Indeed, since the maximum payment the PBGC makes to workers may be well below workers' contracted pensions, and since supplemental payments for early retirement are not covered, the total cost of closing plants would be lower, though at the direct expense of the employees.

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What public policy should not be doing is forcing reinvestment in the steel industry The most misguided aspect of the trade protection currently in place is its requirement that the industry reinvest its net cash flow from steel businesses back into steel plants (Steel Import Stabilization Act of 1984, 19 U.S.C. 2253). The result of this directive may be to force investment in plants that will never yield an adequate return, a circumstance that will increase plant owners' losses when the plants are eventually closed.

Lack of reinvestment is not the underlying problem of the steel industry Although investment in the plants that will survive is essential to their competitiveness, it is clear that additional capacity will eventually close. But shutdowns will be delayed as long as steel firms find that exit barriers make continued operation of marginal plants less costly than closing.

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