Trade Policy and Plant Exits in the Steel Industry[*]

by

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Abstract

Over the last 50 years, the U.S. integrated steel industry has been in a marked state of decline. While the overall market for steel has been growing, the U.S. industry has faced growing competition from foreign sources, new ownership structures, and new technologies. And, while the industry sought and received considerable import protection from foreign sources, the decline has continued. In this paper, we present and examine a novel data set that contains product line information in specific plants held by steel firms in the industry. Such detailed data allow us to accurately estimate the effects of product-specific trade policies (such as antidumping protection) and plant characteristics (such as employed technologies, product lines, spells of foreign direct investment, etc.) on the likelihood of exit at the plant-product level. We also have firm characteristics and can therefore examine exit decisions by multi-product and multi-plant firms across the dimensions of their production structure. As in previous literature, we find that plant capacity as well as total firm capacity each has a significant effect on exit as does the age of the plant. In addition, we find considerable differences across products, real market prices, and, in particular, trade policies.

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1. INTRODUCTION

For decades the U.S. integrated steel industry has sought and received protection from increasing foreign competition. The industry has held that this trade protection is necessary for its continued viability. A primary argument is that foreign companies receive subsidies from their governments, which cause them to overcapitalize and dump their excess production on the U.S. markets; thereby placing U.S. firms at a competitive disadvantage in their own domestic market. In this paper, we present a novel data set on steel plants and use it to examine the effectiveness of U.S. trade policy in preventing the exit of steel production capacity by U.S. firms.

Over the last several decades, the consumption of steel in the U.S. has increased, but the production of steel in the U.S has remained relatively constant at about 100 million net tons. In fact, the net production of U.S steel is remarkably uneventful. In 1960, it was about 100 million net tons, and in 2006 it was about 100 million net tons. Through the 1960s, production rose slightly and fell in the early 1980s (during the recession) with very modest increases over time. In 2002, a rash of bankruptcies marked declines and some rebound (Blonigen and Wilson (2007)). At the same time, the market penetration of imports has been growing steadily. In the early 1960s it was about 5 percent, rising to over 30 percent in 2006. Throughout these time periods there have been a number of different trade policy regimes. In the late-1960s and early 1970s, there were voluntary restraint agreements with the European Community and Japan. In the late 1970s and early 1980s, there were trigger price mechanisms, while in the mid-1980s to early 1990s, there were various forms of voluntary restraint agreements, while in 2002-3 there were safeguard protections. Since 1980, there have been literally hundreds of antidumping and countervailing duty investigations on various steel products as well.

Cursory examination of these trends, suggests that trade policy has had an effect at least on the import share. Indeed in the mid-1980s market shares fell from about 27 percent to 18 percent in 1992, a period of time with significant levels of comprehensive voluntary restraint agreements, and in 2003-4 market penetration fell from 28 to 18 percent after the introduction of safeguards. Whether such policies have an effect on the survivability of U.S. firms is not documented. With significant heterogeneity in the types of steel products receiving trade protection, sufficiently detailed data can accurately estimate the impacts of various trade protection programs steel plant outcomes.

There is an established literature focusing on the exit of firms from markets. Standard neo-classical theory suggests that exit typically occurs in high cost firms due to (inefficiently) smaller scale in the presence of scale economies. More recently, strategic exit models have been developed, beginning largely with theoretical papers by Ghemawat and Nalebuff (1985; 1990), Whinston (1988) and others. The typical focus of these studies is on the exit decision of firms in the light of a declining market. In Ghemawat and Nalebuff (1986), the decision is first framed as an all or nothing capacity decision in which a single plant large firm plays an exit game with a single plant small firm. In this case, it is demonstrated that there is a strategic liability of firm size. Later, they demonstrate that when firms can adjust capacity, the large firm moves first and will adjust capacity to mimic the smaller firm. Fudenberg and Tirole (1986) find that firms enter knowing their own costs but not that of their rivals, and that the longer its rivals survive, firms grow more pessimistic of their rivals costs and will be more likely to exit.

Whinston (1988) extends Ghemawat and Nalebuff (1985) to multiplant operations, finding that size does not give clear predictions of exit order. Instead, size, rate of market decline, and outside factors will negate any clear cut predictions.

Empirically, there is a large and growing literature on the determinants of firm and plant exits. Lieberman (1990) may be the first to test the predictions of Ghemawat and Nalebuff (1985), framing the decision to exit in terms of a "shakeout" of small firms (costs are higher due to scale or learning) versus a stakeout wherein large firms have the strategic disadvantage of firm size, and then exit first. The results indicate the small plants are more likely to close.The study alsofinds that as firms' capacity shares increase, the likelihood of exit also increases.

More recent empirical research on exit decisions (including,, Chen (2002), Buehler (2004), Dunne *et al*. (2005), Sabuhoror *et al.* (2006), and Bernard and Jensen (2007)) focus on other factors affecting exit.. Chen (2002) presents a duration model of U.S. petroleum refining plants from 1981-1986. He finds that in his data, there may be unobserved heterogeneity that downward biases duration dependence. He also finds that size and technology effects enhance survival duration. Survival duration is also enhanced by the number of plants held, but vertical integration may reduce survivability, while younger refineries have lower rates of survival. Buehler (2004) finds that a tightening of Swiss antitrust legislation had asymmetric effects on firm exit probabilities, finding that firms not involved in exporting were more likely to exit with a tightening, while firms that were involved in exporting were not affected. They used these results to posit a positive relationship between the intensity of product market competition and the likelihood of exit. Dunne *et al.* (2005) hold that producers that enter a market have different prior production experience. They quantify the nature of experience and find that these differences affect the decision to exit markets. They find that exit patterns differ according to prior experience. In particular, experienced plants that enter to diversify their product mix are the most likely to exit, followed by de novo entrants and then new plants owned by experienced firms. They conclude that characteristics of the plant at time t are not sufficient to explain the decision to exit a market, but the initial conditions and the experience at time of enter are central. Finally, Bernard and Jensen (2007) examine firm structure, multinationals and manufacturing plant deaths. They find that plants belonging to multiplant firms and those owned by multinationals are less likely to exit, but that after controlling for plant and industry attributes, multiunit and multinationals are more likely to close.

There have also been a number of studies that examine exit in the context of the steel industry. These include Deily (1988a, 1988b), Baden-Fuller (1989) and Deily (1991). Deily (1988a) points to the chronic overcapacity of the industry and the role of exit barriers to restrict exit. Deily (1988b) tests and finds support for the hypothesis that firms adjust to a declining state by disinvesting first and then closing their high cost plants. Her empirical analysis, which used data on 43 steel plants from 1960-1981, found that firms disinvested from plants least likely to remain profitable, and more generally that the industry was highly competitive due to strong competition from minimills and imports along with stagnate domestic demand. Baden-Fuller (1989) examined exit in a declining market by examining steel castings. In this paper, there is "only a little support for the strategic view of exit." While plant profitability is an influence on exit there are other explanations. Firm characteristics such as diversification and operations in other markets increase the likelihood of closure. Finally, Deily (1991) also shows that plant characteristics that determine expected revenues and costs explain much of exit, but that firm size may have some effect as well.

This study provides a number of important contributions to the literature. First, we have compiled a rich data set that contains not only firm and plant level data, but also detailed product line data. This allows us to explore determinants of exit over a very rich set of dimensions. Second, trade policy has not been closely examined in the previous steel industry exit literature, despite the extensive history of steel firms lobbying and gaining various forms of protection. With many of these trade protection actions occurring at the product level, our detailed data on product lines by steel plants and firms allows us to construct very accurate measures of trade protection and, hence, well-suited to estimate their impact on exit decisions. With the steady decline of the integrated steel mills over time, the natural question is whether trade policies have been ineffective or simply not comprehensive enough across products.

Given these rich data, our primary focus is on the decision to shutdown a production line of a plant. As such, we are able to control for plant and firm heterogeneity in capacities, products, the level of foreign direct investments, and type of firm. We frame the decision to shutdown a production line in terms of product line, plant and firm characteristics. We also include individual product market variables as well as import penetration and trade policy variables at the product level. Our data are at the individual production line which allows to examine differences across products produced, the number of lines operated within a plant and throughout the firm. We also observe the startup year of the individual production line within each plant as well as major modernization efforts and the role of foreign and domestic investment in the form of joint ventures. Finally, we observe all of the plants operated by all of the firms operated in the U.S. which offers an opportunity to examine the effect of trade policy on the ability of a production line, plant and firm to survive. We find that, as in previous research, the capacity of the product lines reduce the exit probability, while the total product line capacity of the firm increases the exit probability. We also find significant differences across product lines and types of plants e.g., integrated versus minimills as well as vintage of plants. With regard to the central focal point of the paper, the effects of trade policy, we find strong evidence that the quotas of the 1980s had a strong and negative influence on the likelihood of exit, as have trade barriers in the form of tariffs and countervailing and antidumping duties. Yet, given the extent of product-line shutdowns, the research also provides strong evidence that the policies in place have not been large enough to reduce the decline of the industry.

In the next section, we provide a brief background on the steel industry along with various trade policy regimes over the range of the data. We then describe a model of exit, data and results.

2. BACKGROUND

U.S. steel firms produce a range of different products and use a variety of different production technologies. Integrated steel firms use an "integrated" process that involves melting iron ore into pig iron with a blast furnace, followed by melting pig iron into raw steel inside a basic oxygen furnace. This raw steel is then cast into semifinished steel products, which are rolled into a wide variety of finished steel goods. Minimills melt scrap steel with an electric arc furnace into raw steel which is then cast into semifinished steel and rolled into an array of final products. The minimum efficient scale of an integrated steel firm is generally much larger than that of a minimill, and minimills often carry cost advantages over integrated firms even when the latter are producing at efficient scales of operation.[1] Through the years, the integrated producers held that the steel they produced was "purer" than that of minimills and hence they could compete through quality differences.[2] Recent technological innovations, however, have allowed minimills to encroach upon downstream markets that traditionally required integrated steel products, such automobiles.

The existing theoretical and empirical literature is usually framed around the notion of a declining market. In the steel market, it is well noted that domestic consumption is growing, and with a few modest exception, total consumption continues to grow (Figure 1). Indeed, in all cases from 1980 to 2006, quantities consumed in the U.S. have grown. While growth is lower than the growth of the economy, the market is nevertheless still growing. Further, as shown in Figure 2, the import shares of the five products we examine, have grown from 1980-2006. In the case of wire rods, the growth of imports as a share of U.S. consumption is very sizable. But, in the other cases, the share of imports, while larger, also indicate substantial patterns in the data. During the VRA periods (1982-1991) import shares fell. As seen later, the effects of growing trade restrictions (tariffs, cvd and ad duties) in the late 1990s pointed to a stronger U.S. market and the import share declined during this period.

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[1] Integrated firms are often unionized while minimills are not.

[2] According to an interview with a U.S. integrated firm, purer quality means that for example the steel could be rolled thinner with the same strength.

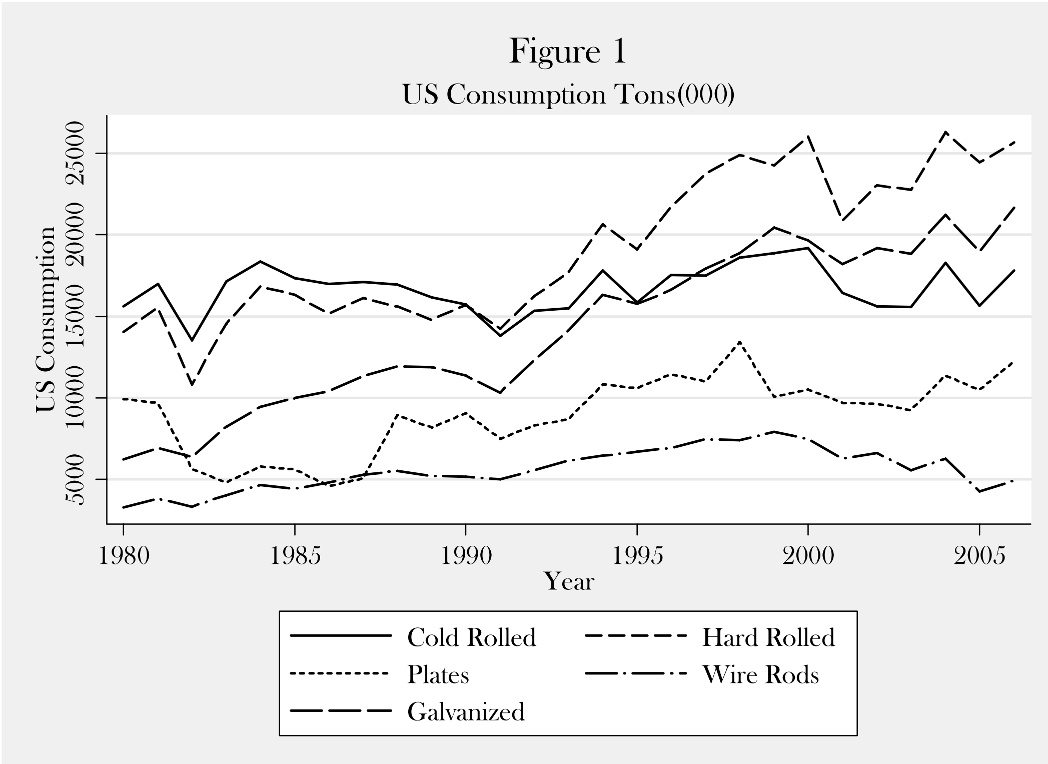

Figure 1
US Consumption Tons(000)
US Consumption
5000
10000
15000
20000
25000
1980
1985
1990
1995
2000
2005
Year
Cold Rolled
Hard Rolled
Plates
Wire Rods
Galvanized

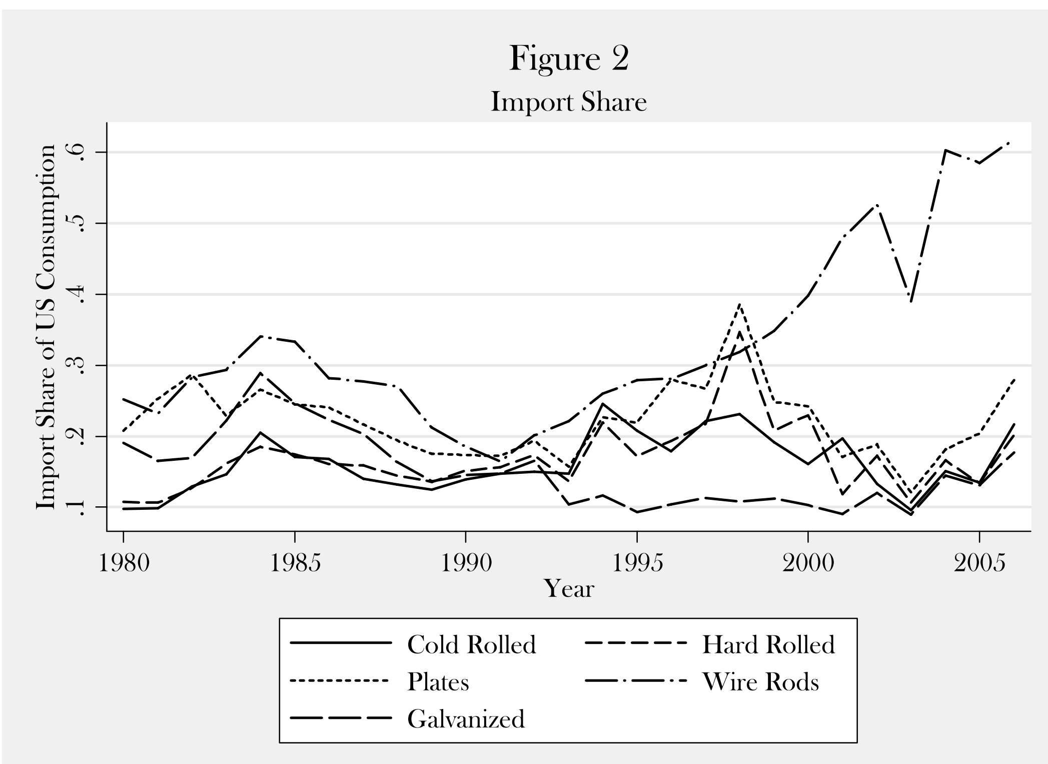

Figure 2
Import Share
Import Share of US Consumption
.1
.2
.3
.4
.5
.6
1980
1985
1990
1995
2000
2005
Year
Cold Rolled
Hard Rolled
Plates
Wire Rods
Galvanized

3. CONCEPTUAL BASIS

We employ is an exit model used throughout the bulk of the literature. Essentially, the model is one of long-run profits with and without operations. It is usually developed with the idea that exit occurs if long-run profits fall below a threshold. The threshold may or may not explicitly reflect salvage costs, opportunity costs, etc. Long-run profits are not observed but are represented by the discrete outcome of exit. That is, long-run profits are taken to depend on observed and unobserved effects captured in the error. The model then is given by

$$\Pi = x\beta + \varepsilon$$

with

$$\text{Prb(exit)=Prb}(x\beta + \varepsilon < 0)$$

In the model, there are several different variables. Based on neo-classical models and on strategic models of exit, the capacity of a line enters. Neo-classical models suggest it has a negative effect on exit, while the single-plant, 'all-or-nothing' decision of Ghemawat and Nalebuff (1985) suggests that it has a positive effect. In addition, there should be some presence of firm capacity in multiple locals. This follows directly from Whinston (1988) who found that firms with multiple plants may act first. Technology, age, product specific effects, and prices are also determinants. Each of these is explained in greater detail in the next section.

4. DATA SOURCE, VARIABLES AND SUMMARY

Our data cover the operation of steel production lines inside individual U.S. steel plants over the last thirty years. More specifically, we have constructed a panel dataset that tracks specific production lines operating within individual U.S. plants of all steel firms producing five key carbon steel products. These products include hot rolled sheet, cold rolled sheet, galvanized sheet, plate, and wire rod. The primary source of these data is the trade journal 'Metal Producing and Processing', which periodically surveyed steel firms operating in the U.S. during 1978-2000. Specific survey years are 1978, 1982, 1987, 1989, 1991, 1996, 1998, and 1999. We used the Directory of Iron and Steel Plants published by the Association for Iron and Steel Technology (AIST) to update the data to plants operating in 2007. It is also noted that we also did internet searches and contacted individual plants and companies to fill out any uncertainties in the data and missing variables.[3] In total, there are 290 production lines that produce at least one of these five products that operated in at least one year of our data (Table 1). Of these 290 lines, there are 44 Hot Rolled Sheet lines, 98 Cold Rolled Sheet Lines, 91 Galvanized Lines, 30 Plate Lines, and 27 Wire Rod lines.

Table 1. Product Lines in Data

Product	Frequency	%
Hot Rolled	44	15
Cold Rolled	98	34
Galvanized	91	31
Plates	30	10
Wire Rods	27	9
Total	290	100

Table 2 contains the frequency of lines in production through time by product. First note that overall there were 215 lines in operation in 1978. This fell through 1996 and then

[3] In some cases, data were verified and/or taken from a variety of secondary sources. These include:Christopher Hall's 1997 volume, Steel Phoenix – the Fall and Rise of the U.S. Steel Industry, the University of Pittsburgh's Center for Industry Studies 'Steel Plant Database, The U.S. International Trade Commission's 2005 report, "Steel: Evaluation of the Effectiveness of Import Relief", William T. Hogan's 1994 volume, Steel in the United States: Restructuring to Compete, and Purchasing Magazine's 1999 report of 'North America Galvanized Steel Capacity."

increase in 1998 and 1999 to 1985 lines. However, by 2007, the number of lines had fallen dramatically to 166. Also note that in 1978, the number of Cold Rolled Sheet lines was 82, but by 2007, the number had fallen to only 46. Indeed, for all products except Galvanized, the number of production lines in 2007 is lower than the number in 1978.

Table 2. Operating Production Lines by Year and Type

Year	Cold Rolled	Galvanized	Hot Rolled	Plate	Wire Rods	Total
1978	82	50	35	27	21	215
1982	70	46	32	24	20	192
1987	61	51	29	16	18	175
1989	58	50	28	16	17	169
1991	55	53	29	15	17	169
1996	49	62	28	13	15	167
1998	50	77	30	14	14	185
1999	49	79	30	13	14	185
2007	46	71	27	11	11	166

The focal point of the empirical model is to explain exit across different product lines across different trade regimes. Clearly there were significant changes in industry composition from 1978 through the mid-1990s, a period time with extensive trade protection measures in place, with further changes from 1999 to 2007, another period with safeguard protection. The data are drawn from different points in time. Hence, the precise year of exit cannot be quantified. Table 3 provides a summary of exits over time. Exit is identified in our data as a production line that was in operation in one time period and not operating in the following time period. Over the entire time period, there were a total of 131 exits. These included 25 from 1979-1982, 28 from 1983-1987 and 24 from 1992-1996, and 28 from 2000-2007. By product, there were 56, 21, 19, 19, and 16 exits for Cold-Rolled, Galvanized, Hot-Rolled, Plate and Rods, respectively. These reflect exit rates (exits/(lines in operation +exits)) of 10.75, 3.83, 7.06, 12.67 and 8.01, respectively.

Hence, while the frequency of exits is greatest for Cold-Rolled Steel, the exit rate was greatest for Plate Steel.

Table 3. Exits by Year			
Years of Exit	Operating	Exits	Total
1979-1982	191	25	216
1983-1987	165	28	193
1988-1989	168	8	176
1990-1991	162	8	170
1992-1996	146	24	170
1997-1998	160	8	168
1999-1999	184	2	186
2000-2007	158	28	186
2008	170	0	170
Total	1,504	131	1,635

In addition to product attributes, there are a number of other control variables. These include the capacity of the line, the capacity of the company, the age of the line, whether it has been modernized, and whether it has received investments from foreign sources, production technology, and, of course, market variables including the real price of the product and trade barrier variables. Capacity of each production line is recorded in tons per year. The expected influence of this variable is not entirely clear, since some articles in the literature find that size is positively related to exit e.g., Ghemawat and Nalebuff (1985) while neoclassical models find that capacity is negatively correlated with exit. Our capacity variable captures the size of each individual production line, which is distinct from the more commonly used plant or overall firm-size variables. We are able to make use of these latter variables as well by summing the capacity of all production lines of a given product for each firm. This would give an analog to Whinston (1988), which finds that plants operated by firms with a lot of capacity in other plants might be more likely to be shutdown while the firm continues to operate its other facilities, a result which is contrary to the recent evidence by Bernard *et al.* (2007). Finally, we also examined the potential for size to enter through the total capacity of all products produced by a firm, but note that the proxy is flawed since our data apply to only five product groups.

In addition to the capacity variables, we also observe the age of a production line, since the survey data record startup and modernization years. Our *a priori* expectation is that older production lines are more likely to shutdown during the course of our data set, while younger and/or more modernized lines are more likely to survive. In addition, also recorded is the year a plant was last modernized. From Hall (1997) (updated by us), we have a measure of foreign ownership, which denotes whether a plant is controlled by a foreign firm or not. Foreign ownership has been shown to be correlated with increased profits and efficiency as well as overall survival. Interestingly, our dataset contains instances in which a single production line is foreign-owned, while other parts of a facility are U.S.-owned. Thus, our data capture foreign ownership at a highly disaggregated level. Such a variable may be interpretable as a proxy for unobserved cost differences across lines.

The final set of variables discussed relate to production technology. There are three types of firms in the data. These include whether a production line is operated by an integrated steel firm, a minimill, or a steel processor. The primary difference between these three types of firms is the way in which they produce the raw steel that is ultimately processed into five steel commodities included in our data. Integrated firms produce steel by first combining iron ore and coking coal in blast furnaces, while mini-mills produce steel from recycled scrap that is melted down in electric arc furnaces. The raw steel that emerges from the integrated furnaces is sometimes processed into downstream commodities on-site, and other times shipped to processing facilities nearby. Raw steel produced at minimills is almost always processed into downstream steel products on-site. Finally, steel processing firms are distinct from integrated and minimill producers since they don't actually produce raw steel, but instead buy steel that has already been processed to varying degrees, which they then refine into more downstream commodities.

Minimills are traditionally smaller than integrated plants and can idle facilities far more cheaply than integrated firms during periods of slack demand. Thus, minimills generally face much lower fixed costs than integrated firms. Steel processors are entirely unburdened with the capital costs involved in raw steel production. They also benefit when the upstream steel products which they are forced to purchase are cheap and/or unfettered by tariffs or antidumping duties. These three types of firms differ from each not only because of the capital that they employ, but also because of their labor policies. Integrated firms tend to be unionized, whereas minimill and steel processing firms tend to have un-unionized workforces with more incentive-based compensation.

Table 4 contains a summary of these variables by exit status. Capacity is measured in tonnage capacity that can be produced in a line; Firm Product Capacity is the sum of all capacities across all lines of a firm for a given product minus the product line capacity; Firm Capacity of All Products is the sum of capacity across all product lines owned by a firm; Age is the number of years since startup; quota is a dummy variable for each product and year combination if a quota was in place or not; and trade restrictions is a total protection measure defined as (Tariffs+Antidumping Duties+Countervailing Duties)*real price of imports.[4]

Cursory examination of Table 4 suggests that there are statistically important differences in the line capacity, firm product line capacity, age and real price per ton across exit status. Firms that exit have smaller line capacities and greater product capacities in the firm. They also tend to be older, receive lower prices[5], and have received less protection on average compared to non-exiters. Each of these is as predicted by theory. In addition, the table reveals the fact that there are a higher proportion of exits by integrated firms and lower number by processers (these are identified by dummy variables), with no differences across minimills. There are no differences across exit and non-exit with regard to having modernized their lines. Finally, exiting lines are less likely to have experienced investment by a foreign firm than non-exiting firms.

Table 4. Means and Differences of Selected Variables by Exit Status.

Variable	Exit	Non-Exit	Overall
Capacity	568,181	893,953	869322*
Firm Product Capacity	3,149,403	2,479,065	2,528,032*
Firm Capacity All Products (000)	13,200	11,900	12,000
Age (years since startup)	39	29	29*
Real Prices per Ton	408	475	470*
Quota	30.5	31.7	31.6
Trade Restrictions	.017	.034	.033*
Integrated Steel	80.2	71.4	72.01*
Minimill	13.98	16.29	16.02
Processor	6.87	12.33	11.89*
No Modernization	25.19	26.61	26.49
FDI-Joint Venture	16.20	25.20	24.46*

Note: A * indicates statistically important differences in the variable across exit status.

[4] The real price of imports is the border price before tariffs and duties. The tariffs, antidumping and countervailing duties are defined in percentages of this price and deflated by the gdp deflator. Attempts to separately identify these effects yielded mixed results.
[5] Of course, since we use industry prices, this is a kin to differences in product values.

5. RESULTS

The data were used to estimate a set of logit models with different variables included and are presented in Table 5. The base model (1) contains only product dummies (Steel plates is our base product). Type of production is reflected in specifications 2-5, firm and plant characteristics are added in specifications 3-5, market variables are added in specifications 4-5, and modernization and foreign ownership are added in specification 5. In all specifications, a dummy for year=1978 is provided.[6]

Product Dummies

The base model reflected in all other models contains only product dummies where Plate steel is the base dummy. In this regard, there are product specific differences in every specification. Lines that produce hot rolled and galvanized steel are in every specification less likely to exit than lines of plate steel. Further, in other specifications, lines that produce cold rolled steel are also less likely to exit than lines that produce plate steel. In all specifications, there no differences between lines that produce plate and lines that produce wire rod.

Technology Dummies

Models 2-5 contain dummies to capture differences between an integrated steel firm, a minimill and a processor. In all specifications, the processor dummy is not statistically different from integrated firms, but the lines operated by minimills are negative and statistically important in each of the specifications. Further, the coefficients are relatively stable, suggesting that the results are not sensitive to specification.

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[6] This dummy captures unobserved heterogeneity not captured in the model. This may be the result of a slackening economy, measurement error in the price data, etc.

Plant and Firm Characterisics

Models 3-5 contain various capacity measures. These include the capacity of the line within a plant producing a product, the total capacity of the firm (minus the capacity of the line) and total capacity of the firm for all the products in the sample (minus the capacity of the line). Each of these is measured in logs and a zero is used if the plant or firm has a single line. To capture the inherent differences, a single-line dummy captures differences from multi-line firms. Hence, the company level capacity numbers can be viewed as interacted with this dummy. In addition, to capture differences between new and old lines (an index for technology), the age of the plant is included and measured in logs.

In all relevant specifications, line capacity is negative and statistically important as well as stable. This provides strong evidence that smaller lines are more likely to exit than larger lines. If a line is the only line operated by the firm, it is more likely to exit. This somewhat counterintuitive finding may be offset by the observation that if there is substantial capacity for producing the product in other plants, the line is more likely to exit. Again, this is relatively stable across specifications. Finally, total capacity of the firm in all of the products does not have a statistically important effect in any specification. Hence, the results suggest that it is the total capacity of a specific product, not total capacity in all products, that matters.

Finally, the results also point to the age of the line in having statistically important effects. In all specifications, the age of the plant is positive and statistically important. And until modernization is added in specification 5, the coefficient estimate is relatively stable.

Market and Protection Variables

In specifications 4 and 5, we added the real price per ton of steel and the protection variables. In all cases, these variables are statistically important. An increase in the real price of steel should and does have a statistically important effect in reducing the likelihood of exit. In both specifications, the estimates are negative and similar. Quotas should and do reduce the likelihood of exit and again, the estimates are similar. The trade restriction variable should also enhance the viability of lines, plants and firms. Indeed, as the level of protection increases, the likelihood of exit decreases.

Firm Actions

As noted in Audretch and Mahmod (1995), firms that innovate tend to be survivors. The estimates in model (5) support this hypothesis. Indeed, if there has been a modernization of the line, the line is less likely to exit than without. Another type of action that could affect viability is that of fdi. Fdi is not statistically important in this specification.

Table 5. Logit Model Results	Model				
Variable	1	2	3	4	5
Hard Rolled Dummy	-0.65	-0.887	-0.007	-0.787	-0.719
	(1.90)*	(2.53)**	(0.02)	(1.75)*	(1.56)
Cold Rolled Dummy	-0.191	-0.488	-0.71	-1.034	-0.979
	(0.68)	(1.63)	(2.04)**	(2.88)***	(2.63)***
Galvanized Dummy	-1.282	-1.526	-2.243	-1.723	-1.665
	(3.87)***	(4.38)***	(5.26)***	(3.66)***	(3.45)***
Wire Rods Dummy	-0.18	0.171	0.247	-0.555	-0.555
	(0.5)	(0.45)	(0.59)	(1.20)	(1.19)
Minimill Dummy		-0.978	-0.861	-1.007	-1.097
		(2.92)***	(2.06)**	(2.39)**	(2.43)**
Processor Dummy		-0.479	0.432	0.470	0.373
		(1.3)	(1.02)	(1.05)	(0.79)
Log(Capacity)			-0.804	-0.923	-0.892
			(6.34)***	(6.86)***	(6.48)***
Single Line Dummy			2.787	3.713	3.296
			(1.69)*	(2.10)**	(1.86)*

Log(Capacity of Product for All Plants)			0.207	0.284	0.257
			(1.82)*	(2.32)**	(2.10)**
Log(Company-All Products-All Plantst) Capacity			0.012	0.013	0.004
			(0.34)	(0.37)	(0.12)
Log(Age of Line)			0.66	0.591	0.703
			(3.39)***	(2.99)***	(3.32)***
Real Price of US Steel per Ton				-0.004	-0.004
				(3.28)***	(3.57)***
Quota Dummy				-0.675	-0.708
				(2.46)**	(2.55)**
(Tariff+CVD+AD)*Real Price of Imports				-0.008	-0.009
				(3.11)***	(3.42)***
Dummy for 1978				-2.964	-3.197
				(4.06)***	(4.31)***
Modernization Dummy					-0.444
					(1.63)
FDI Dummy					0.279
					(0.91)
Constant	-1.923	-1.562	3.425	7.263	7.351
	(7.83)***	(5.88)***	-1.62	(3.02)***	(2.99)***
Observations	1623	1623	1569	1569	1569
Note: A *, **, and *** indidcate statistical significance at the 10, 5, and 1 percent leves. Plate steel is the base dummy for products, and Integrated steel is the base dummy for type of technology.					

Table 6 contains the marginal effects for the model 5 presented in table 5. In all cases, the reference point for the calculations are at overall sample means. The discrete variables are simply averages with and without the dummy, while the continuous variables are presented in terms of elasticities. The inferences from column five are largely borne out by the magnitudes and z-statistics presented in table 6. The magnitudes for product line dummies point to statistically important reductions in probabilities of up to 5.2 points. Lines operated by minimills are about 3.2 points less likely than lines operated by integrated firms.[7]

An increase in the log of the capacity of the line points to a -0.854 percentage change in the probability of exit. Given the range in line sizes, this points to dramatic

[7] Of course, some of these effects may be masked by the use of overall means.

differences in the likelihood of exit e.g., the minimum value of cap is 12672 while the maximum is about 6.1 million. Such an effect might be partially offset by a multiplant firm with extensive operations in other lines as the marginal effect for that variable is positive and significant with an .24 elasticity. Finally, the vintage or age of plant also points to another source of substantive differences. Indeed, the range in is from 0 to 90 years and the elasticity estimate is .9. Differences of this magnitude point to considerable differences in probabilities between young and old lines. An increase in the real price of steel should and does reduce the probability of exit, and the effect is substantial with a -1.9 elasticity. Trade policy is discussed in the next section. But, the modernization variable does strengthen lines propensity to remain in the market. At mean values, the effect is to reduce probabilities by 1.6 points.

Table 6. Marginal Effects

Variable	Marginal	Standard Error	z-statistic	Mean of X
Hard Rolled Dummy	-0.02325	0.01213	-1.92	0.168897
Cold Rolled Dummy	-0.03396	0.01185	-2.86	0.318674
Galvanized Dummy	-0.05512	0.01488	-3.7	0.325048
Wire Rods Dummy	-0.01804	0.01235	-1.46	0.09369
Minimill Dummy	-0.03219	0.01006	-3.2	0.165711
Processor Dummy	0.01688	0.02428	0.7	0.123008
Log(Capacity)	-0.85469	0.13341	-6.41	13.195
Single Line Dummy	0.30593	0.28855	1.06	0.270236
Log(Capacity of Product for All Plants)	0.24616	0.11715	2.1	10.5532
Log(Company-All Products-All Plantst) Capacity	0.00414	0.03462	0.12	13.6015
Log(Age of Line)	0.673862	0.2042	3.3	3.16967
Real Price of US Steel per Ton	-1.9010	0.53611	-3.55	471.801
Quota Dummy	-0.02530	0.00919	-2.75	0.316125
(Tariff+CVD+AD)*Real Price of Imports	-0.76996	0.22668	-3.40	93.41780
Modernization Dummy	-0.01613	0.00912	-1.77	0.271511
FDI Dummy	0.01181	0.01380	0.86	0.250478
Dummy for 1978	-0.05754	0.00903	-6.37	0.123646

Note: Dummy variables marginal effects are differences in the probabilities with and without the dummy effect.

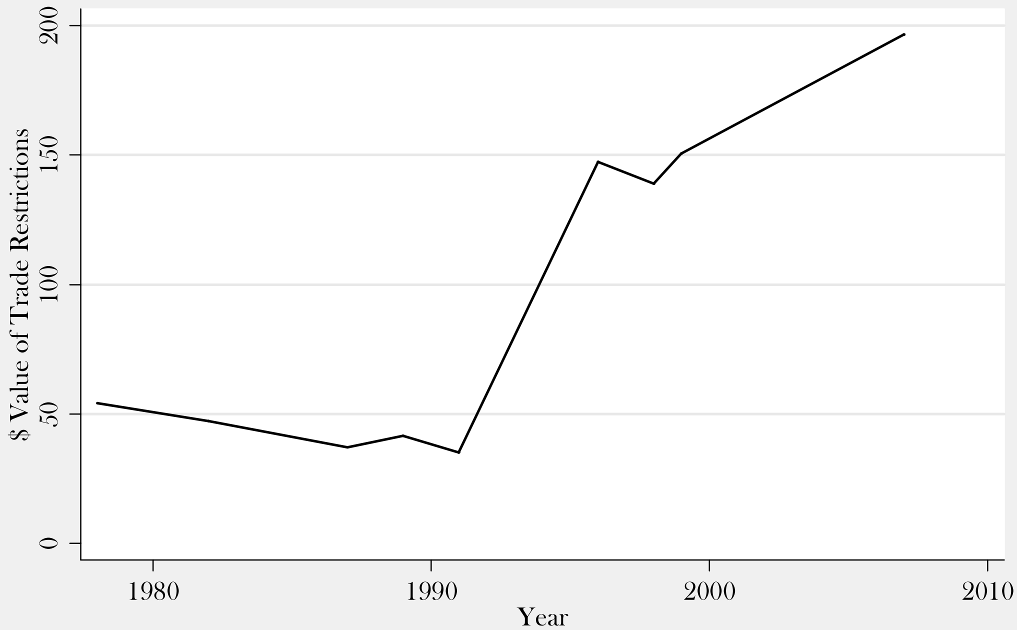
6. TRADE POLICY

Through the data, there are tariffs, anti-dumping duties, and countervailing duties as well as Voluntary Export Restrictions on various products. At presented in Tables 5 and 6, Quotas do have a statistically important effect on reducing the likelihood of exit. From table 6, the marginal effect for the average line is to reduce the probability by about 2.53 points.

The other trade restrictions also have an effect of reducing the likelihood of exit. Indeed, the real dollar equivalent of these barriers suggests the numbers are quite large. Specifically, on average, $93.42 per ton represents about 25 percent of the average domestic price. These range from $8.22 (for hot rolled steel in 1998) to 328.81 (for plate steel in 2007). Our inspection of the data (averaging across all products) suggests that these barriers have become quite significant (Figure 2). Given the elasticity estimate of -.77, the change from $35.07 in 1991 to 147.58 in 1996 marks a very significant effect in reducing the probability of exit.

Figure 3

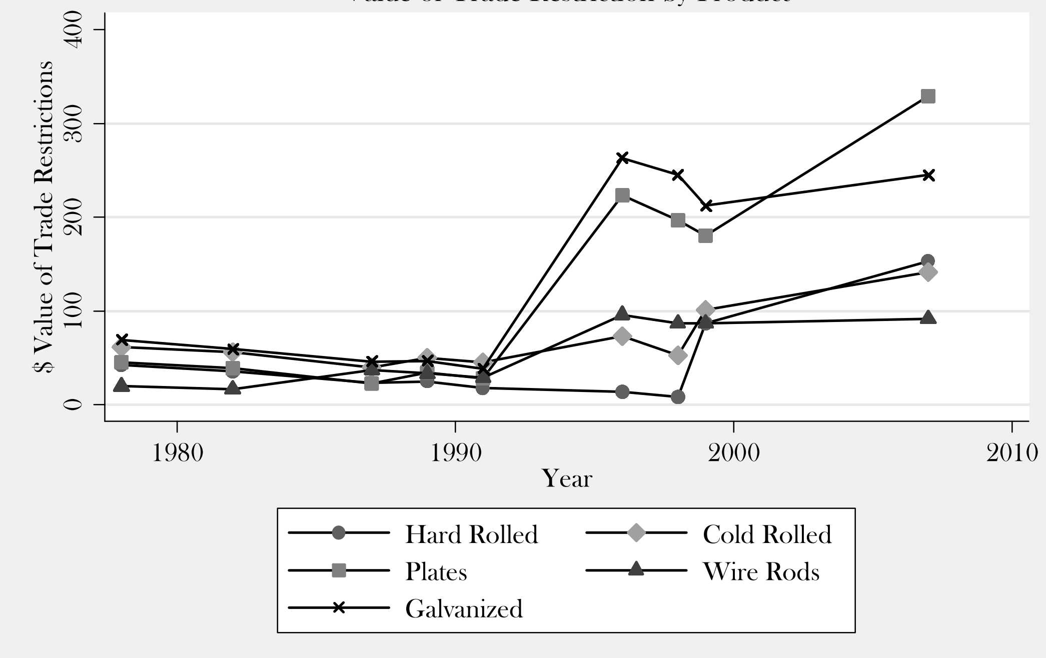
Value of Trade Restrictions over Time



Within products, the changes are similar, although more diverse because of differences in real prices across products, the level of the trade restriction, and timing. Nevertheless, as indicated in Figure 4, protection fell for most products through the 1980s, and increased, in some cases, dramatically, in the mid-1990s and even further since 2000. The results overall point to substantial effect that reduce the probability of exit.

Figure 4

Value of Trade Restriction by Product



7. SUMMARY AND CONCLUSIONS

This paper provides an examination of the exodus of production facilities in steel markets. The primary purpose is to evaluate the role of trade policy in preventing exit. The results provide strong evidence that trade policy has an important effect on reducing the likelihood of exit. Further, not only has trade policy had an important statistical affect, given the major increases in the protective wedge between foreign and domestic producers; it seems to have been somewhat successful.

In addition, the examination uses a novel data set that frames exit in terms of products produced by specific production lines within a plant. Yet, we also observe the totality of plants and ownership allowing consideration of firm-product capacity versus overall firm size. We find the former is statistically and empirically important while the latter is not. Indeed, we find that as the productive capacity of a line increases, the probability of exit falls (this is akin to a myriad of studies that find increases in the capacity of plant reduces the likelihood of exit). But, we find that it is the product-capacity of the firm not the overall firm size that increases the propensity to exit. Hence, firms that can produce a lot of a product in other production lines are more likely to shut down a line of same capacity than a firm without a lot of product capacity in other lines.

The age of a line has a very important effect on exit behavior similar to the findings of others on the age of plant. However, this effect may be offset somewhat by a modernization episode. This is completely consistent with findings of Audretch and Mahmod (1995) and others that suggest that firms that are engaged in growth and innovation are more likely than firms that do not. In this case, firms can offset the deleterious effects of age, by modernizing their plants.

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