A Time Series Analysis of Exports and Price Relationship: The case of the Steel Industry

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INTRODUCTION

There have been several studies that explain the change in the world trade structure for agricultural products in recent years. These studies are done by Benejie in 1972, Coffin in 1971, and the most important of all by Barr in 1973. His famous price equation of $P = a + b\left(\frac{A\phi}{TE}\right)^C$ for wheat, well explains the changes in wheat prices. $A\phi$ is the three years moving average of domestic use of wheat for food, TE is the total ending U.S. wheat carryover stock, and a, b, and c, are parameters to be estimated. Although these studies have provided a fairly good explanation of what has occured in the grain market lately, they left unanswered the question of how the change in other product markets, for example, steel, should be explained. Moreover, Barr has chosen parameters C in his price equation equal to 5 without having a satisfactory explanation for it. Therefore, the purpose of this paper is to verify the possibility of such an existing relationship in steel products and to develop productive models for price and volume of exports in the steel industry.

A. Economic Analysis of Steel Industry

An analysis of export-import specialization of the United States in the past 20 years shows that the U.S. steel industry is continuing to age and for the most part, not very gracefully[1]. The 1980s are characterized by declining profits and cash flow levels and by escalating debt, labor, energy and raw materials cost. Additionally, its ability to compete with foreign producers has ebbed drastically during the past decade. In spite of having these problems the steel production still account for the bulk of U.S. production.

Today, there are two primary users of steel products, auto and construction. Therefore, the derived demand for steel depends on the vitality of auto and construction industries. The high dependence of steel industry on autos and construction is one of the primary reasons that the steel industry is cyclical. Consequently, it is difficult for this industry to adjust to production for the upswing and downswing of cyclical fluctuations. Moreover, the inability of the U.S. steel industry to compete with other nations can be attributed to a number of factors such as: relative productive differences, strikes, high cost of labor, major crisis, and government policies. The current economic recession and its effects on autos and construction industries have resulted in lower volume of new orders. Steel shipment in 1982 was expected to plunge to 60 million tons, down more than 30 percent from the 87 million tons shipped in 1981 and the lowest since 1958[2]. Production in the October 30, 1982 was the lowest since 1934.

Unemployment among steelworkers is over 40 percent and a typical steel-worker receives an incredible $24.84 an hour, which is 95 percent more than the average wage rate in other domestic industries and 9.25 above the wage rates of Japanese workers, yet Japanese workers produce 2.5 to 3 times as much steel per hour[3]. These statistics clearly show the high cost of labor in relation to their production and in comparison to those of their Japanese counterparts. The continuous high cost of labor along with low rates of production in steel industry obviously will result in lower employment in the future.

For many years the U.S. steel industry "administered" prices, i.e., it set prices at a level much higher than costs in order to increase profits. Steelworkers followed similar practices, bargaining for wage gains that have given them 70 percent higher wages than those of other manufacturing workers.

Basically the steel industry suffers from world wide capacity and over production which create a constant glut on the market. The United States also suffers from obsolete plants, low productivity, and high wages. The President of the American Institute of Imported Steel calls imports a result, not a cause, of the U.S. steel industry's problems. Moreover, the deteriorated international trade in the past decade and its continuing to the present, has had a significant impact on production and employment in the U.S. steel industry.

In 1981 the United States imported steel products from 39 different countries. Therefore, the more competitively foreign steel has caused U.S. steel makers to lose market share and has eroded their profitability. However, the more severe competition to U.S. steel in the future, is expected to come from countries such as South Korea and Brazil, where labor costs are below $4 per hour compared with the wage rate more than $24 per hour in the U.S.

B. Analysis of Sales and Profits in the Steel Industry

Table 1 shows the sales and profits in steel industry compared with the Value Line's Industrial Composite figures for years 1974-1978[4]. The low net profit of the steel industry in 1977 reflects the substantial impact of permanent closing of a plant in that year. As this table shows, the net profit of the Industrial Composite has experienced a relatively stable growth while those for steel industry are subjected to dramatic declines. These changes can be better seen in Table 2, where the calculated net profit margins (profit as percentage of sales) are shown. The net profit margins of the steel industry during these years are not as stable as those of the Industrial Composite. It has a lower average, higher standard deviation, and consequently, a higher measure of relative dispersion. Therefore, these tables clearly indicate that the steel industry, generally, is not performing well when compared to the Industrial Composite. It has a very low net profit margin with a relatively high variance. The declining sales and profits in the steel industry is due mostly to the high cost of labor, unpredictable prices, low quantity of sales, lowproductivity, and thus inability to compete with foreign industries in increasing the volume of exports. The prices and the volume of exports are studied in this paper and some predictive models are constructed and discussed in the following sections.

MODELS AND RESULTS

A. Price Models

Three different price models for raw steel production are constructed and studied in this paper. The estimated models are[5]:

Table 1

	Steel Industry (• Billion)		*Industrial Composite (• Billion)*	
Year	*Sales*	*Net Profit*	*Sales*	*Net Profit*
1974	37.745	2.4752	1008.5	49.2
1975	33.144	1.595	1059.0	43.3
1976	36.093	1.3374	1195.4	55.8
1977	39.3998	.0223	1347.3	61.9
1978	42.429	1.292	1532.7	72.5

Source: U.S. Industrial Outlook, 1980; and the Value Line

Table 2

Net Profit Margins (percent)

Year	*Steel Industry*	*Industrial Composite*
1974	6.60	4.90
1975	4.80	4.10
1976	3.70	4.70
1977	0.06	4.60
1978	2.80	4.70
standard deviation	2.17	0.27
average	3.60	4.60
relative dispersion	0.60	0.06

Table 3

Variables	*Coefficients*	*Beta Coefficients*	*Beta Coefficient*
EX	-3.85	-.10	.10
IM	-0.86	-.08	.08
MC	0.16	.20	.20
C	-0.69	-.12	.12
OT	0.34	.56	.56
D_1	4.01	.03	.03
D_2	58.10	.45	.45
	Net Total Impact :	.94	
		Total Absolute Impact	1.54

(1) $P = 89.69 - 3.85EX - .86IM + .16MC - .69C + .34OT + 4.01D_1 + 58.10D_2$

(2.17) (−1.02) (−.46) (2.68) (−1.64) (6.8) (.25) (5.31)

RMSE = 8.35 $R^2 = .994$

(2) $P = 56.34 + .01\left(\frac{A\phi}{TE}\right)^4$ RMSE = 63.05

(1.43) (2.1)

(3) $P = 55.21 + .001\left(\frac{A\phi}{TE}\right)^5$ RMSE = 63.11

(1.33) (1.5)

EX is representative of exports of steel products, IM - imports MC - the production of raw steel by major competitors (Japan, France, West Germany, United Kingdom, and USSR), C-domestic consumption of steel products and OT - the steel production by other countries excluding the U.S. and the major competitors. D_1 and D_2 are dummy variables representing the two major government policies of devaluation of the dollar in 1971 and 1973[6]. Aϕ is a three year moving average of domestic consumption of steel products. TE is the total ending U.S. raw steel carryover stock and P - the prices index of steel production. "t" statistics are reported under the estimated regression coefficients enclosed in paranthesis. Equations 2 and 3 are Barr's price model adopted to the steel industry. This model is studied with different exponents of 1 to 6. Results indicate that equation 2 explains the variations in price better than the other equations. Moreover, this equation has a smaller RMSE (root mean square error) than equation 3. However, Barr's equation in comparison with the alternate estimated price model, (equation 1) has a much higher RMSE and, thereby lower prediction power[7]. Although Barr's model can well explain the variations in the price of steel production in the past, it is relatively inferior to the proposed and estimated equation 1 which has a RMSE of 8.35. Table 3 shows the relative impact of all factors in equation 1 on the price of steel production.

The three most important factors in determing the price are the total production of steel by other countries, the devaluation of the dollar in 1973, and the production of steel by major competitors. The total production of steel by foreign countries has a significant impact on the price of steel in this country[8]. Their total impact counts for 49 percent of total absolute impact on the price of raw steel production. The unexpected sign of coefficients for C, OT and MC are due to the growth of the domestic economy, the government policies in protecting the U.S. steel industry against the major competitors, and controlling the domestic price of steel products (administered price) in spite of the existing continuing sluggish and cyclical domestic demand for these products.

B. Export Models

The export equation in Barr's study is adopted in this paper (equation 4) and compared with a different export model (equation 5). The estimated export equations are as follows[9]:

$$(4)\quad EX = \underset{(-2.71)}{-8.02} + \underset{(3.73)}{-.06MC} - \underset{(-3.01)}{.77TN} + \underset{(1.59)}{.01OT}$$

$$RMSE = 1.04 \quad R^2 = .93$$

$$(5)\ EX = -3.04 + .03MC - .01OT - 1.91D_1 - .003D_2$$
$$(-1.29)\ (3.33)\ (-1.67)\ (-1.35)\ (-.002)$$
$$RMSE = 1.35\quad R^2 = .898$$

EX is the export of steel products and TM is a time trend. MC and OT are the total production of raw steel by major competitors and other countries, respectively. "t" statistics are reported under the estimated coefficient enclosed in parenthesis.

Results of these estimated equations show that Barr's adopted equation has lower RMSE and therefore, higher prediction power. In addition, Table 4 indicates that the total impact of all variables in equation 4 is larger than that in equation 5. Thus, Barr's adopted export equation appears to be a better predictive model to explain the variations in quantity of export for steel products. However, equation 5 indicates that the impact of devaluation of the dollar in 1971 is negative (-.66) while it is approximately zero for 1973. It could be because of the positive impacts of these policies on the price of steel products, and consequently the inability of these products to compete with the low priced steel products in other countries[10]. Equation 4 (Barr's adopted model) shows the significant role of TM and its impact on export. MC and OT have their expected positive coefficients and impacts. The production of raw steel at low prices by major competitors has increased, its imports to this country may have contributed to more production of steel products by U.S. companies for exporting to other countries. However, the overall impact of these variables suggest a possible steady increase in the export of steel products when the rate of increase in MC and OT outweigh the impact of the time trend.

Table 4

Variables	Coefficients		Beta Coefficients		Beta Coefficients	
	Equation 4	Equation 5	Equation 4	Equation 5	Equation 4	Equation 5
MC	.06	.03	3.09	1.55	3.09	1.55
TM	-.77	---	-3.13	---	3.13	---
OT	.01	-.01	.69	-.69	.69	.69
D_1	---	-1.91	---	-.66	---	.66
D_2	---	-.003	---	-.001	---	.001
		Net Total Impact	.65	.20		
			Total Absolute Impact		6.91	2.9

CONCLUSION AND REMARKS

The purpose of this paper has been to examine the existence of Barr's price and export models for steel products, and to find predictive models for price and volume of exports in steel industry. The results of this study indicate that although Barr's price model well explains the change in price of steel products, it has lower predictive power than the proposed price model (equation 1). On the contrary, the Barr's adopted export model resulted in a lower RMSE than equation 5. The outcome of the study suggests the following major conclusions.

1. The devaluations of the dollar have had a negative impact on the volume of export (although the opposite was expected to be true) and have raised the price of steel products to consumers.
2. The increase in raw steel production by other countries may result in future increases of U.S. export of steel products.
3. The impact of raw steel production by other countries (excluding the major competitors) on the price of U.S. steel products is much greater than other factors (beta coefficient = .56)
4. Barr's adopted export model performance is better than the alternate equation estimated in this paper.
5. U.S. exports of steel products have had a negative trend since 1961 and it may be due to major government policies of the 1960s and 1970s, the high cost of labor in producing these products, and the need for faster modernization of the steel industry.

This study and a number of other studies and reports do not foresee a shining future for the U.S. steel industry. With real GNP estimated to grow at about 3 percent next year, the outlook for the industry is far from buoyant. Experts believe that shipments can climb 20 percent in 1983, largely reflecting the absence of inventory liquidation. However, it may not bring the industry back to breakeven point, given the present cost-price relationships. If a stronger-than-expected economic recovery materialized, then the steel industry may afford some price relief and an increase in the export of steel products (see the beta coefficient for TM). Moreover, if meaningful wage concessions can be obtained from steelworkers in bargaining talks in the future, at least modest profitability in steel operations can be restored. Many experts believe that the industry is in the midst of a major transformation that will ultimately leave the U.S. with a few giant producers. Whatever the case, employment seems sure to shrink if workers do not end up with a meaningful wage concession and the future of the high paid mill hand will continue to be bleak.

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NOTES:

1. Kaminarides, John and Javad Varzandeh, "an Analytical Study of Export-Import Ideas, 1961-1979." Midsouth Journal of Economics, Vol. 6, Nov. 2, p. 327, Aug. 1982.
2. US. Industrial Outlook, 1981.
3. The Value Line Investment Survey, No. 17, 1982.
4. The composite figures for industrial companies consist of over 950 major industrial, retail, and transportation companies.
5. These equations are corrected for problems of serial correlation, using non-linear least square technique.
6. The 1978 devaluation of the dollar is not taken into consideration in this study.
7. In addition to a a higher RMSE, equation 2 has a higher estimated forecast error of 75.66 and 72.51 in comparison with 10.2 and 9.6 for equation 1 in 1982 and 1981, respectively.
8. The total impact is.56 + .20 = .76.
9. Equations 4 and 5 are properly corrected for problems of serial correlations using non-linear least square technique.
10. See Table 3 and notice the total impacts of these policies (.45 + .03 = .48) on price of steel products.

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