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# **The Impact of Financial Price Risk on the U.S. Nonferrous Metals Industry**

**By Fredricka Santos and Thomas Rasmussen**

**U. S. DEPARTMENT OF THE INTERIOR**

**Bruce Babbitt, Secretary**

**U. S. BUREAU OF MINES**

**Rhea Lydia Graham, Director**

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# THE IMPACT OF FINANCIAL PRICE RISK ON THE U.S. NONFERROUS METALS INDUSTRY

By Fredricka Santos<sup>1</sup> and Thomas Rasmussen<sup>2</sup>

## ABSTRACT

The U.S. Bureau of Mines studied the effects of dramatic changes in the financial environment of the U.S. nonferrous metals industry. Fluctuations in metals prices, exchange rates, and interest rates during two time periods—the post World War II era until the early 1970's, and the early 1970's until 1992—show a dramatic increase in volatility in the sources of financial risk for the nonferrous metals industry. Price and exchange rate volatility, measured by the average magnitude and standard deviation of monthly changes in revenues from the sale of

25,000 lbs of aluminum, copper, lead, and zinc prices show dramatic increases between the first and second periods. For example, the average magnitude of revenue changes caused by changes in the prices of aluminum and zinc increased more than five-fold in the second period. This comparison of the volatility of prices and exchange rates between the two periods reveals significant growth in financial price risk and documents the emergence of a more volatile financial environment for nonferrous metals producers and processors.

## INTRODUCTION

More than 20 years ago, Congress passed the "Mining and Minerals Policy Act of 1970." That act states that it is the continuing policy of the Federal Government in the national interest to foster and encourage enterprise in "the development of economically sound and stable domestic mining, metal and mineral reclamation industries." To this end, the U.S. Bureau of Mines engages in program activities whose objective is to promote the economic health and well-being of the domestic metals industry. These activities include information generation and distribution, analysis and research. In the past, there was less concern about the financial price risk facing the minerals firms because foreign exchange rates were fixed, interest rates on U.S. bank deposits were contained by federally imposed ceilings, and metals prices were dampened by producer pricing. By the early 1970's, these controls were removed, and sharp oscillations occurred in exchange rates, interest rates, and metals prices.

Thus, metals markets not only moved away from producer pricing, becoming very competitive and global in scope; they became highly volatile. This paper will demonstrate analytically and empirically, the very different financial

environment in which metals producers and processors of the 1990's must operate. It begins by summarizing the movements away from —

- Producer pricing;
- Fixed exchange rates;
- Interest rate ceilings.

It goes on to compare fluctuations in metals, prices, exchange rates, and interest rates during the post World War II era until the early 1970's and then from the early 1970's until 1992. Finally, historical data on aluminum, copper, lead, and zinc prices and US\$/Yen exchange rates are used to calculate measures of price and exchange rate volatility. A comparison of price and exchange rate volatilities between the two periods reveals its significant growth and substantiates the challenging financial environment encountered by both large and small metals producers and processors.

As a result of the large price fluctuations which began in the early 1970's, revenues became more unpredictable and net earnings often revealed a frustrating volatility experienced by companies trying to meet their operating expenses, as well as to pay dividends to their shareholders. Metals producers and processors subsequently faced a greater need

<sup>1</sup> Senior economist, Office of Special Projects, U.S. Bureau of Mines, Washington DC, (now with the World Bank, Washington DC).

<sup>2</sup> Physical scientist, Office of Special Projects, U.S. Bureau of Mines, Washington DC.

to develop and use financial instruments and strategies to protect against these oscillations.

Detailed information on the strategies used by producers and processors and their success is not readily available. Presumably, those mining companies that are successfully

engaged in such programs feel that they have a competitive edge over other firms and do not want to give away that advantage. Those firms that are less successful in protecting themselves against unstable earnings would not be eager to make this information available.<sup>3</sup>

## THE PROBLEM: FINANCIAL PRICE RISK

This section will define financial price risk and analyze and quantitatively measure the changes which took place to make it a troublesome problem for asset/liability management carried on by domestic metals producers and processors. Basic asset/liability management dictates that, whether a company is large or small, it should generally earn a return on the assets it holds (under and above ground) greater than its costs per period. Such an approach is not difficult to effect if the return on assets is stable and exceeds costs which are long term and fixed. As we will see, this was largely the case for U.S. mining companies until the early 1970's. Prices did not fluctuate and costs reflected long-term financing ranging from 5 to 15 years.<sup>4</sup> Therefore, financial price risk was not a problem; it is now.

Financial price risk, defined in its broadest sense, refers to the possibility of rapid and large increases in any or all of the following:

1. Metals prices.
2. Exchange rates.
3. Interest rates.

These volatilities represent a long-term pattern reflecting underlying changes in financial markets. Volatility, deriving from any of the above three sources of financial price risk, can result in declining earnings and possibly losses even for richly endowed, well-situated mining companies, whether large or small.

## AN EXAMPLE OF FINANCIAL PRICE RISK

Consider the quarterly net cash flows received by a U.S. mining company exposed to changes in metals prices, interest rates, and exchange rates. Suppose the firm finances its operation with floating-rate dollar denominated debt and the interest rate charged is adjusted quarterly. If most of the firm's mining operations are in another country, the company needs to make payments for labor and other factors of production in the currency of the foreign country. The dollar denominated revenues from the sale of the metal depend on the world price. Thus, the net cash flows suffer from a high degree of financial price risk stemming from exposure to the possibility of:

1. Increasing interest rates which will raise the cost of servicing debt.
2. Falling metal prices which will diminish revenues from the sale of the metal.
3. Dollar depreciation which will make it more expensive to meet expenses abroad.

If large enough, any one of these movements could result in a loss. If all three move adversely, then the loss depends on the aggregated effect. On a quarterly basis, diverse movements in 1, 2, and 3 can put a U.S. mining company and its net earnings on a financial roller coaster. Under such circumstances, there would be an acute need to hedge the firm's net equity value (the difference between the market value of the firm's assets and the market value of its liabilities).

<sup>3</sup>In September 1992, the Office of Special Projects of the U.S. Bureau of Mines informally surveyed representatives of five domestic mining companies (Arimetco International Inc., ASARCO Inc., Cyprus Minerals Co., Magma Copper Co., and Phelps Dodge Corp.). This survey revealed that only one used futures contracts and options to hedge its foreign exchange risk. Of the four remaining companies, one had no foreign currency exposure and the other three tried to offset their exposure by matching foreign currency assets with foreign currency liabilities.

<sup>4</sup>The informal survey showed that the five companies surveyed had all arranged fixed rate financing with maturities ranging from 5 to 15 years.

## MOVEMENT AWAY FROM PRODUCER PRICING TO GLOBAL AND COMPETITIVE METALS MARKETS

Mining companies in the United States are no longer participants in the markets where prices are controlled, i.e., producer pricing has lost out to competitive pricing. Furthermore, they are players in markets for metals that are global in scope. Before World War II, U.S. mining companies traded in U.S. markets where producer pricing prevailed as a way to stabilize short-term earnings period by period. There were essentially two metals markets, the U.S. market and the rest of the world. This was possible because the United States was relatively self-sufficient in metals production and the trading of metals internationally (except for the World War II period) was modest, partially due to trade barriers. After World War

II, with takeovers and nationalizations of mines in countries like Chile and Zambia, domestic producers lost a significant share in the world production of nonferrous metals. Furthermore, foreign producers added most of the world's new smelter capacity, while U.S. smelters tended to close because of environmental constraints and technical obsolescence, among other reasons. Because of these changes, plus the removal of trade barriers, company cartels or similar agreements, and price support programs by the major world metal producers, there ceased to be a separate U.S. market.<sup>5</sup> Nonferrous metals prices became competitively determined in international markets.

## MOVEMENT AWAY FROM FIXED EXCHANGE RATES AND INTEREST RATE CEILINGS

Not only were nonferrous metals prices liberalized, so were exchange rates and interest rates. Empirical evidence shows that during the past 20 years market economies began to experience sharp and unexpected swings in foreign exchange rates, inflation rates, interest rates, and metals prices. That is, lower price levels and lower volatility characterized metals markets before 1972 as compared to the 1972-92 period (figure 1).<sup>6</sup> Before 1972, exchange rates were fixed with respect to the U.S. dollar, and interest rate ceilings constrained rates offered on U.S. bank deposits.

The change in exchange rate patterns is observable when we examine movements of the dollar in relation to the German mark, Japanese yen, and Swiss franc (figures 2A through 2F). Very stable exchange rates existed from the 1950's up through the second quarter of 1971. These rates, which changed infrequently and by very small amounts, did so only because the relevant central banks decided that a currency had become over or undervalued in international markets and took corrective action. For example, figure 2A shows that the German mark was considered undervalued and subsequently revalued twice during the 1951-71 period, in 1961 and in 1969 (i.e., more dollars had to be paid for each mark). Figures 2B, 2D, and 2F, pertaining to the post-1971 period, reveal a dramatic increase in exchange rates volatility and an overall trend toward dollar devaluation (again, more dollars needed to purchase each unit of a foreign currency).

After 1979, interest rates followed a path similar to that of exchange rates and began fluctuating (see figure 3). Both short-term interest rates (represented by the 3-month Treasury Bill rate) and long-term rates (reflected in the 10-year Treasury Bond rate) experienced a sudden burst of volatility. Since prices, interest rates, and exchange rates are interrelated, the

volatility of one tended to affect the volatility of the others.

The unprecedented level of price, exchange rate, and interest rate volatility since 1971 is itself a function of two major financial market deregulations with significant international repercussions.<sup>7</sup> The first occurred in 1971 with the collapse of the Bretton Woods agreement. Under the Bretton Woods System of fixed exchange rates, the dollar was valued at \$35 per ounce of gold, and the value of other currencies was tied to the dollar. The major world currencies could be pegged to the dollar because the countries involved cooperated by manipulating their economic policies to maintain fixed exchange rates. When the dollar ceased to be convertible into gold, exchange rates were determined by market forces and a floating exchange rate system came into being. The abrogation of the Bretton Woods agreement meant that the dollar was no longer the international medium of exchange.

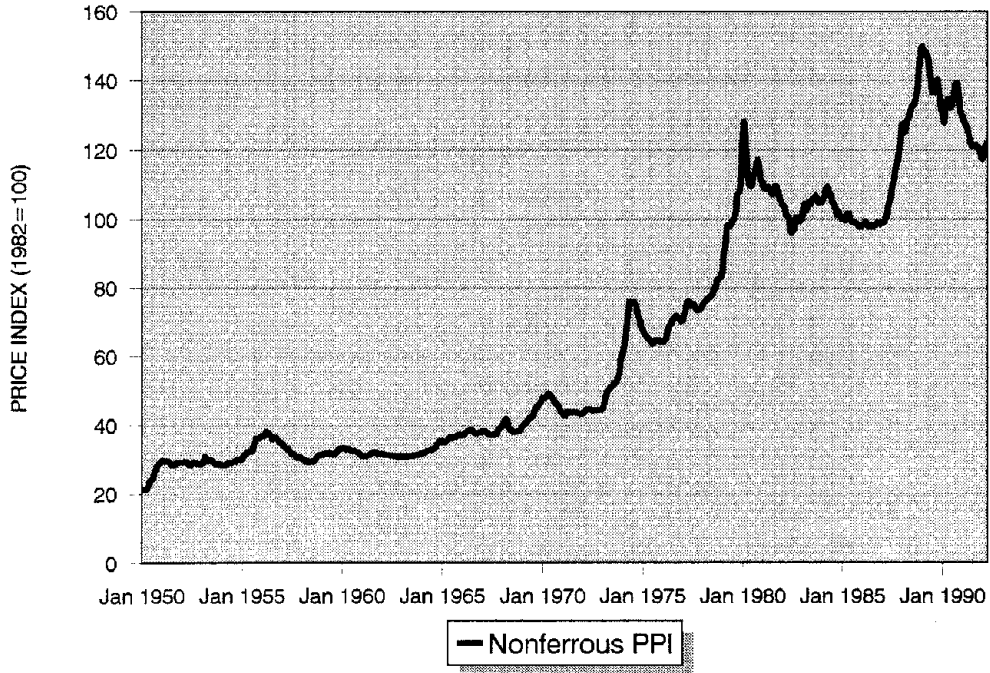
The second deregulation occurred in 1979, when the Federal Reserve stopped targeting the interest rates paid by banks on deposits so the banks could compete with interest rates offered by money market funds. The deregulation of

<sup>5</sup>This period is aptly described in Rudolf Wolff & Co. Ltd., *Wolff's Guide to the London Metal Exchange*, 4th edition, 1991, pp. 16-24; see also, Simon D. Strauss, "Producer Prices Versus Futures Market Quotations." Paper presented at the A.I.M.E. Symposium on Internationally Traded Minerals, March 6, 1986; U.S. Bureau of Mines, *Nonferrous Metal Prices in the United States*, U.S. Government Printing Office, 1991. In particular, see the chapters on aluminum, copper, lead, and zinc.

<sup>6</sup>The nonferrous metals price index includes prices for aluminum, copper, lead, tin, and zinc. This study will not analyze tin prices because tin mining in the United States has never been significant.

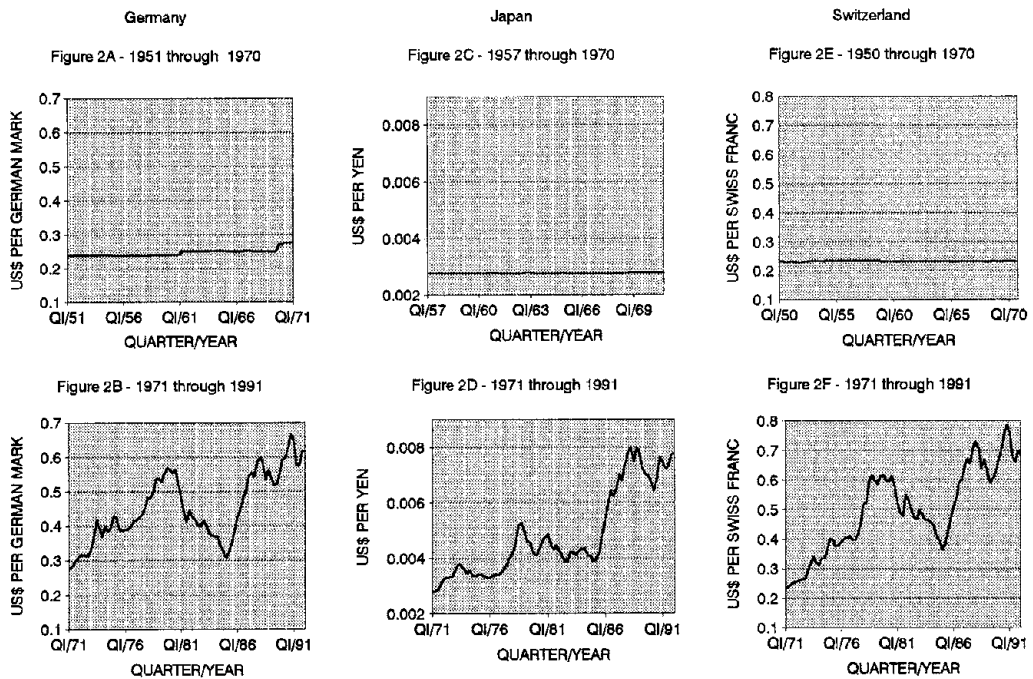
<sup>7</sup>See discussions in George Hanjincolau, "The Place of Interest Rate Swaps in Financial Markets," in *Interest Rate Swaps*, ed. by Carl R. Beidleman (Homewood, Illinois: Business One Irwin, 1991), pp. 30-37; Clifford W. Smith, Jr., Charles W. Smithson, and D. Sykes Wilford, *Managing Financial Risk*, (New York: Harper & Row, 1990), pp. 4-10.

**Figure 1**  
**Nonferrous metals producer price index**



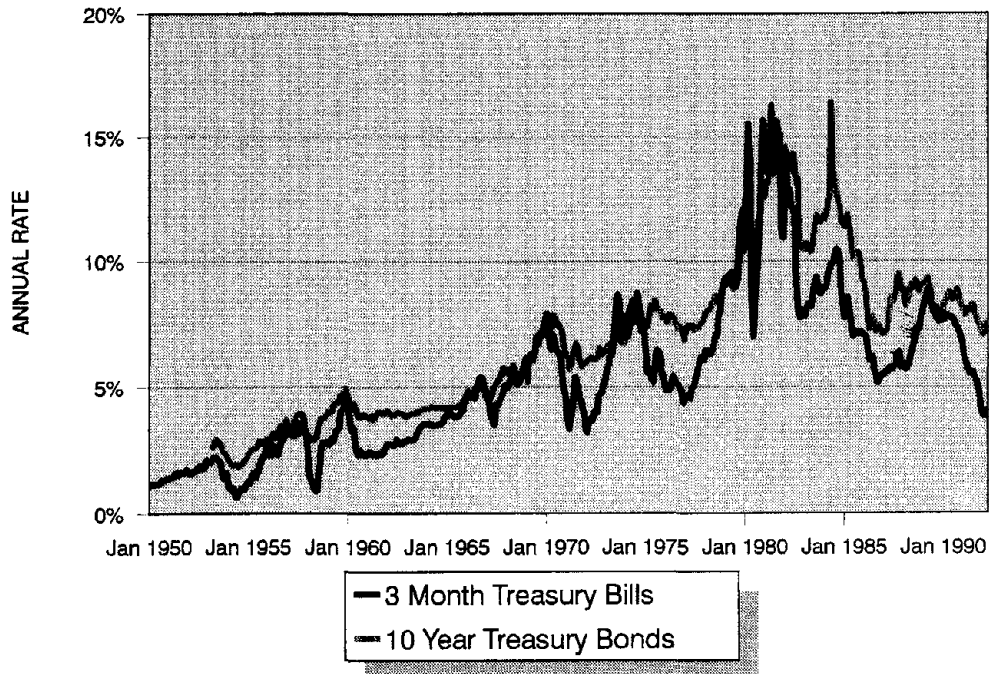
Source: Department of Labor, Bureau of Labor Statistics (not seasonally adjusted).

**Figure 2**  
**Foreign Exchange Movements**



Source: Board of Governors of the Federal Reserve System, *Foreign Exchange Rates*, Statistical Release G.5 (405).

**Figure 3**  
**Interest Rates**



Source: Board of Governors of the Federal Reserve System, *Selected Interest Rates*, Statistical Release G.13 (415).

exchange rates and interest rates had an extraordinary impact on world financial markets, whether they were markets for debt instruments, foreign exchange, or commodities such as copper.

### **POLICY CHANGE TO FLOATING EXCHANGE RATES**

Since metals traded internationally are usually priced in U.S. dollars, those mining firms that only operated and traded domestically escaped and need to consider exchange rate movements. However, those U.S. mining companies in the post-1971 era which did operate and/or trade abroad could no longer rely on exchange rate stability when entering into contracts. Allowing exchange rates to "float" against the dollar meant that U.S. mining companies would face uncertainty in the dollar value of cash flows from any contract for future delivery of a given amount of metal for a fixed amount of foreign currency. The dollar value of foreign currencies fluctuated according to free market forces, and the changes in the relative value of the currencies could have adverse effects on the profits and balance sheets of those U.S. mining companies with revenues and expenditures in different currencies.

To illustrate the adverse effect price fluctuations can have on a company's profits, consider the following example. A U.S. copper producer agreed to sell 25,000 pounds of copper to a German metals trader 3 months in the future for DM38,250. The exchange rate when the copper producer signed the contract is 0.6536 US\$/DM, and copper's market price is \$1 per pound. Therefore, the copper would generate \$25,000 in revenues under the conditions that prevailed when the contract was signed. Even if the market price of copper remains the same over the next 3 months, the dollar value of the sale could decline if the dollar appreciates against the mark. For example, if the dollar appreciated to an exchange rate of 0.6170 US\$/DM, the copper producer's dollar revenues would only be \$23,600. Thus, the copper producer would suffer an implicit loss of \$1,400.

U.S. mining companies with mining or other operations abroad may find it desirable to earn a specific foreign currency instead of dollars. A company can use foreign currency revenues to pay expenses denominated in the foreign currency. Predicting exchange rate movements is very difficult because of the many factors that can affect it. For example, exchange rates are sensitive to the monetary and fiscal policies, balances of trade, political risk, and the growth rate of the economy in each given country, as well as possible intervention in foreign exchange markets by the central banks of major industrialized nations. Therefore, if a firm has

foreign currency transactions, it must operate responsibly by considering the increased risk which has arisen in the last 20 years from adverse movements in exchange rates. It can do so by offsetting its exposure by hedging with instruments like foreign exchange futures, options, or swaps, and by matching the specific currency of its sales revenues and assets with that of its expenses and liabilities.

### **Floating Exchange Rates and the Value of the Dollar**

Because the dollar had been the international medium of exchange, and because of large U.S. expenditures abroad from 1945 to 1970 (and, therefore, a sizeable balance of payments deficit), an excess of dollars remained outside the United States. With the change from fixed to floating exchange rates, this dollar surplus led to a longer term weakening of the dollar with respect to major currencies such as the German mark and the Japanese yen. Devaluation of the dollar meant that U.S. imports cost more. This had the effect of increasing pressures to raise domestic prices.

Since oil prices were denominated in U.S. dollars, the devaluation of the dollar resulted in reduction in revenues for world oil producers. The oil price shock of 1973 largely reflected a response to low export revenues for the world's oil producers. The result of the shock was a burst of inflation across oil-consuming countries, which varied according to the monetary, fiscal, and exchange rate policies of each country. The resulting impacts on price levels and interest rates across countries served to further exacerbate fluctuations in exchange rates.

### **POLICY WITH RESPECT TO INTEREST RATES**

As the average price level rose after financial deregulation, so did domestic interest rates. In the United States, double-digit inflation led to double-digit interest rates. Banks, locked into Regulation Q<sup>8</sup> interest that a bank could pay on a passbook savings account was only 5% , while the annual rate of inflation was 7.6%, thereby providing a depositor with a negative real return of 2.6%. Banks and thrifts were

therefore unable to compete with the market return offered by money market funds, a deposit substitute which came into being in 1972. Money market funds were based on pools of Treasury Bills, investment grade (Baa or better) corporate bonds, and large commercial bank certificates of deposits (CDs with face values greater than \$100,000 and, therefore, not subject to regulation Q). In the late 1970's, Treasury Bill rates jumped to double digit levels. Money Market funds proliferated, climbing from assets of \$3 billion in 1977 to \$233 billion in 1982, as depositors sought to earn a return that would more than offset the rate of inflation and therefore provide a positive real return.

The increase in the assets of money market funds at the expense of banks and thrift institutions was so pronounced that Congress began taking steps in 1979 to phase out interest rate ceilings on deposits.<sup>9</sup> Congress enabled banks and thrifts to pay competitive rates on their deposits by passing the Depository Institutions Deregulation and Monetary Control Act in 1980. This legislation ordered the phasing out of Regulation Q interest rate ceilings by 1986.

Interest rate deregulation resulted in an increase of domestic interest rates to levels well above 10% per annum. Worse yet, the volatility of interest rates jumped dramatically. For example, in 1980, the 3-month Treasury Bill rate (a measure of short-term borrowing costs) moved up or down an average of 2.8% each month, while the 10-year Treasury Bond rate fluctuated an average of slightly more than 1% each month. This volatility in interest rates drove many firms with interest-sensitive assets or interest-sensitive liabilities into insolvency. Thrift institutions are a case in point, having lent long term at low rates and borrowed short term. The revenues from their assets were comparatively low, and the rates upon which these revenues were based were locked in for 10, 20, even 30 years. Their liabilities, on the other hand, matured in a matter of months, and the new short-term funding was available at higher costs that were very volatile.

<sup>8</sup>In the Banking Act of 1933, Congress prohibited banks from paying any interest on demand deposits and delegated to the Federal Reserve the authority (Regulation Q) to set ceiling rates on time and savings deposits.

<sup>9</sup>These developments are described in detail in Robert E. Litan, *What Should Banks Do?*, (Washington DC.: The Brookings Institution, 1987), pp. 32-35; Lawrence J. White, *The Savings & Loan Debacle: Public Policy Lessons for Bank and Thrift Regulation*, (New York: Oxford University Press, 1991), pp. 58-74.

## HOW WERE U.S. METALS PRODUCERS AND PROCESSORS AFFECTED?

In contrast to thrift institutions with their short-term liabilities, metals producers and processors are generally funded longer term. Medium- and long-term debt issues at fixed interest rates and with maturities of 5 to 10 years are commonly used to finance expansion of mining operations and purchase of new plant and equipment.<sup>10</sup> Therefore, the costs of borrowing for mining companies were more stable than those of firms forced to engage in shorter term borrowing and exposed to an adverse change in interest rates change upon maturity of the loan.

Interest rate movements, however, do not affect the asset side of the balance sheet to the extent that metals prices reflect the opportunity cost of storage. If real interest rates rise, there is implicitly greater income foregone from bearing the cost of holding inventories of metals (cost of carry). That is, instead of paying to warehouse a stock of metal, any company could have been investing the money at a higher return. The net revenue from selling a metal (price times quantity minus inventory cost) therefore tends to decline as the inventory cost component rises, unless a compensatory upward adjustment is made to the price of the metal.

After 1979, firms were exposed to sharp interest rate movements (figure 3) and, as a result, asset liability management became essential. For example, a firm might experience funding which matures within 1 month and reprices from an interest cost of 7% to 8%, because of the rising cost of carry. The result is a negative interest spread of 0.5%. Sharp interest rate movements also served to exacerbate<sup>11</sup> movements in the value of the U.S. dollar against other major currencies. Therefore, to the extent that contracts were denominated in currencies other than the U.S. dollar, asset/liability management had to increasingly consider foreign exchange risk.

### CHANGES IN THE NONFERROUS METAL FIRMS' EXPOSURE TO LOSS OWING TO PRICE MOVEMENTS AND EXCHANGE RATE FLUCTUATIONS

The quarterly exposure to sharp drops in sales revenue of U.S. aluminum, copper, lead, and zinc mining companies engaged in the sale of nonferrous metals 3 months in the future is traced out in Appendix A and shown graphically in figures

<sup>10</sup>See footnote 1.

<sup>11</sup>Purchasing power parity and its corollary, interest rate parity, theorize that exchange rates will adjust in a manner appropriate to changes in the difference between two countries' real market interest rates and real prices. The literature is replete with efforts to prove one or the other parity empirically, but only, at best, moderate success. Cumby and Obstfeld, among others, argue that classical parity relationships are far too simple to provide adequate explanation for the substantial exchange rate movements seen in recent years. See Robert E. Cumby and Maurice Obstfeld, "International Interest Rate and Price Level Linkages Under Flexible Exchange Rates: A Review of Recent Evidence," in *Exchange Rate Theory and Practice*, ed. by John Bilson and Richard Marston (Chicago, The University of Chicago Press, 1984), pp. 121-151.

4 through 7. For each of these nonferrous metal industries, the gain or loss in revenue from historical price changes and exchange rate movements was estimated and the net gain or loss from such changes. The Yen/US\$ exchange rate was used as a basis for calculating gains (losses) from exchange rate changes during the quarter, since the greatest share of U.S. base metals exports goes to Japan and Canada. It is assumed in each case that the metals are being sold in quantities of 25,000 lbs, a standard unit of deliveries specified in Commodities Exchange (COMEX) contracts. Quarterly Price changes and Yen/US\$ rate changes were obtained from 1957 through 1991, to demonstrate the relative size of the exposures to drops in sales revenues of mining companies owing to price risk and exchange rate risk, before and after deregulation of world financial markets.

### Tracking the Pure Price Effect over Time

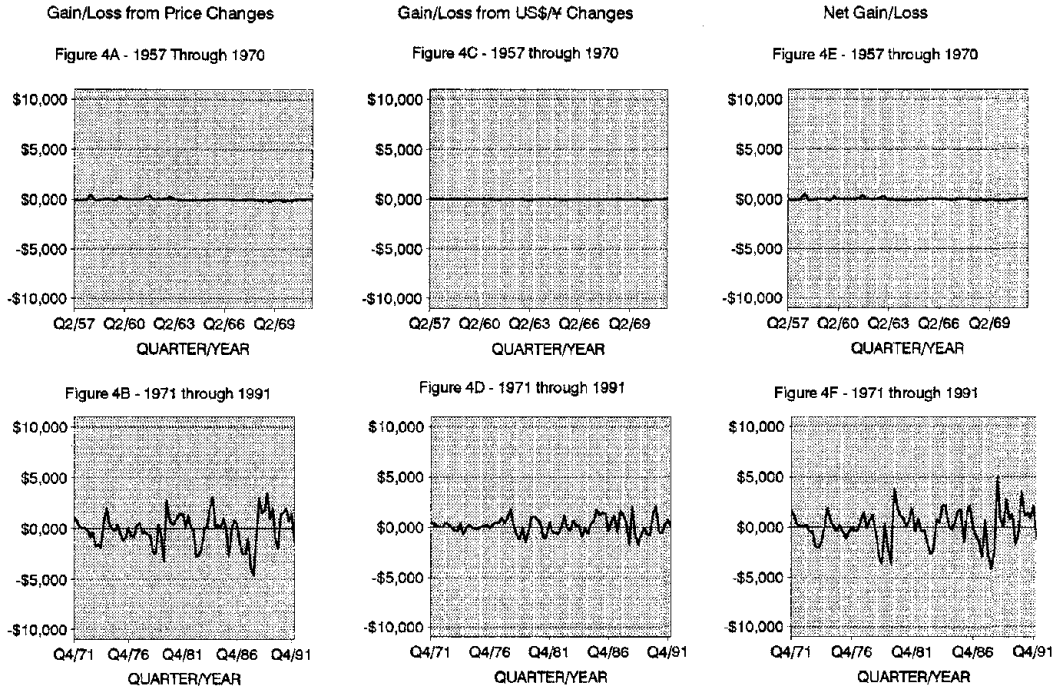
Column 1 in Appendix A provides estimated gains or losses in quarterly revenue owing to historical price changes of a particular metal over each quarter. It is assumed that the contractual price locked in at the beginning of the quarter is the (historical) average pertaining to the previous quarter.<sup>12</sup> It is assumed that there is no change in the exchange rate, so that the dollar amount recorded in column 1 of Appendix A (and shown graphically in figures 4A - 7A and 4B - 7B) represents the implicit gain or loss from contracting to sell a metal at a given price. In other words, the "pure" effect of a price change during the quarter is observed. Should the price increase over the quarter, an implicit loss results, since the firm has already committed to selling its metal at the lower price and cannot make the sale at the new higher price. A price decrease would have the opposite effect, causing an implicit gain from selling the metal at the higher price specified in the contract. Figures 4A to 7A show comparatively small revenue gains and losses from price changes during the period 1957 through 1971. After 1971, the size of the gains and losses shown in figures 4B - 7B increased dramatically, especially for copper.

### Tracking the Pure Exchange Rate Effect over Time

The estimates in column 2 of Appendix A are based on the assumption that prices remained constant, but that the firm has contracted to receive payment in yen from a Japanese company at a Yen/US\$ rate which reflects the historical

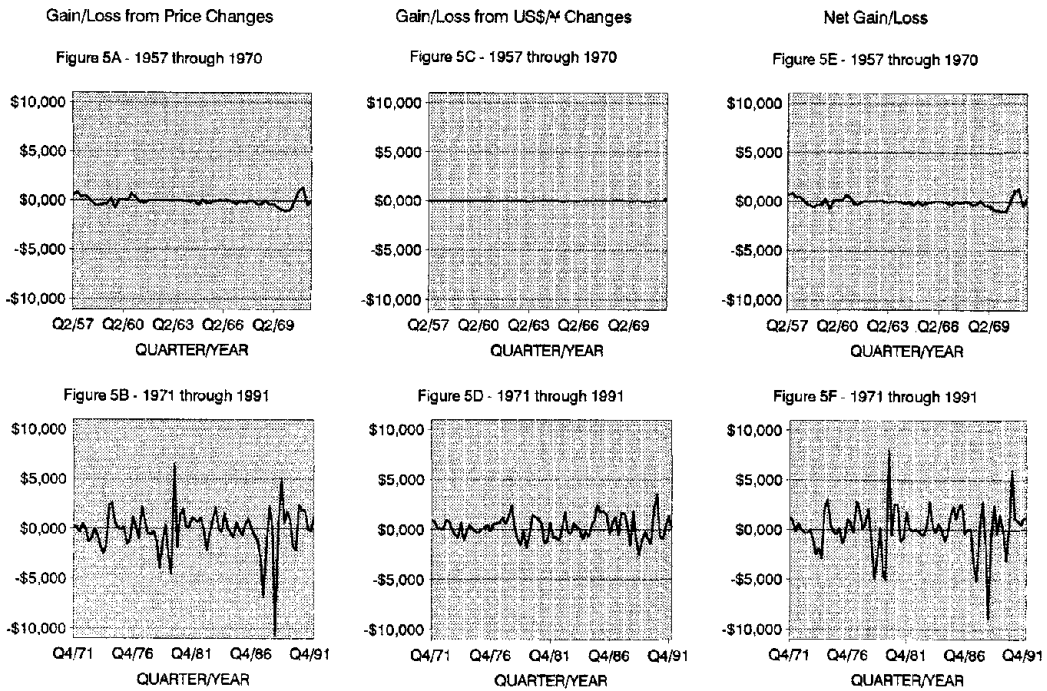
<sup>12</sup>The informal survey taken by the Office of Special Projects suggests that the contractual price negotiated by U.S. copper companies usually reflects the spot price on either the Commodities Exchange (COMEX) or the London Metal Exchange (LME).

**Figure 4**  
Aluminum Revenue Gains and Losses



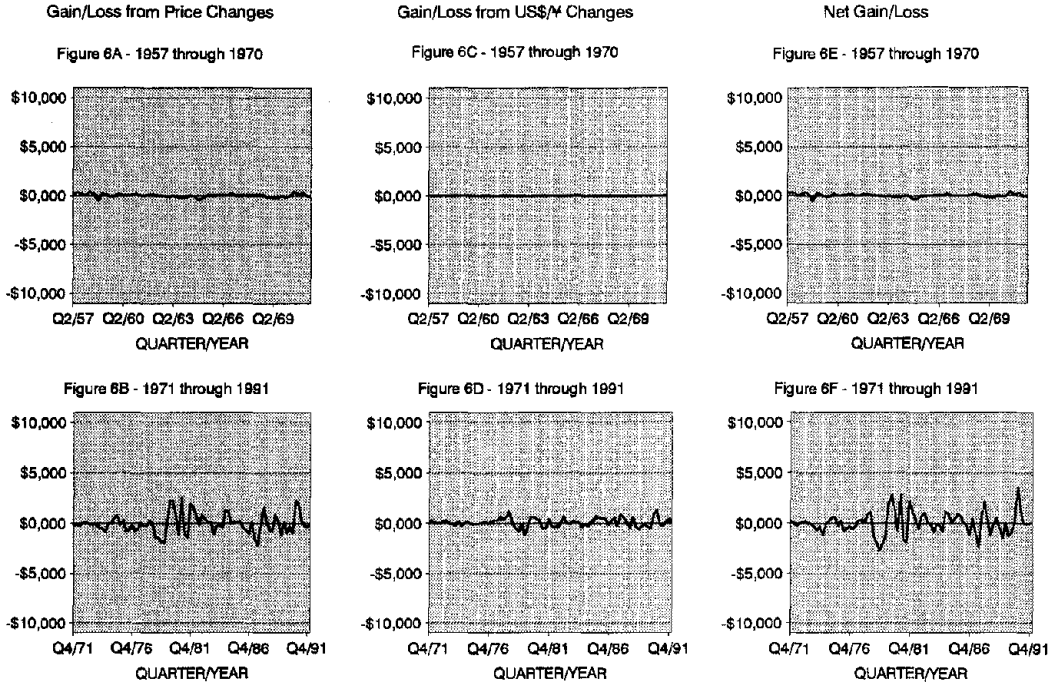
Source: Appendix A.

**Figure 5**  
Copper Revenue Gains and Losses



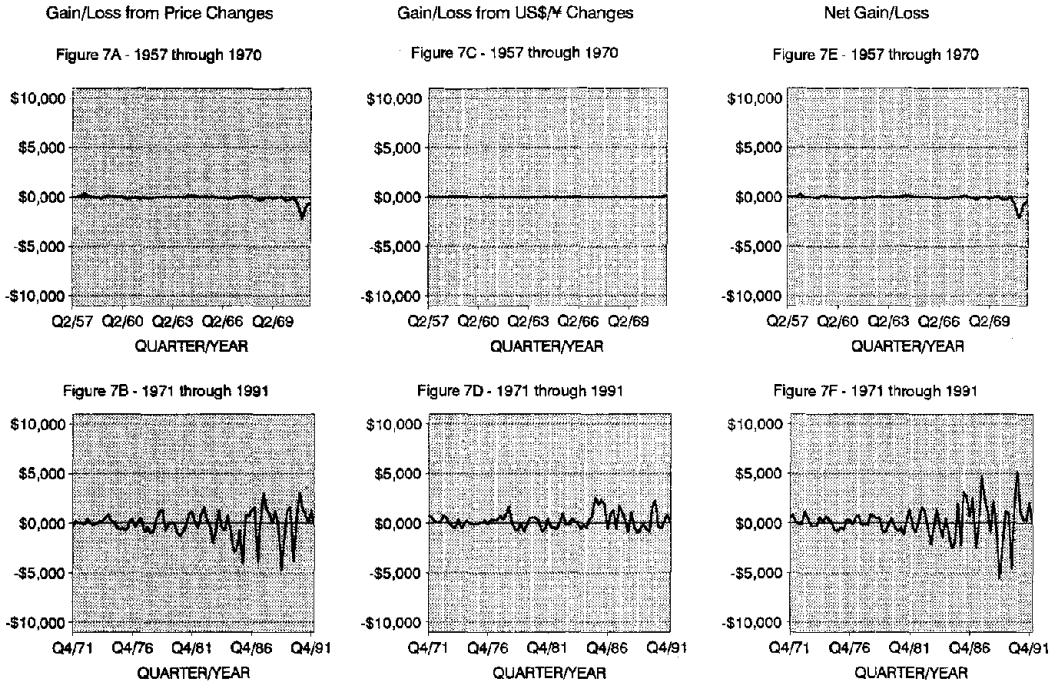
Source: Appendix A.

**Figure 6**  
Lead Revenue Gains and Losses



Source: Appendix A.

**Figure 7**  
Zinc Revenue Gains and Losses



Source: Appendix A.

average for the previous quarter. During the current quarter, the exchange rate may remain constant or move up or down. If the Yen/US\$ rate appreciates, there is an implicit gain from having contractually locked in an exchange rate that provides more yen for each dollar of revenue. The mining company making the sale can turn around and exchange yen at the newly appreciated exchange rate (fewer yen are needed to buy each dollar). Here, the effect of a "pure" exchange rate change has been to provide the mining company with an unanticipated gain. Obviously, should the yen depreciate, the company will suffer an unanticipated loss owing to the pure exchange rate effect. These movements are shown for each metal in figures 4C - 7C and 4D - 7D. Revenue gains or losses owing to US\$/Yen change were almost nil until 1971 and then became very evident thereafter. However, the absolute size and volatility of the exchange rate-induced revenue changes were much less than those induced by movements in metals prices.

### Tracking the Net Gain (Loss) over Time

Column 3 of Appendix A reflects the net dollar gain or loss in revenue from each quarterly transaction, assuming that the contract was denominated in yen and both metals prices and the exchange rate change. This net dollar amount (calculated by summing the gains and losses shown in columns 1 and 2) indicates the net size of fluctuations in the firm's quarterly revenues owing to price and exchange rates changes.

In some quarters, the price effects and exchange rate effects reinforce each other. In other quarters, the two effects offset one another. For example, in the fourth quarter of 1988, a drop in the copper price, which caused an implicit loss of \$10,760 in revenue, was partially offset by a small gain of \$1,833 from a change in the exchange rate. This caused a net loss of \$8,927 or almost 25% of the value of the copper ( $\$8,827 / (25,000 \text{ lbs} \times \$1.5052/\text{lb})$ ). Figures 4E-7E and 4F-7F indicated that the net revenue gains or losses were mainly affected by metals price changes as they followed a pattern very similar to that shown in Figures 4A - 7A and 4B - 7B.

### Comparison of Volatility Between the Two Periods

Any firm experiencing such quarterly fluctuations would find it difficult to judge its ability to meet its future short-term expenses. Furthermore, potential investors would tend to be unwilling to provide financing (whether as debt or equity) to an enterprise with such uncertain cash flows. If they did so, it would only be at a return which incorporated a very high risk premium.

Table 1 provides statistics which summarize the sales and revenue gains and losses shown in Appendix A and figures 4 through 7 by presenting average quarterly revenue changes (absolute dollar amounts) owing to "pure" exchange rate changes for two periods — before and after the financial

Table 1. — Quarterly Revenue Changes

|                       | (1)<br>Average<br>magnitude of<br>price related<br>changes <sup>1</sup> | (2)<br>Average<br>magnitude of<br>exchange rate<br>related changes <sup>1</sup> | (3)<br>Average<br>magnitude of<br>net changes <sup>1</sup> | (4)<br>Standard<br>deviation of<br>price related<br>changes | (5)<br>Standard<br>deviation of<br>exchange rate<br>related changes | (6)<br>Standard<br>deviation of<br>net changes |
|-----------------------|---|---|--|---|---|--|
| <b>Aluminum</b>       |   |   |  |   |   |  |
| QII/57 through QIV/78 | \$267.25  | \$124.14  | \$284.52   | \$432.55  | \$265.42  | \$477.27                                       |
| QI/79 through QI/92   | \$1,484.34  | \$797.26  | \$1,616.06   | \$1,097.70  | \$534.19  | \$1,176.56                                     |
| <b>Copper</b>         |   |   |  |   |   |  |
| QII/57 through QIV/78 | \$495.78  | \$201.31  | \$558.11   | \$601.33  | \$388.03  | \$698.53                                       |
| QI/79 through QI/92   | \$1,719.54  | \$1,083.39  | \$1,824.99   | \$2,001.39  | \$716.48  | \$2,057.02                                     |
| <b>Lead</b>           |   |   |  |   |   |  |
| QII/57 through QIV/78 | \$201.84  | \$76.19   | \$227.33   | \$237.46  | \$170.93  | \$259.85                                       |
| QI/79 through QI/92   | \$883.33  | \$399.41  | \$1,023.77   | \$720.78  | \$282.34  | \$873.48                                       |
| <b>Zinc</b>           |   |   |  |   |   |  |
| QII/57 through QIV/78 | \$222.66  | \$124.73  | \$241.64   | \$325.18  | \$258.67  | \$339.45                                       |
| QI/79 through QI/92   | \$1,217.53  | \$725.24  | \$1,466.40   | \$1,093.18  | \$599.37  | \$1,299.36                                     |

<sup>1</sup> Calculated using absolute values of estimated revenue changes - (Appendix A).

deregulation previously discussed. That is, taking the periods (1) 1957 through 1978 and (2) 1979 through the first quarter of 1992, we would expect to observe greater revenue instability in the second period. Indeed, column 1 of table 1 shows that, on average, aluminum price movements for the period 1957 through 1978 caused an average revenue change of \$267. Quarterly price movements pertaining to the second period, 1979 through Q1/1992, had an average impact on revenue almost six times greater, i.e., \$1,484. These estimates represent the effects of price fluctuations assuming no other changes. For each metal, the difference in mean impacts pertaining to the periods was tested and found to be significant at a 95% level of confidence.

Now let us examine column 2 of table 1, where only the Yen/US\$ exchange rate changes, and observe the impact of these changes on average quarterly revenue from the sale of 25,000 lbs of a metal. The impact of exchange rate movements on sales revenue is about half that of price changes. Nevertheless, a similar pattern is observable; gains and losses in revenues during the second period were far greater than those observed in the first period. Again, this difference was found to be significant for all four metals at a 95% confidence level.

## RATIONALE FOR HIGH METAL PRICE VOLATILITY

Why don't gains/losses from movements in the Yen/US\$ rate fluctuate as much as gains/losses arising from changes in metals prices? Perhaps because the floating exchange rate system actually reflects a "managed float," where central banks can and do intervene in foreign currency markets in order to dampen fluctuations. Central banks do not intervene in commodities markets. Furthermore, as mentioned previously, metals markets have become more globally competitive. Thus, the comparatively large fluctuations in metals prices seen in table 1 appear to be free-market determined and may reflect the market's efforts to incorporate or subsume a price adjustment to compensate for various factors tending to modify the real value of sales revenue (from a given quantity of metal). Factors which could affect revenues include recent changes in the value of the dollar relative to other currencies (hurting the mining company if the value of the dollar depreciates relative to the currency that firms often use to meet expenses), recent changes in interest rates suggesting modifications in the opportunity cost of transporting and storing the metal, and recent jumps in inflation which reflect sharp changes in the cost of inputs. If the price movements compensate to some degree for one, two, or all three of these factors, then the real value of the firm's sales revenues would be protected if prices were determined ex post. Since prices of metals for future delivery are determined ex ante, the only way that the firm can protect itself, and ensure earning

The net effect, considering the effect of price changes and exchange rate changes, is shown in column 3 of table 1. Because the impact of price changes is significantly stronger than the effect of exchange rate changes, the dollar amount (net change in sales revenue) pertaining to each period tends to be closer to the "pure" price effect. This strong price effect suggests that whether or not mining companies actively engage in foreign currency transactions, they are still subject to significant revenue volatility owing to fluctuations in metals prices.<sup>13</sup>

Not only did the average size of the revenue changes increase substantially in the second period, the volatilities did as well. Volatilities of price-related, exchange rate-related, and net value-related changes in quarterly revenue are shown in columns 4, 5, and 6 as measured by the standard deviation (a measure of dispersion around the mean) of revenue changes. They suggest that U.S. mining companies selling aluminum, copper, lead, and zinc faced a much greater exposure to quarterly revenue loss after financial deregulation. Furthermore, the average fluctuation in sales revenue gains or losses owing to metals price changes was two to three times that resulting from the change in the Yen/US\$ exchange rate. That is, metals price risk was much greater than exchange rate risk.

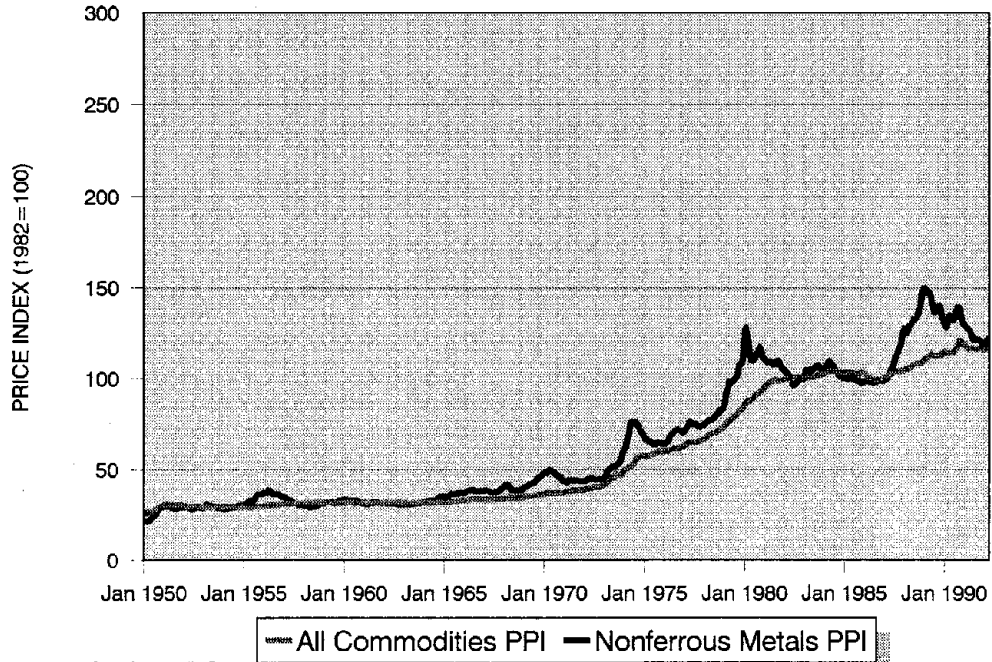
stability, is to engage in some form of hedge by investing in futures or options.

## INFLATION-LED INCREASES IN PRICES OF NONFERROUS METALS

What has been the pattern of metals price movements compared with inflation? Figure 8 shows that the index of nonferrous metals prices tended to rise above the producer price index for all commodities, and demonstrated much more volatility in price movements after 1972 than the producer price index for all commodities. Figures 9 through 12 compare movements in the price index for each metal analyzed in this study with the commodities price index. Figures 9 and 10, pertaining to copper and aluminum prices respectively, suggest that, except for a period between 1980 and 1985, the variation in metals price movements after 1973 tended to exceed that of the general commodity price level and did so in an unstable way. Lead and zinc followed a similar pattern as shown in figures 11 and 12.

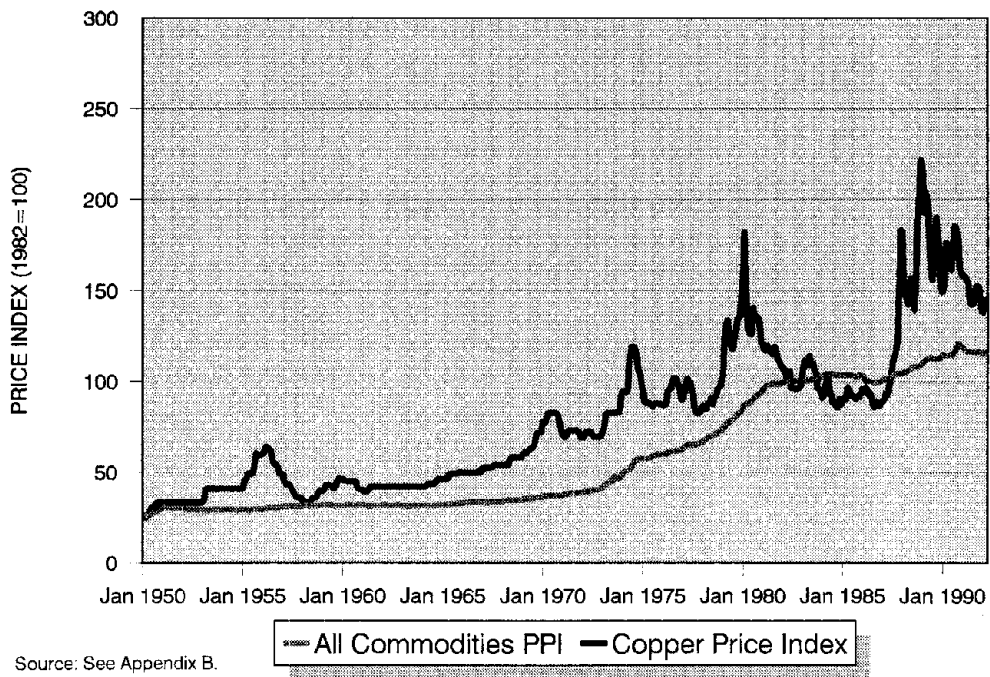
<sup>13</sup>The informal survey of the five U.S. copper mining companies suggests that most have foreign currency expenses while all receive revenues in US\$. The companies hedged depending on the size of their foreign exchange exposure. If their exposure was small, they did not hedge their foreign exchange risk at all.

**Figure 8**  
**Nonferrous Metals Producer Price Index Versus**  
**All Commodities Producer Price Index**



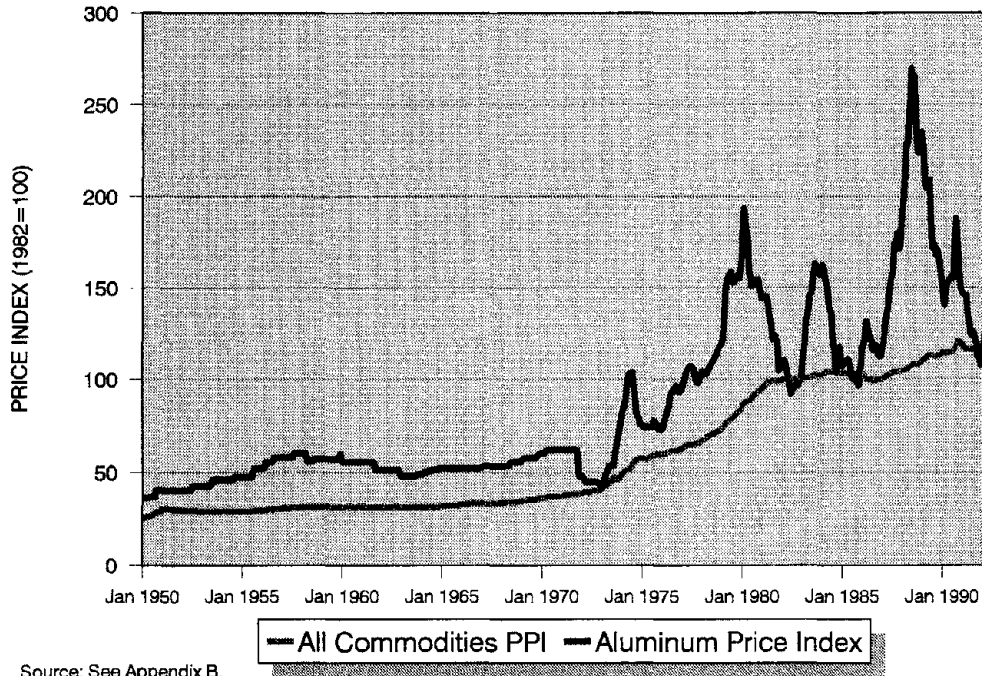
Source: See Appendix B.

**Figure 9**  
**Copper Price Index Versus Producer Price Index**

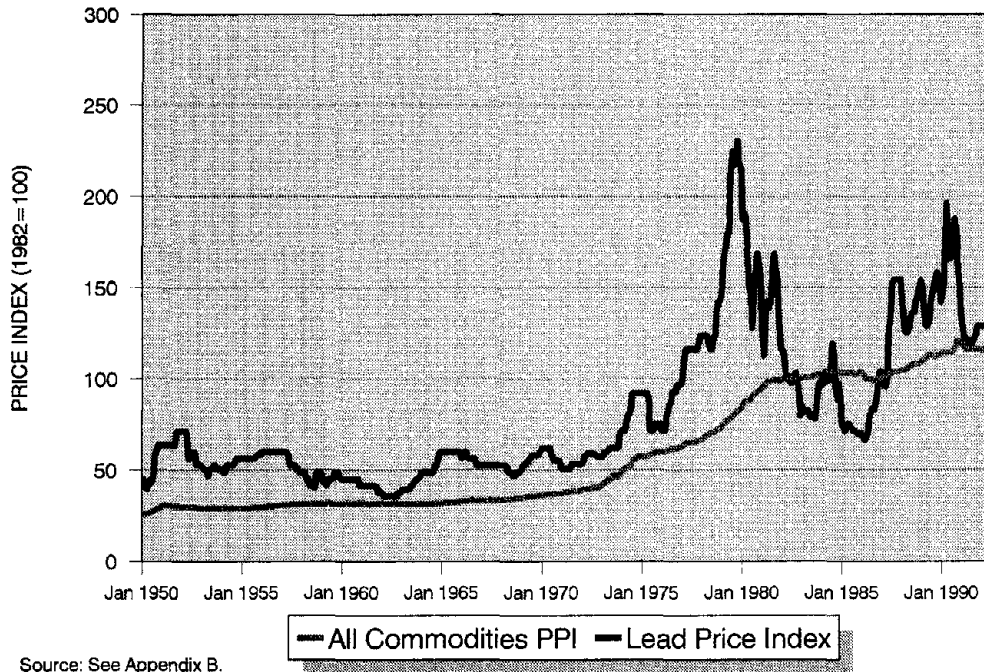


Source: See Appendix B.

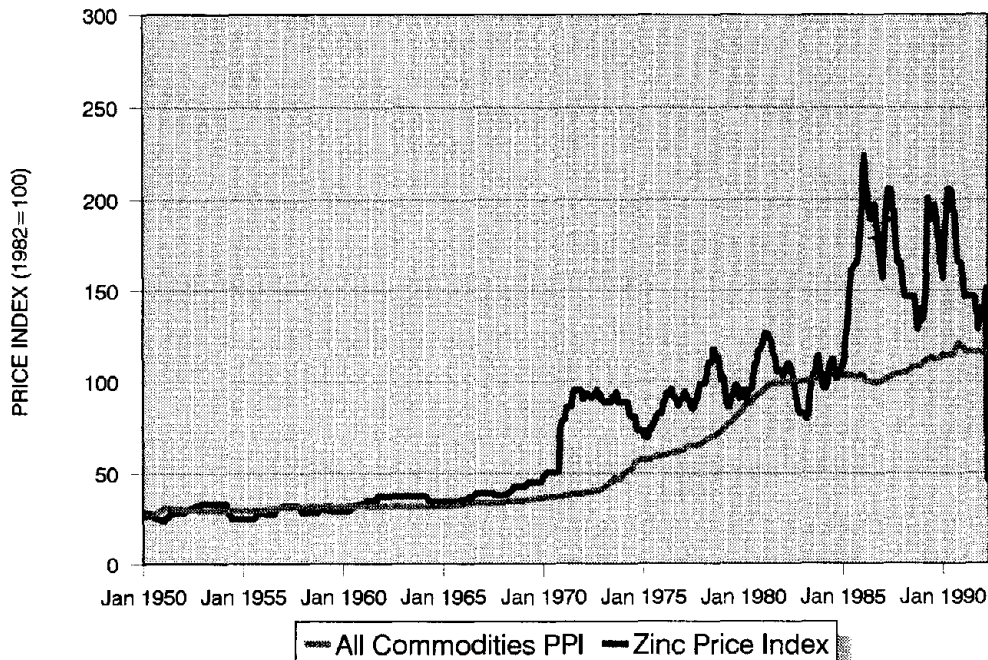
**Figure 10**  
**Aluminum Price Index Versus Producer Price Index**



**Figure 11**  
**Lead Price Index Versus Producer Price Index**



**Figure 12**  
Zinc Price Index Versus Producer Price Index



Source: See Appendix B.

### Interest Rate Effects on Metals' Prices

Nonferrous metals prices appear to have incorporated the effects of inflation, but obviously other factors are coming into play as well. The dip in metals' price movements below the producer price index, during the 1980's, reflects the net effect of plummeting interest rates. That is, a rise in the general price level led to higher metal prices, while falling interest rates signified lower cost-of-carry and therefore a downward pressure on real prices. The impact of these opposing influences and their net effect on metals price movements also depended on the tightness of supply and demand.

### Dollar Devaluation Pressures on Metals Prices

Another factor affecting metals' price movements was the effect of dollar devaluation since, like oil, nonferrous metals are mostly denominated in U.S. dollars. Unless contractually specified otherwise (which was the case in the example used to clarify Appendix A, where the company was paid in yen), sellers of nonferrous metals are paid in U. S. dollars<sup>14</sup>. Assume

<sup>14</sup>Although the LME clears contracts in several currencies, open outcry trading is conducted in U.S. dollars. The COMEX denominates all trades and transaction in futures contracts in U.S. dollars.

that, initially, the price of the copper on the exchange and from the smelter have the same value in yen. If the value of the dollar then declines against the yen, the fabricator will save money by buying copper from the exchange. The devaluation of the dollar means that the fabricator can buy more dollars with each yen. This translates to more copper for each yen in the dollar denominated market. Consequently, the yen denominated cost of the dollar denominated copper declines. As other copper consumers realize copper is cheaper on the exchanges, more and more will buy copper, which will increase the price on the exchanges. Eventually, the dollar-denominated copper price will rise to a yen-denominated value equal to the yen-denominated price of copper from Japanese smelters. Actual ring trading of copper contracts at the LME is denominated in U.S. dollars.

The weakening of the dollar against other major currencies also implied a reduction in net revenue for U.S. and non-U.S. mining companies with non-dollar operating and/or funding costs; that is, dollar revenues earned could be exchanged for fewer yen, marks, francs, etc. Therefore, metal price increases above the general commodities price movements may reflect, in part, movements designed to offset and decline in metals producers' revenues owing to dollar devaluation.

## CONCLUSION

The post World War II period witnessed a relative decline in U.S. domestic production and processing of nonferrous metals. As a result, the ability of U.S. producers to influence metals prices waned. Competitive pricing of metals, as opposed to producer pricing, emerged. Not only were prices freed, the deregulation of exchange rates and interest rates completed the liberalization, causing an international financial environment characterized by significant instability. Particularly high metals price volatility (relative to commodity prices in general) meant that U.S. mining companies suddenly faced much greater risk. Their short-term earnings are no longer predictable and the probability of sudden drops in earnings looms large.

Empirical estimates of the impacts of metal price changes (all four metals) and exchange rate changes (yen only) on the revenue derived from sale of a given quantity (standard unit) of metals show that:

1. The average size of the sales revenue gain or loss owing to metals price movements was three to five times greater after exchange rates and interest rates were deregulated.
2. The volatility (standard deviation) of sales revenue gains or losses approximately trebled after the liberalization of exchange rates and interest rates.

3. The size of the sales revenue gains and losses from metals price changes was double that derived from changes in the exchange rate, for mining companies with foreign currency exposure.
4. Of the four nonferrous metals analyzed, copper displayed the greatest post deregulation price volatility.

The advent of a new, highly volatile financial environment led to an increased need for risk management products such as futures, options, swaps and derivative debt instruments. Many of these products are less than 10 years old, having been developed in response to the intensified risk environment. Despite being so new, the markets for these products have grown rapidly to enormous size (e.g., in 1981, the interest rate and currency swap markets did not exist, while at the end of 1990, the outstanding notional principal of these contracts stood at \$3.5 trillion). This paper shows that metals producers and processors face an even greater need for risk management than most industries. This will continue to be an important factor in the nonferrous metals industry for the foreseeable future.

**APPENDIX A -GAINS (LOSSES) DUE TO CHANGES IN METALS PRICES  
AND EXCHANGE RATES**

**ALUMINUM**

| Qtr/Yr | (1)<br>Gain (loss)<br>from<br>price change | (2)<br>Gain (loss)<br>from<br>exchange rate<br>changes | (3)<br>Net<br>gain (loss) |
|--------|--|--|---------------------------|
| Q2/57  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q3/57  | (\$166.67)                                 | \$0.00   | (\$166.67)                |
| Q4/57  | (\$83.33)                                  | \$0.00   | (\$83.33)                 |
| Q1/58  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q2/58  | \$500.00                                   | \$0.00   | \$500.00                  |
| Q3/58  | (\$116.67)                                 | \$0.00   | (\$116.67)                |
| Q4/58  | (\$58.33)                                  | \$0.00   | (\$58.33)                 |
| Q1/59  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q2/59  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q3/59  | \$0.00                                     | (\$1.61)   | (\$1.61)                  |
| Q4/59  | (\$108.33)                                 | (\$5.64)   | (\$113.98)                |
| Q1/60  | \$308.33                                   | (\$5.73)   | \$302.61                  |
| Q2/60  | \$0.00                                     | (\$2.34)   | (\$2.34)                  |
| Q3/60  | \$0.00                                     | \$30.48  | \$30.48                   |
| Q4/60  | \$0.00                                     | (\$8.56)   | (\$8.56)                  |
| Q1/61  | \$0.00                                     | \$9.30   | \$9.30                    |
| Q2/61  | \$0.00                                     | (\$46.68)  | (\$46.68)                 |
| Q3/61  | \$166.67                                   | (\$9.40)   | \$157.27                  |
| Q4/61  | \$333.33                                   | \$0.00   | \$333.33                  |
| Q1/62  | \$0.00                                     | \$2.38   | \$2.38                    |
| Q2/62  | \$0.00                                     | (\$1.16)   | (\$1.16)                  |
| Q3/62  | \$0.00                                     | \$16.95  | \$16.95                   |
| Q4/62  | \$125.00                                   | \$42.58  | \$167.58                  |
| Q1/63  | \$250.00                                   | (\$1.97)   | \$248.03                  |
| Q2/63  | \$0.00                                     | (\$54.58)  | (\$54.58)                 |
| Q3/63  | \$0.00                                     | (\$11.32)  | (\$11.32)                 |
| Q4/63  | (\$125.00)                                 | \$4.09   | (\$120.91)                |
| Q1/64  | (\$41.67)                                  | \$0.42   | (\$41.24)                 |
| Q2/64  | (\$125.00)                                 | (\$1.17)   | (\$126.17)                |
| Q3/64  | (\$83.33)                                  | \$5.61   | (\$77.73)                 |
| Q4/64  | (\$83.33)                                  | \$26.06  | (\$57.27)                 |
| Q1/65  | (\$41.67)                                  | \$15.73  | (\$25.94)                 |
| Q2/65  | \$0.00                                     | (\$41.43)  | (\$41.43)                 |
| Q3/65  | \$0.00                                     | (\$2.82)   | (\$2.82)                  |
| Q4/65  | \$0.00                                     | \$11.74  | \$11.74                   |

| Aluminum | (1)                                 | (2)   | (3)                |
|----------|-------------------------------------|---|--------------------|
| Qtr/Yr   | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/66    | \$0.00                              | (\$0.85)  | (\$0.85)           |
| Q2/66    | \$0.00                              | (\$12.06)                                       | (\$12.06)          |
| Q3/66    | \$0.00                              | (\$3.88)  | (\$3.88)           |
| Q4/66    | \$0.00                              | \$0.23  | \$0.23             |
| Q1/67    | (\$100.00)                          | \$2.37  | (\$97.63)          |
| Q2/67    | (\$25.00)                           | \$9.06  | (\$15.94)          |
| Q3/67    | \$0.00                              | (\$3.28)  | (\$3.28)           |
| Q4/67    | \$0.00                              | \$2.94  | \$2.94             |
| Q1/68    | \$0.00                              | (\$2.13)  | (\$2.13)           |
| Q2/68    | (\$75.00)                           | (\$0.40)  | (\$75.40)          |
| Q3/68    | (\$175.00)                          | \$41.20   | (\$133.80)         |
| Q4/68    | \$0.00                              | \$29.10   | \$29.10            |
| Q1/69    | (\$216.67)                          | \$4.54  | (\$212.13)         |
| Q2/69    | (\$33.33)                           | (\$9.43)  | (\$42.77)          |
| Q3/69    | \$0.00                              | (\$13.66)                                       | (\$13.66)          |
| Q4/69    | (\$216.67)                          | \$23.32   | (\$193.35)         |
| Q1/70    | (\$83.33)                           | \$3.77  | (\$79.57)          |
| Q2/70    | (\$200.00)                          | (\$17.56)                                       | (\$217.56)         |
| Q3/70    | \$0.00                              | \$2.09  | \$2.09             |
| Q4/70    | \$0.00                              | \$16.21   | \$16.21            |
| Q1/71    | \$0.00                              | \$0.81  | \$0.81             |
| Q2/71    | \$0.00                              | \$5.00  | \$5.00             |
| Q3/71    | \$0.00                              | \$146.08  | \$146.08           |
| Q4/71    | \$1,083.33                          | \$527.40  | \$1,610.74         |
| Q1/72    | \$745.25                            | \$398.24  | \$1,143.49         |
| Q2/72    | \$171.42                            | \$60.15   | \$231.57           |
| Q3/72    | \$0.00                              | \$40.68   | \$40.68            |
| Q4/72    | \$76.83                             | \$0.46  | \$77.30            |
| Q1/73    | (\$172.58)                          | \$382.19  | \$209.61           |
| Q2/73    | (\$801.08)                          | \$312.62  | (\$488.46)         |
| Q3/73    | (\$432.08)                          | (\$4.72)  | (\$436.80)         |
| Q4/73    | (\$1,755.42)                        | (\$235.24)                                      | (\$1,990.66)       |
| Q1/74    | (\$1,624.75)                        | (\$442.92)                                      | (\$2,067.67)       |
| Q2/74    | (\$1,861.00)                        | \$371.46  | (\$1,489.54)       |
| Q3/74    | \$708.75                            | (\$696.28)                                      | \$12.47            |
| Q4/74    | \$1,992.42                          | (\$93.84)                                       | \$1,898.57         |
| Q1/75    | \$417.92                            | \$214.28  | \$632.20           |
| Q2/75    | \$47.42                             | \$21.13   | \$68.55            |
| Q3/75    | (\$258.42)                          | (\$166.25)                                      | (\$424.67)         |
| Q4/75    | \$344.50                            | (\$159.44)                                      | \$185.06           |

| Aluminum | (1)                                 | (2)   | (3)                |
|----------|-------------------------------------|---|--------------------|
| Qtr/Yr   | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/76    | (\$415.92)                          | \$35.72   | (\$380.20)         |
| Q2/76    | (\$1,173.83)                        | \$94.61   | (\$1,079.23)       |
| Q3/76    | (\$890.33)                          | \$287.51  | (\$602.82)         |
| Q4/76    | \$81.58                             | (\$105.71)                                      | (\$24.12)          |
| Q1/77    | (\$638.83)                          | \$317.35  | (\$321.48)         |
| Q2/77    | (\$828.25)                          | \$433.15  | (\$395.10)         |
| Q3/77    | \$299.58                            | \$422.85  | \$722.43           |
| Q4/77    | \$536.00                            | \$949.21  | \$1,485.21         |
| Q1/78    | (\$495.17)                          | \$441.98  | (\$53.19)          |
| Q2/78    | (\$252.50)                          | \$937.03  | \$684.53           |
| Q3/78    | (\$595.17)                          | \$1,787.78                                      | \$1,192.62         |
| Q4/78    | (\$709.17)                          | \$150.11  | (\$559.06)         |
| Q1/79    | (\$2,216.92)                        | (\$744.86)                                      | (\$2,961.77)       |
| Q2/79    | (\$2,495.00)                        | (\$1,181.74)                                    | (\$3,676.74)       |
| Q3/79    | \$418.08                            | (\$101.48)                                      | \$316.61           |
| Q4/79    | (\$545.25)                          | (\$1,473.65)                                    | (\$2,018.90)       |
| Q1/80    | (\$3,263.75)                        | (\$380.59)                                      | (\$3,644.34)       |
| Q2/80    | \$2,800.58                          | \$1,065.58                                      | \$3,866.17         |
| Q3/80    | \$1,062.50                          | \$1,068.10                                      | \$2,130.60         |
| Q4/80    | \$374.00                            | \$778.89  | \$1,152.89         |
| Q1/81    | \$563.83                            | \$424.76  | \$988.59           |
| Q2/81    | \$1,214.58                          | (\$1,102.45)                                    | \$112.13           |
| Q3/81    | \$1,444.67                          | (\$800.27)                                      | \$644.40           |
| Q4/81    | \$1,432.42                          | \$457.03  | \$1,889.45         |
| Q1/82    | \$123.33                            | (\$508.64)                                      | (\$385.31)         |
| Q2/82    | \$1,327.08                          | (\$537.97)                                      | \$789.12           |
| Q3/82    | \$222.92                            | (\$661.79)                                      | (\$438.87)         |
| Q4/82    | (\$278.33)                          | (\$4.03)  | (\$282.36)         |
| Q1/83    | (\$2,713.33)                        | \$1,143.72                                      | (\$1,569.62)       |
| Q2/83    | (\$2,600.50)                        | (\$108.24)                                      | (\$2,708.74)       |
| Q3/83    | (\$1,937.67)                        | (\$341.19)                                      | (\$2,278.85)       |
| Q4/83    | \$85.17                             | \$664.84  | \$750.00           |
| Q1/84    | \$211.92                            | \$261.17  | \$473.09           |
| Q2/84    | \$2,080.58                          | \$91.39   | \$2,171.98         |
| Q3/84    | \$3,097.08                          | (\$928.73)                                      | \$2,168.36         |
| Q4/84    | \$187.08                            | (\$135.40)                                      | \$51.68            |
| Q1/85    | \$341.67                            | (\$578.56)                                      | (\$236.89)         |
| Q2/85    | \$79.67                             | \$340.79  | \$420.46           |
| Q3/85    | \$905.08                            | \$658.57  | \$1,563.65         |
| Q4/85    | (\$3.83)                            | \$1,765.97                                      | \$1,762.14         |

| Aluminum | (1)                                 | (2)   | (3)                |
|----------|-------------------------------------|---|--------------------|
| Qtr/Yr   | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/86    | (\$2,741.67)                        | \$1,209.98                                      | (\$1,531.69)       |
| Q2/86    | (\$15.17)                           | \$1,526.98                                      | \$1,511.81         |
| Q3/86    | \$820.50                            | \$1,305.94                                      | \$2,126.44         |
| Q4/86    | \$425.75                            | (\$393.26)                                      | \$32.49            |
| Q1/87    | (\$1,473.58)                        | \$625.15  | (\$848.43)         |
| Q2/87    | (\$2,484.92)                        | \$1,087.80                                      | (\$1,397.11)       |
| Q3/87    | (\$2,515.42)                        | (\$502.48)                                      | (\$3,017.89)       |
| Q4/87    | (\$945.08)                          | \$1,644.81                                      | \$699.73           |
| Q1/88    | (\$3,761.33)                        | \$1,237.09                                      | (\$2,524.25)       |
| Q2/88    | (\$4,566.25)                        | \$440.98  | (\$4,125.27)       |
| Q3/88    | (\$846.17)                          | (\$1,730.91)                                    | (\$2,577.07)       |
| Q4/88    | \$2,995.58                          | \$2,035.67                                      | \$5,031.25         |
| Q1/89    | \$1,582.33                          | (\$707.09)                                      | \$875.24           |
| Q2/89    | \$1,771.50                          | (\$1,722.75)                                    | \$48.75            |
| Q3/89    | \$3,479.92                          | (\$720.56)                                      | \$2,759.36         |
| Q4/89    | \$911.25                            | (\$114.13)                                      | \$797.12           |
| Q1/90    | \$1,923.08                          | (\$625.77)                                      | \$1,297.32         |
| Q2/90    | (\$909.67)                          | (\$818.43)                                      | (\$1,728.09)       |
| Q3/90    | (\$1,999.83)                        | \$1,299.53                                      | (\$700.30)         |
| Q4/90    | \$1,372.50                          | \$2,159.97                                      | \$3,532.47         |
| Q1/91    | \$1,624.08                          | (\$415.97)                                      | \$1,208.11         |
| Q2/91    | \$2,005.83                          | (\$553.59)                                      | \$1,452.24         |
| Q3/91    | \$714.67                            | \$226.02  | \$940.69           |
| Q4/91    | \$1,429.42                          | \$758.43  | \$2,187.85         |
| Q1/92    | (\$1,327.83)                        | \$81.09   | (\$1,246.74)       |

## COPPER

| Qtr/Yr | (1)<br>Gain (loss)<br>from<br>price change | (2)<br>Gain (loss)<br>from<br>exchange rate<br>changes | (3)<br>Net<br>gain (loss) |
|--------|--|--|---------------------------|
| Q2/57  | \$541.67                                   | \$0.00   | \$541.67                  |
| Q3/57  | \$825.00                                   | \$0.00   | \$825.00                  |
| Q4/57  | \$358.33                                   | \$0.00   | \$358.33                  |
| Q1/58  | \$450.00                                   | \$0.00   | \$450.00                  |
| Q2/58  | \$16.67                                    | \$0.00   | \$16.67                   |
| Q3/58  | (\$383.33)                                 | \$0.00   | (\$383.33)                |
| Q4/58  | (\$558.33)                                 | \$0.00   | (\$558.33)                |
| Q1/59  | (\$383.33)                                 | \$0.00   | (\$383.33)                |
| Q2/59  | (\$366.67)                                 | \$0.00   | (\$366.67)                |
| Q3/59  | \$216.67                                   | (\$1.88)   | \$214.79                  |
| Q4/59  | (\$783.33)                                 | (\$6.39)   | (\$789.72)                |
| Q1/60  | \$91.67                                    | (\$7.04)   | \$84.63                   |
| Q2/60  | \$125.00                                   | (\$2.98)   | \$122.02                  |
| Q3/60  | \$0.00                                     | \$38.22  | \$38.22                   |
| Q4/60  | \$666.67                                   | (\$10.73)  | \$655.93                  |
| Q1/61  | \$291.67                                   | \$10.70  | \$302.37                  |
| Q2/61  | (\$241.67)                                 | (\$51.65)  | (\$293.32)                |
| Q3/61  | (\$216.67)                                 | (\$10.74)  | (\$227.41)                |
| Q4/61  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q1/62  | \$0.00                                     | \$3.03   | \$3.03                    |
| Q2/62  | \$0.00                                     | (\$1.48)   | (\$1.48)                  |
| Q3/62  | \$0.00                                     | \$21.62  | \$21.62                   |
| Q4/62  | \$0.00                                     | \$54.28  | \$54.28                   |
| Q1/63  | \$0.00                                     | (\$2.56)   | (\$2.56)                  |
| Q2/63  | \$0.00                                     | (\$74.23)  | (\$74.23)                 |
| Q3/63  | \$0.00                                     | (\$15.39)  | (\$15.39)                 |
| Q4/63  | \$0.00                                     | \$5.56   | \$5.56                    |
| Q1/64  | (\$41.67)                                  | \$0.56   | (\$41.10)                 |
| Q2/64  | (\$208.33)                                 | (\$1.56)   | (\$209.89)                |
| Q3/64  | (\$50.00)                                  | \$7.49   | (\$42.51)                 |
| Q4/64  | (\$466.67)                                 | \$34.53  | (\$432.13)                |
| Q1/65  | \$16.67                                    | \$21.76  | \$38.43                   |
| Q2/65  | (\$325.00)                                 | (\$56.82)  | (\$381.82)                |
| Q3/65  | (\$175.00)                                 | (\$4.01)   | (\$179.01)                |
| Q4/65  | (\$100.00)                                 | \$17.06  | (\$82.94)                 |
| Q1/66  | (\$16.67)                                  | (\$1.24)   | (\$17.91)                 |
| Q2/66  | \$8.33                                     | (\$17.75)  | (\$9.41)                  |
| Q3/66  | \$0.00                                     | (\$5.71)   | (\$5.71)                  |
| Q4/66  | (\$116.67)                                 | \$0.33   | (\$116.34)                |

| Copper | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/67  | (\$383.33)                          | \$3.52  | (\$379.81)         |
| Q2/67  | (\$25.00)                           | \$13.83   | (\$11.17)          |
| Q3/67  | (\$175.00)                          | (\$5.00)  | (\$180.00)         |
| Q4/67  | (\$66.67)                           | \$4.56  | (\$62.11)          |
| Q1/68  | \$0.00                              | (\$3.33)  | (\$3.33)           |
| Q2/68  | (\$398.33)                          | (\$0.63)  | (\$398.96)         |
| Q3/68  | (\$351.67)                          | \$66.26   | (\$285.41)         |
| Q4/68  | \$0.00                              | \$47.11   | \$47.11            |
| Q1/69  | (\$450.00)                          | \$7.35  | (\$442.65)         |
| Q2/69  | (\$366.67)                          | (\$15.41)                                       | (\$382.08)         |
| Q3/69  | (\$766.67)                          | (\$22.95)                                       | (\$789.61)         |
| Q4/69  | (\$950.00)                          | \$41.83   | (\$908.17)         |
| Q1/70  | (\$1,050.00)                        | \$7.06  | (\$1,042.94)       |
| Q2/70  | (\$908.33)                          | (\$35.14)                                       | (\$943.48)         |
| Q3/70  | (\$8.33)                            | \$4.33  | (\$4.00)           |
| Q4/70  | \$1,008.33                          | \$33.60   | \$1,041.93         |
| Q1/71  | \$1,308.33                          | \$1.57  | \$1,309.90         |
| Q2/71  | (\$491.67)                          | \$8.77  | (\$482.90)         |
| Q3/71  | (\$20.83)                           | \$265.97  | \$245.14           |
| Q4/71  | \$279.17                            | \$961.75  | \$1,240.92         |
| Q1/72  | \$150.00                            | \$835.76  | \$985.76           |
| Q2/72  | (\$358.33)                          | \$141.92  | (\$216.41)         |
| Q3/72  | \$500.00                            | \$101.90  | \$601.90           |
| Q4/72  | \$0.00                              | \$1.12  | \$1.12             |
| Q1/73  | (\$1,250.00)                        | \$934.58  | (\$315.42)         |
| Q2/73  | (\$1,125.00)                        | \$812.87  | (\$312.13)         |
| Q3/73  | \$0.00                              | (\$11.53)                                       | (\$11.53)          |
| Q4/73  | (\$533.33)                          | (\$537.25)                                      | (\$1,070.58)       |
| Q1/74  | (\$1,608.33)                        | (\$826.84)                                      | (\$2,435.17)       |
| Q2/74  | (\$2,525.00)                        | \$640.30  | (\$1,884.70)       |
| Q3/74  | (\$1,716.67)                        | (\$1,159.97)                                    | (\$2,876.64)       |
| Q4/74  | \$2,391.67                          | (\$180.81)                                      | \$2,210.86         |
| Q1/75  | \$2,566.67                          | \$446.86  | \$3,013.53         |
| Q2/75  | \$525.00                            | \$39.95   | \$564.95           |
| Q3/75  | \$83.33                             | (\$305.94)                                      | (\$222.61)         |
| Q4/75  | (\$108.33)                          | (\$283.42)                                      | (\$391.75)         |
| Q1/76  | \$111.25                            | \$66.49   | \$177.74           |
| Q2/76  | (\$1,548.25)                        | \$166.80  | (\$1,381.45)       |
| Q3/76  | (\$1,112.42)                        | \$492.15  | (\$620.26)         |
| Q4/76  | \$1,239.67                          | (\$177.01)                                      | \$1,062.66         |

| Copper | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/77  | \$135.17                            | \$499.49  | \$634.66           |
| Q2/77  | (\$972.83)                          | \$639.18  | (\$333.66)         |
| Q3/77  | \$2,214.08                          | \$615.49  | \$2,829.57         |
| Q4/77  | \$782.50                            | \$1,242.55                                      | \$2,025.05         |
| Q1/78  | (\$494.17)                          | \$575.49  | \$81.33            |
| Q2/78  | (\$576.50)                          | \$1,208.42                                      | \$631.92           |
| Q3/78  | (\$246.00)                          | \$2,341.90                                      | \$2,095.90         |
| Q4/78  | (\$1,208.17)                        | \$190.44  | (\$1,017.72)       |
| Q1/79  | (\$3,952.75)                        | (\$961.84)                                      | (\$4,914.59)       |
| Q2/79  | (\$1,333.67)                        | (\$1,607.18)                                    | (\$2,940.84)       |
| Q3/79  | \$371.58                            | (\$126.63)                                      | \$244.96           |
| Q4/79  | (\$2,620.75)                        | (\$1,851.21)                                    | (\$4,471.96)       |
| Q1/80  | (\$4,502.50)                        | (\$517.94)                                      | (\$5,020.44)       |
| Q2/80  | \$6,543.92                          | \$1,453.14                                      | \$7,997.06         |
| Q3/80  | (\$1,892.58)                        | \$1,303.00                                      | (\$589.58)         |
| Q4/80  | \$1,482.50                          | \$1,089.03                                      | \$2,571.53         |
| Q1/81  | \$1,959.08                          | \$570.62  | \$2,529.71         |
| Q2/81  | \$200.58                            | (\$1,402.88)                                    | (\$1,202.29)       |
| Q3/81  | \$191.75                            | (\$1,086.74)                                    | (\$894.99)         |
| Q4/81  | \$1,090.25                          | \$677.24  | \$1,767.49         |
| Q1/82  | \$916.50                            | (\$794.55)                                      | \$121.95           |
| Q2/82  | \$644.50                            | (\$809.79)                                      | (\$165.29)         |
| Q3/82  | \$1,064.58                          | (\$1,074.65)                                    | (\$10.07)          |
| Q4/82  | (\$177.17)                          | (\$6.29)  | (\$183.45)         |
| Q1/83  | (\$2,179.17)                        | \$1,759.74                                      | (\$419.43)         |
| Q2/83  | (\$425.75)                          | (\$151.31)                                      | (\$577.06)         |
| Q3/83  | \$826.50                            | (\$411.67)                                      | \$414.83           |
| Q4/83  | \$2,133.92                          | \$689.77  | \$2,823.69         |
| Q1/84  | \$21.08                             | \$242.30  | \$263.38           |
| Q2/84  | (\$362.67)                          | \$85.66   | (\$277.01)         |
| Q3/84  | \$1,597.17                          | (\$1,001.90)                                    | \$595.26           |
| Q4/84  | \$93.17                             | (\$163.90)                                      | (\$70.74)          |
| Q1/85  | (\$437.75)                          | (\$706.25)                                      | (\$1,144.00)       |
| Q2/85  | (\$899.67)                          | \$438.92  | (\$460.74)         |
| Q3/85  | \$703.33                            | \$900.45  | \$1,603.78         |
| Q4/85  | (\$180.17)                          | \$2,495.02                                      | \$2,314.85         |
| Q1/86  | (\$606.67)                          | \$1,727.51                                      | \$1,120.85         |
| Q2/86  | \$410.08                            | \$1,831.14                                      | \$2,241.22         |
| Q3/86  | \$1,027.00                          | \$1,527.47                                      | \$2,554.47         |
| Q4/86  | \$89.67                             | (\$458.03)                                      | (\$368.37)         |

| Copper | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/87  | (\$718.75)                          | \$747.29  | \$28.54            |
| Q2/87  | (\$1,156.50)                        | \$1,223.26                                      | \$66.76            |
| Q3/87  | (\$2,979.08)                        | (\$517.20)                                      | (\$3,496.29)       |
| Q4/87  | (\$6,873.92)                        | \$1,725.54                                      | (\$5,148.37)       |
| Q1/88  | (\$1,586.42)                        | \$1,650.01                                      | \$63.60            |
| Q2/88  | \$2,287.00                          | \$526.23  | \$2,813.23         |
| Q3/88  | (\$10.83)                           | (\$1,603.63)                                    | (\$1,614.46)       |
| Q4/88  | (\$10,760.75)                       | \$1,833.24                                      | (\$8,927.51)       |
| Q1/89  | \$423.00                            | (\$991.34)                                      | (\$568.34)         |
| Q2/89  | \$4,994.92                          | (\$2,537.75)                                    | \$2,457.16         |
| Q3/89  | \$598.08                            | (\$988.25)                                      | (\$390.17)         |
| Q4/89  | \$1,697.67                          | (\$180.35)                                      | \$1,517.31         |
| Q1/90  | \$888.83                            | (\$980.38)                                      | (\$91.55)          |
| Q2/90  | (\$1,713.08)                        | (\$1,383.46)                                    | (\$3,096.54)       |
| Q3/90  | (\$2,201.67)                        | \$2,209.31                                      | \$7.65             |
| Q4/90  | \$2,470.42                          | \$3,543.26                                      | \$6,013.68         |
| Q1/91  | \$1,848.33                          | (\$677.50)                                      | \$1,170.83         |
| Q2/91  | \$1,829.17                          | (\$927.47)                                      | \$901.70           |
| Q3/91  | \$122.50                            | \$401.62  | \$524.12           |
| Q4/91  | (\$281.67)                          | \$1,408.25                                      | \$1,126.58         |
| Q1/92  | \$1,067.50                          | \$168.98  | \$1,236.48         |

| LEAD   | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q2/57  | \$213.33                            | \$0.00  | \$213.33           |
| Q3/57  | \$296.67                            | \$0.00  | \$296.67           |
| Q4/57  | \$170.00                            | \$0.00  | \$170.00           |
| Q1/58  | \$85.00                             | \$0.00  | \$85.00            |
| Q2/58  | \$339.17                            | \$0.00  | \$339.17           |
| Q3/58  | \$190.83                            | \$0.00  | \$190.83           |
| Q4/58  | (\$530.00)                          | \$0.00  | (\$530.00)         |
| Q1/59  | \$255.00                            | \$0.00  | \$255.00           |
| Q2/59  | \$84.17                             | \$0.00  | \$84.17            |
| Q3/59  | (\$169.17)                          | (\$0.72)  | (\$169.88)         |
| Q4/59  | (\$126.67)                          | (\$2.64)  | (\$129.31)         |
| Q1/60  | \$211.67                            | (\$2.75)  | \$208.92           |
| Q2/60  | \$0.00                              | (\$1.10)  | (\$1.10)           |
| Q3/60  | \$0.00                              | \$14.33   | \$14.33            |
| Q4/60  | \$84.17                             | (\$4.02)  | \$80.14            |
| Q1/61  | \$168.33                            | \$4.25  | \$172.58           |
| Q2/61  | \$0.00                              | (\$20.13)                                       | (\$20.13)          |
| Q3/61  | \$0.00                              | (\$4.05)  | (\$4.05)           |
| Q4/61  | \$150.83                            | \$0.00  | \$150.83           |
| Q1/62  | \$191.67                            | \$1.05  | \$192.72           |
| Q2/62  | \$42.50                             | (\$0.48)  | \$42.02            |
| Q3/62  | \$0.00                              | \$6.83  | \$6.83             |
| Q4/62  | (\$85.00)                           | \$17.15   | (\$67.85)          |
| Q1/63  | (\$172.50)                          | (\$0.84)  | (\$173.34)         |
| Q2/63  | (\$20.83)                           | (\$25.96)                                       | (\$46.79)          |
| Q3/63  | (\$190.83)                          | (\$5.42)  | (\$196.26)         |
| Q4/63  | (\$210.00)                          | \$2.10  | (\$207.90)         |
| Q1/64  | (\$215.83)                          | \$0.23  | (\$215.61)         |
| Q2/64  | \$0.00                              | (\$0.67)  | (\$0.67)           |
| Q3/64  | (\$84.17)                           | \$3.14  | (\$81.03)          |
| Q4/64  | (\$423.33)                          | \$14.75   | (\$408.58)         |
| Q1/65  | (\$255.00)                          | \$9.88  | (\$245.12)         |
| Q2/65  | \$0.00                              | (\$27.57)                                       | (\$27.57)          |
| Q3/65  | \$0.00                              | (\$1.87)  | (\$1.87)           |
| Q4/65  | \$0.00                              | \$7.81  | \$7.81             |
| Q1/66  | \$78.33                             | (\$0.56)  | \$77.77            |
| Q2/66  | \$91.67                             | (\$7.87)  | \$83.80            |
| Q3/66  | \$85.00                             | (\$2.48)  | \$82.52            |
| Q4/66  | \$255.00                            | \$0.14  | \$255.14           |

| Lead   | (1)          | (2)           | (3)          |
|--------|--------------|---------------|--------------|
|        | Gain (loss)  | Gain (loss)   |              |
|        | from         | from          | Net          |
| Qtr/Yr | price change | exchange rate | gain (loss)  |
|        |              | changes       |              |
| Q1/67  | \$0.00       | \$1.38        | \$1.38       |
| Q2/67  | \$0.00       | \$5.19        | \$5.19       |
| Q3/67  | \$0.00       | (\$1.87)      | (\$1.87)     |
| Q4/67  | \$0.00       | \$1.67        | \$1.67       |
| Q1/68  | \$0.00       | (\$1.21)      | (\$1.21)     |
| Q2/68  | \$168.33     | (\$0.23)      | \$168.10     |
| Q3/68  | \$172.50     | \$22.12       | \$194.62     |
| Q4/68  | (\$88.33)    | \$14.43       | (\$73.90)    |
| Q1/69  | (\$210.83)   | \$2.31        | (\$208.52)   |
| Q2/69  | (\$210.00)   | (\$4.95)      | (\$214.95)   |
| Q3/69  | (\$214.17)   | (\$7.55)      | (\$221.72)   |
| Q4/69  | (\$42.50)    | \$13.64       | (\$28.86)    |
| Q1/70  | (\$215.00)   | \$2.16        | (\$212.84)   |
| Q2/70  | \$0.00       | (\$10.47)     | (\$10.47)    |
| Q3/70  | \$362.50     | \$1.21        | \$363.71     |
| Q4/70  | \$105.83     | \$8.59        | \$114.43     |
| Q1/71  | \$299.17     | \$0.42        | \$299.58     |
| Q2/71  | \$0.00       | \$2.37        | \$2.37       |
| Q3/71  | (\$192.50)   | \$69.26       | (\$123.24)   |
| Q4/71  | \$8.33       | \$264.06      | \$272.40     |
| Q1/72  | (\$127.50)   | \$233.88      | \$106.38     |
| Q2/72  | (\$241.67)   | \$41.60       | (\$200.07)   |
| Q3/72  | \$0.00       | \$30.93       | \$30.93      |
| Q4/72  | \$86.67      | \$0.35        | \$87.02      |
| Q1/73  | (\$64.17)    | \$288.44      | \$224.27     |
| Q2/73  | (\$171.67)   | \$232.07      | \$60.40      |
| Q3/73  | (\$65.00)    | (\$3.18)      | (\$68.18)    |
| Q4/73  | (\$168.33)   | (\$150.36)    | (\$318.69)   |
| Q1/74  | (\$466.67)   | (\$232.42)    | (\$699.09)   |
| Q2/74  | (\$530.00)   | \$180.53      | (\$349.47)   |
| Q3/74  | (\$870.00)   | (\$316.33)    | (\$1,186.33) |
| Q4/74  | \$0.00       | (\$52.70)     | (\$52.70)    |
| Q1/75  | \$0.00       | \$146.63      | \$146.63     |
| Q2/75  | \$540.00     | \$15.15       | \$555.15     |
| Q3/75  | \$775.00     | (\$109.51)    | \$665.49     |
| Q4/75  | (\$170.00)   | (\$88.11)     | (\$258.11)   |
| Q1/76  | \$255.00     | \$21.24       | \$276.24     |
| Q2/76  | (\$826.67)   | \$50.97       | (\$775.69)   |
| Q3/76  | (\$638.33)   | \$160.40      | (\$477.93)   |
| Q4/76  | (\$252.50)   | (\$60.33)     | (\$312.83)   |

| Lead   | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/77  | (\$785.83)                          | \$189.77  | (\$596.06)         |
| Q2/77  | (\$551.67)                          | \$274.09  | (\$277.58)         |
| Q3/77  | \$0.00                              | \$268.51  | \$268.51           |
| Q4/77  | (\$255.83)                          | \$617.63  | \$361.79           |
| Q1/78  | (\$254.17)                          | \$310.63  | \$56.46            |
| Q2/78  | \$254.17                            | \$651.28  | \$905.45           |
| Q3/78  | (\$62.50)                           | \$1,180.38                                      | \$1,117.88         |
| Q4/78  | (\$1,380.00)                        | \$95.27   | (\$1,284.73)       |
| Q1/79  | (\$1,444.17)                        | (\$523.51)                                      | (\$1,967.68)       |
| Q2/79  | (\$1,908.33)                        | (\$822.08)                                      | (\$2,730.41)       |
| Q3/79  | (\$1,996.67)                        | (\$71.55)                                       | (\$2,068.21)       |
| Q4/79  | (\$85.00)                           | (\$1,227.20)                                    | (\$1,312.20)       |
| Q1/80  | \$2,209.17                          | (\$309.34)                                      | \$1,899.83         |
| Q2/80  | \$2,206.67                          | \$627.93  | \$2,834.60         |
| Q3/80  | \$762.50                            | \$598.06  | \$1,360.56         |
| Q4/80  | (\$1,186.67)                        | \$428.83  | (\$757.84)         |
| Q1/81  | \$2,545.00                          | \$267.63  | \$2,812.63         |
| Q2/81  | (\$1,102.50)                        | (\$552.21)                                      | (\$1,654.71)       |
| Q3/81  | (\$1,400.00)                        | (\$487.85)                                      | (\$1,887.85)       |
| Q4/81  | \$1,910.00                          | \$351.54  | \$2,261.54         |
| Q1/82  | \$1,570.00                          | (\$359.27)                                      | \$1,210.73         |
| Q2/82  | \$763.33                            | (\$317.35)                                      | \$445.98           |
| Q3/82  | (\$126.67)                          | (\$391.53)                                      | (\$518.19)         |
| Q4/82  | \$827.50                            | (\$2.48)  | \$825.02           |
| Q1/83  | \$444.17                            | \$603.46  | \$1,047.63         |
| Q2/83  | \$129.17                            | (\$42.79)                                       | \$86.38            |
| Q3/83  | \$105.83                            | (\$111.35)                                      | (\$5.52)           |
| Q4/83  | (\$1,124.17)                        | \$190.75  | (\$933.41)         |
| Q1/84  | (\$255.83)                          | \$91.04   | (\$164.80)         |
| Q2/84  | (\$202.50)                          | \$33.49   | (\$169.01)         |
| Q3/84  | (\$427.50)                          | (\$395.20)                                      | (\$822.70)         |
| Q4/84  | \$1,260.00                          | (\$75.46)                                       | \$1,184.54         |
| Q1/85  | \$1,164.17                          | (\$271.23)                                      | \$892.93           |
| Q2/85  | (\$113.33)                          | \$132.85  | \$19.52            |
| Q3/85  | \$178.33                            | \$264.26  | \$442.59           |
| Q4/85  | \$131.67                            | \$736.45  | \$868.12           |
| Q1/86  | \$177.50                            | \$490.84  | \$668.34           |
| Q2/86  | (\$423.33)                          | \$483.37  | \$60.04            |
| Q3/86  | (\$708.33)                          | \$451.13  | (\$257.21)         |
| Q4/86  | (\$1,077.50)                        | (\$164.38)                                      | (\$1,241.88)       |

| Lead   | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/87  | \$114.17                            | \$320.58  | \$434.75           |
| Q2/87  | (\$1,582.50)                        | \$493.54  | (\$1,088.96)       |
| Q3/87  | (\$2,197.50)                        | (\$241.27)                                      | (\$2,438.77)       |
| Q4/87  | (\$43.33)                           | \$872.33  | \$829.00           |
| Q1/88  | \$1,535.00                          | \$628.68  | \$2,163.68         |
| Q2/88  | \$218.33                            | \$161.87  | \$380.21           |
| Q3/88  | (\$642.50)                          | (\$522.26)                                      | (\$1,164.76)       |
| Q4/88  | (\$794.17)                          | \$640.63  | (\$153.54)         |
| Q1/89  | \$793.33                            | (\$268.28)                                      | \$525.05           |
| Q2/89  | \$250.00                            | (\$640.47)                                      | (\$390.47)         |
| Q3/89  | (\$1,193.33)                        | (\$280.42)                                      | (\$1,473.75)       |
| Q4/89  | \$100.00                            | (\$58.95)                                       | \$41.05            |
| Q1/90  | (\$983.33)                          | (\$335.37)                                      | (\$1,318.70)       |
| Q2/90  | (\$346.67)                          | (\$534.61)                                      | (\$881.28)         |
| Q3/90  | (\$949.17)                          | \$831.08  | (\$118.09)         |
| Q4/90  | \$2,200.83                          | \$1,345.88                                      | \$3,546.72         |
| Q1/91  | \$1,899.17                          | (\$229.27)                                      | \$1,669.89         |
| Q2/91  | \$334.17                            | (\$272.59)                                      | \$61.57            |
| Q3/91  | (\$221.67)                          | \$121.09  | (\$100.58)         |
| Q4/91  | (\$450.00)                          | \$438.25  | (\$11.75)          |
| Q1/92  | \$0.00                              | \$54.86   | \$54.86            |

| ZINC   |  |  |                           |
|--------|--|--|---------------------------|
| Qtr/Yr | (1)<br>Gain (loss)<br>from<br>price change | (2)<br>Gain (loss)<br>from<br>exchange rate<br>changes | (3)<br>Net<br>gain (loss) |
| Q2/57  | (\$8.33)                                   | \$0.00   | (\$8.33)                  |
| Q3/57  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q4/57  | \$43.33                                    | \$0.00   | \$43.33                   |
| Q1/58  | \$326.67                                   | \$0.00   | \$326.67                  |
| Q2/58  | \$5.00                                     | \$0.00   | \$5.00                    |
| Q3/58  | \$0.00                                     | \$0.00   | \$0.00                    |
| Q4/58  | (\$41.67)                                  | \$0.00   | (\$41.67)                 |
| Q1/59  | (\$148.33)                                 | \$0.00   | (\$148.33)                |
| Q2/59  | \$67.50                                    | \$0.00   | \$67.50                   |
| Q3/59  | \$60.00                                    | (\$0.75)   | \$59.25                   |
| Q4/59  | \$0.00                                     | (\$2.58)   | (\$2.58)                  |
| Q1/60  | \$0.00                                     | (\$2.58)   | (\$2.58)                  |
| Q2/60  | (\$20.00)                                  | (\$1.10)   | (\$21.10)                 |
| Q3/60  | (\$232.50)                                 | \$14.45  | (\$218.05)                |
| Q4/60  | (\$103.33)                                 | (\$4.37)   | (\$107.70)                |
| Q1/61  | (\$81.67)                                  | \$4.89   | (\$76.78)                 |
| Q2/61  | (\$187.50)                                 | (\$25.14)  | (\$212.64)                |
| Q3/61  | \$0.00                                     | (\$5.33)   | (\$5.33)                  |
| Q4/61  | (\$166.67)                                 | \$0.00   | (\$166.67)                |
| Q1/62  | (\$83.33)                                  | \$1.53   | (\$81.81)                 |
| Q2/62  | \$0.00                                     | (\$0.76)   | (\$0.76)                  |
| Q3/62  | \$0.00                                     | \$11.13  | \$11.13                   |
| Q4/62  | \$0.00                                     | \$27.94  | \$27.94                   |
| Q1/63  | \$0.00                                     | (\$1.32)   | (\$1.32)                  |
| Q2/63  | \$0.00                                     | (\$38.21)  | (\$38.21)                 |
| Q3/63  | \$0.00                                     | (\$7.92)   | (\$7.92)                  |
| Q4/63  | \$0.00                                     | \$2.86   | \$2.86                    |
| Q1/64  | \$0.00                                     | \$0.29   | \$0.29                    |
| Q2/64  | \$166.67                                   | (\$0.80)   | \$165.87                  |
| Q3/64  | \$145.83                                   | \$3.57   | \$149.41                  |
| Q4/64  | \$0.00                                     | \$15.75  | \$15.75                   |
| Q1/65  | \$0.00                                     | \$9.37   | \$9.37                    |
| Q2/65  | \$0.00                                     | (\$24.52)  | (\$24.52)                 |
| Q3/65  | \$0.00                                     | (\$1.67)   | (\$1.67)                  |
| Q4/65  | \$0.00                                     | \$6.95   | \$6.95                    |
| Q1/66  | (\$135.00)                                 | (\$0.50)   | (\$135.50)                |
| Q2/66  | (\$73.33)                                  | (\$7.40)   | (\$80.73)                 |
| Q3/66  | (\$104.17)                                 | (\$2.43)   | (\$106.60)                |
| Q4/66  | (\$187.50)                                 | \$0.14   | (\$187.36)                |

| Zinc   | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/67  | \$0.00                              | \$1.59  | \$1.59             |
| Q2/67  | \$0.00                              | \$6.00  | \$6.00             |
| Q3/67  | \$40.83                             | (\$2.16)  | \$38.67            |
| Q4/67  | \$81.67                             | \$1.92  | \$83.58            |
| Q1/68  | \$0.00                              | (\$1.36)  | (\$1.36)           |
| Q2/68  | (\$122.50)                          | (\$0.26)  | (\$122.76)         |
| Q3/68  | (\$290.83)                          | \$26.87   | (\$263.97)         |
| Q4/68  | (\$84.17)                           | \$19.77   | (\$64.40)          |
| Q1/69  | \$0.00                              | \$3.14  | \$3.14             |
| Q2/69  | (\$208.33)                          | (\$6.32)  | (\$214.65)         |
| Q3/69  | (\$41.67)                           | (\$9.53)  | (\$51.19)          |
| Q4/69  | \$0.00                              | \$16.41   | \$16.41            |
| Q1/70  | (\$289.17)                          | \$2.57  | (\$286.60)         |
| Q2/70  | (\$305.83)                          | (\$12.55)                                       | (\$318.39)         |
| Q3/70  | \$0.00                              | \$1.54  | \$1.54             |
| Q4/70  | (\$801.67)                          | \$11.95   | (\$789.71)         |
| Q1/71  | (\$2,185.00)                        | \$0.69  | (\$2,184.31)       |
| Q2/71  | (\$793.33)                          | \$5.75  | (\$787.58)         |
| Q3/71  | (\$626.67)                          | \$183.86  | (\$442.80)         |
| Q4/71  | (\$313.33)                          | \$709.39  | \$396.05           |
| Q1/72  | \$230.00                            | \$649.99  | \$879.99           |
| Q2/72  | \$21.67                             | \$109.12  | \$130.79           |
| Q3/72  | \$64.17                             | \$76.05   | \$140.21           |
| Q4/72  | (\$145.83)                          | \$0.86  | (\$144.97)         |
| Q1/73  | \$435.83                            | \$731.04  | \$1,166.87         |
| Q2/73  | \$62.50                             | \$553.17  | \$615.67           |
| Q3/73  | (\$228.33)                          | (\$7.21)  | (\$235.54)         |
| Q4/73  | \$41.67                             | (\$344.16)                                      | (\$302.50)         |
| Q1/74  | \$208.33                            | (\$509.30)                                      | (\$300.97)         |
| Q2/74  | \$250.00                            | \$349.68  | \$599.68           |
| Q3/74  | \$541.67                            | (\$537.52)                                      | \$4.14             |
| Q4/74  | \$771.67                            | (\$72.49)                                       | \$699.17           |
| Q1/75  | \$186.67                            | \$183.56  | \$370.23           |
| Q2/75  | \$83.33                             | \$18.52   | \$101.85           |
| Q3/75  | (\$541.67)                          | (\$144.89)                                      | (\$686.55)         |
| Q4/75  | (\$625.00)                          | (\$144.62)                                      | (\$769.62)         |
| Q1/76  | (\$501.67)                          | \$36.30   | (\$465.36)         |
| Q2/76  | (\$727.50)                          | \$96.99   | (\$630.51)         |
| Q3/76  | \$85.00                             | \$281.29  | \$366.29           |
| Q4/76  | \$455.83                            | (\$94.27)                                       | \$361.56           |

| Zinc   | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/77  | (\$353.33)                          | \$271.94  | (\$81.40)          |
| Q2/77  | \$166.67                            | \$363.92  | \$530.59           |
| Q3/77  | \$487.50                            | \$325.93  | \$813.43           |
| Q4/77  | (\$895.00)                          | \$711.57  | (\$183.43)         |
| Q1/78  | (\$446.67)                          | \$380.75  | (\$65.92)          |
| Q2/78  | (\$1,000.83)                        | \$808.78  | (\$192.05)         |
| Q3/78  | (\$749.17)                          | \$1,656.46                                      | \$907.29           |
| Q4/78  | \$490.83                            | \$141.37  | \$632.21           |
| Q1/79  | \$1,113.33                          | (\$638.29)                                      | \$475.04           |
| Q2/79  | \$1,375.00                          | (\$788.25)                                      | \$586.75           |
| Q3/79  | (\$750.00)                          | (\$50.89)                                       | (\$800.89)         |
| Q4/79  | (\$83.33)                           | (\$817.86)                                      | (\$901.19)         |
| Q1/80  | \$84.17                             | (\$206.71)                                      | (\$122.54)         |
| Q2/80  | \$0.00                              | \$487.79  | \$487.79           |
| Q3/80  | (\$915.83)                          | \$561.19  | (\$354.64)         |
| Q4/80  | (\$1,250.83)                        | \$473.42  | (\$777.41)         |
| Q1/81  | (\$833.33)                          | \$294.02  | (\$539.31)         |
| Q2/81  | (\$290.00)                          | (\$842.70)                                      | (\$1,132.70)       |
| Q3/81  | \$930.00                            | (\$673.68)                                      | \$256.32           |
| Q4/81  | \$1,096.67                          | \$393.88  | \$1,490.55         |
| Q1/82  | \$136.67                            | (\$443.82)                                      | (\$307.15)         |
| Q2/82  | (\$436.67)                          | (\$468.18)                                      | (\$904.85)         |
| Q3/82  | \$828.33                            | (\$668.25)                                      | \$160.08           |
| Q4/82  | \$1,635.83                          | (\$3.85)  | \$1,631.98         |
| Q1/83  | \$306.67                            | \$903.49  | \$1,210.15         |
| Q2/83  | (\$227.50)                          | (\$66.80)                                       | (\$294.30)         |
| Q3/83  | (\$1,976.67)                        | (\$182.55)                                      | (\$2,159.22)       |
| Q4/83  | (\$763.33)                          | \$389.11  | (\$374.22)         |
| Q1/84  | \$1,286.67                          | \$164.26  | \$1,450.92         |
| Q2/84  | (\$473.33)                          | \$51.76   | (\$421.58)         |
| Q3/84  | (\$740.00)                          | (\$619.82)                                      | (\$1,359.82)       |
| Q4/84  | \$669.17                            | (\$119.07)                                      | \$550.10           |
| Q1/85  | (\$729.17)                          | (\$486.40)                                      | (\$1,215.57)       |
| Q2/85  | (\$2,845.00)                        | \$313.76  | (\$2,531.24)       |
| Q3/85  | (\$2,625.83)                        | \$758.45  | (\$1,867.38)       |
| Q4/85  | (\$718.33)                          | \$2,586.17                                      | \$1,867.84         |
| Q1/86  | (\$4,075.00)                        | \$1,845.45                                      | (\$2,229.55)       |
| Q2/86  | \$765.00                            | \$2,317.70                                      | \$3,082.70         |
| Q3/86  | \$704.17                            | \$1,911.17                                      | \$2,615.33         |
| Q4/86  | \$1,298.33                          | (\$589.80)                                      | \$708.53           |

| Zinc   | (1)                                 | (2)   | (3)                |
|--------|-------------------------------------|---|--------------------|
| Qtr/Yr | Gain (loss)<br>from<br>price change | Gain (loss)<br>from<br>exchange rate<br>changes | Net<br>gain (loss) |
| Q1/87  | \$1,633.33                          | \$906.43  | \$2,539.77         |
| Q2/87  | (\$3,790.00)                        | \$1,298.59                                      | (\$2,491.41)       |
| Q3/87  | \$451.67                            | (\$623.90)                                      | (\$172.23)         |
| Q4/87  | \$3,002.50                          | \$1,744.04                                      | \$4,746.54         |
| Q1/88  | \$1,482.50                          | \$1,071.95                                      | \$2,554.45         |
| Q2/88  | \$920.83                            | \$296.49  | \$1,217.33         |
| Q3/88  | \$0.00                              | (\$925.49)                                      | (\$925.49)         |
| Q4/88  | \$1,169.17                          | \$1,057.57                                      | \$2,226.74         |
| Q1/89  | (\$198.33)                          | (\$377.55)                                      | (\$575.88)         |
| Q2/89  | (\$4,650.00)                        | (\$991.01)                                      | (\$5,641.01)       |
| Q3/89  | (\$1,320.00)                        | (\$588.43)                                      | (\$1,908.43)       |
| Q4/89  | \$1,298.33                          | (\$116.95)                                      | \$1,181.38         |
| Q1/90  | \$1,633.33                          | (\$629.25)                                      | \$1,004.08         |
| Q2/90  | (\$3,790.00)                        | (\$837.30)                                      | (\$4,627.30)       |
| Q3/90  | \$451.67                            | \$1,535.01                                      | \$1,986.67         |
| Q4/90  | \$3,002.50                          | \$2,248.69                                      | \$5,251.19         |
| Q1/91  | \$1,482.50                          | (\$398.07)                                      | \$1,084.43         |
| Q2/91  | \$920.83                            | (\$532.09)                                      | \$388.74           |
| Q3/91  | \$0.00                              | \$232.34  | \$232.34           |
| Q4/91  | \$1,169.17                          | \$818.42  | \$1,987.58         |
| Q1/92  | (\$198.33)                          | \$89.85   | (\$108.49)         |

## APPENDIX B - PRICE SERIES SOURCES

| <u>METAL</u> | <u>YEARS</u> | <u>SOURCE</u>   |
|--------------|--------------|---|
| Aluminum     | 1950-1967    | Unalloyed ingot, <u>American Metal Market</u> .   |
|              | 1968-1971    | North American Producer Price for Aluminum ingot, from <u>OECD</u> report dated Feb 22, 1977. |
|              | 1971-1992    | MW U.S. Market <u>Metals Week</u> .   |
| Copper       | 1950-1965    | U.S. Producer price for electrolytic copper, <u>E&amp;MJ and Mineral Markets</u> .            |
|              | 1965-1975    | U.S. Producer price for electrolytic copper, <u>Metals Week</u> .                             |
|              | 1976-1990    | U.S. Producer cathode price, <u>Metals Week</u> .   |
|              | 1990-1992    | Copper cathode cash price, <u>Journal of Commerce</u> .                                       |
| Lead         | 1950-1985    | Pig, Grade A common, <u>American Metal Market</u> .   |
|              | 1986-1992    | Pig, common corroding, <u>Journal of Commerce</u> .   |
| Zinc         | 1950-1961    | Prime Western Zinc in New York, <u>American Metal Market</u> .                                |
|              | 1962-1985    | High Grade Zinc, <u>American Metal Market</u> .   |
|              | 1986-1992    | Special High Grade, <u>Journal of Commerce</u> .  |

## PRODUCER PRICE INDEXES

|                   |   |
|-------------------|---|
| All commodities   | U.S. Department of Labor, Bureau of Labor Statistics (not seasonally adjusted). |
| Nonferrous metals | U.S. Department of Labor, Bureau of Labor Statistics (not seasonally adjusted). |