IS WORLD METAL CONSUMPTION IN DISARRAY? [1]

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Abstract

The consumption pattern of seven major metals - steel, aluminium, copper, lead, nickel, tin and zinc – has frequently violated the law of demand in the late 20th century. This paper examines the patterns of the major metal consumption in the world and seven particular regions and analyzes the disarray of metals consumption. Divisia price-quantity covariance indexes report that the price and quantity consumed moved frequently in the same direction, and the elasticity approach shows that the own price elasticities are extremely small and insignificant, while income elasticities are significant. However, considering the parameters that are crucial in determining the own price elasticity, this paper concludes that the apparent disarray in metals consumption is not in fact real.

Key words: metals consumption, Divisia indexes, elasticities, the law of demand

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Introduction

The law of demand explains that the relationship between the price of a commodity and the quantity demanded is negative, *ceteris paribus*. However, a close look at major metal consumption data in the late 20th century reveals that this law has been violated frequently. This paper investigates the demand patterns of selected metals in the late 20th century and anlayzes why this disarray of metal consumption occurred.

This study takes a microeconomic approach to analyse the relationship between price, income and per capita consumption of seven major metals (steel, aluminium, copper, lead, nickel, tin and zinc), for the world and seven regions (Asia, Europe, North America, Latin America, Oceania, Africa and the USSR). Manthy (1978), in a related study, tabulated prices, production and consumption data for selected metals for the period 1870 to 1973. For regional data, we concentrate on the period from 1973 to 1993, as the data prior to the 1970s are not reliable for some regions, such as Africa, and also the data for the USSR after 1993 is not available. For the whole world, the results covering a longer period (1961-1993) will be presented.

While the macroeconomic and econometric metal demand models show important aspects of the demand for metals, they fail to take into consideration the direct effect of the price of these metals on their consumption, an oversight that we try to redress in this study. Consequently, this study fills the gap between the macroeconomic approach to metal demand analysis (such as Tilton's intensity of use theory, 1993) and the pure econometric approach (such as Evans and Walton's analysis in 1997 of crude steel consumption in the UK).

The following section briefly introduces basic information on metal demand for the period under review. The violation of the laws of demand is demonstrated in Section 3 by the Divisia price-quantity covariance. The results of the cross-regional comparison of various Divisia indices are also presented. Section 4 estimates income and price elasticities using a double-log approach, and confirms the violation of the laws of demand. The last section discusses the disarray in metal consumption found in the previous sections and attempts to reconcile it with the laws of demand.

Metal Consumption in the Late 20th Century

This section provides a brief discussion on the average prices and consumption of the seven metals, before an attempt is made to analyze the demand patterns using Divisia moments and elasticities.

Tables 1 and 2 present the price and per capita consumption of major metals from 1960 to 1993 for the world. Sources of the data are provided in detail in the Appendix. As shown in Table 1, a review of the prices of the seven major metals reveals some common aspects. First, prices were relatively stable during the 1960's; a stability that remained unbroken until the late 1960's or in the early 1970's. Second, the two oil shocks seemed to affect most metal prices significantly, sometimes with lags. Most metal prices rapidly increased around 1973 and 1979. Third, all the metal prices fluctuated to a large extent. For example, the price of nickel increased from $5,125 per metric tonne in 1987 to $14,252 in 1988. However, after six years (1993), the price dropped back to $5,231, which is about the same level as the 1987 price. Marcus and Kirsis (1995) described these kinds of repeated increases and decreases of (steel) prices as 'volcanoes and spirals'. Fourth, while they continued to fluctuate, the price level at the end of each fluctuation was, in general, higher than that at the beginning.

Table 2 summarizes the change in per capita consumption of metals from 1961 to 1993. Overall, except for tin, per capita consumption of all major metals increased in 1993 compared to those in 1960. The percentage increase in per capita consumption during this 34-year period was highest for aluminium. However, the table shows that the maximum amount of *per capita consumption* for all the metals, including aluminium, had already passed, although *the total amount of consumption* for some metals such as aluminium and copper still increased. Per capita consumption of steel and zinc reached its maximum level around 1972 to 1974, while that of aluminium, copper and lead reached its highest level slightly later, around 1977 to 1979. For tin and nickel, per capita consumption remained at a high level for a relatively long period. Per capita consumption of tin continued to be very high (around 0.061-0.066) for 13 years from 1962 to 1974, while that of nickel stayed at peak levels for eight years from 1973 onwards. As their per capita consumption declined after attaining peak levels, in 1993, the level of consumption for some metals was comparable to consumption levels in the early 1960's. The effect of the first oil shock on the consumption of all the metals was significant with lead being the one exception. All the rest experienced a rapid decline in per capita consumption in 1973 or in the years following. For steel, copper, tin and zinc, the decline in per capita consumption caused by the oil shock was not recovered fully for the remaining 20 years. The rapid decline in per capita consumption of all the metals around 1980 indicated that the second oil shock also adversely affected the consumption of metals, though the extent of the decline was less severe than after the first oil shock.

Table 3 shows the changes in per capita consumption over time for the seven regions. In general, the movement of the figures shows a similar tendency to that for the world, however, some distinctive features should be mentioned. (The prices of the metals used in the regional analysis are the same as those in the world analysis.) First, there has been a huge gap between the regions in terms of per capita consumption of the metals. North America and Europe have a larger per capita consumption of the metals compared to Asia, Africa and Latin America. For example, per capita consumption of steel in North America in 1993 was more than ten times, four times and two and a half times larger than consumption levels in Africa, Latin America and Asia respectively. Second, per capita consumption of metals in Asia rose over the period from 1972 to 1993 (except for tin), while in other regions, per capita consumption of most of the metals declined or remained at the same level as occurred in the 1970's. Actually, Asia was the only region that experienced an increase in per capita consumption of steel in the 1980's and 1990's. Third, per capita consumption of steel has been generally decreasing in North America and Europe, although the level of per capita consumption itself was still relatively high. Fourth, per capita consumption of metals in the USSR decreased sharply after 1990, which is most likely related to the political and economic turmoils experienced during this period. Fifth, the adverse effects of the first oil shock on per capita consumption of metals were observed in the all regions except the USSR. In Asia, per capita consumption of steel, aluminium, copper, tin and zinc decreased slightly in 1974 and 1975. In North America, the decline was greater for all the metals except lead in 1975. Europe experienced a decrease in per capita consumption of all the metals, except lead; in 1975. Further investigation needs to be carried out to explain why the consumption of lead in many regions was not significantly influenced by the oil shock. Latin America experienced a decline in per capita consumption of steel, aluminium and tin from 1975 to 1976. The decrease in per capita consumption of copper, lead, nickel and zinc in 1975 was relatively smaller. Oceania was also affected by the oil shock. Per capita consumption of steel, aluminium, copper, nickel, tin and zinc decreased in 1975. The effect of the oil shock on Africa is not clear in terms of per capita consumption of steel and aluminium, while per capita consumption of other minerals decreased around 1975. For the USSR, the effect is not clearly observed.

As discussed previously, most of the effects arising from the oil shock on metal consumption are deduced from the decline of GDP and (probably) the rapid increase in prices. These results are consistent with Hwang and Tilton (1990) and Lohani and Tilton (1993) who analyzed the effect of the changes in GDP on the changes in the level of metal consumption.

The next section will more rigorously examine how prices and consumption of the selected metals have changed.

Analysis of Metal Consumption - the Divisia Moment Approach

Traditional demand theories show an inverse relationship between price and quantity consumed for a commodity under *the assumption of constant budget income* (for example, Marshall, 1890), however, they explain little about the relationship between price and quantity consumed over time. In the real world, in contrast, consumption data is collected in an aggregate form when income changes over time. Therefore, the data has to be adjusted and new statistical techniques have to be introduced to overcome the underlying difficulties in analyzing the actual data. Some previous studies have recognized these problems and extended traditional demand theories to introduce their consumption models (for example, Theil, 1967). One of the most prominent developments in this field is the intensive use of Divisia moments as applied by Clements (1982) and Chen (1999). This section adopts the Divisia moment approach to analyze consumption patterns of major metals over time.[2]

The Divisia Index Approach

Let p_{it} be the price of metal i (i=1, . . . ,n) in year t (t=1, . . . ,T) and q_{it} be the corresponding quantity consumed per capita. The proportion of total expenditure devoted to commodity i (or the budget share of i) is $w_{it} ? \frac{p_{it}q_{it}}{M_t}$, where $M_t ? \overset{n}{\underset{i?1}{?}} p_{it}q_{it}$ is total expenditure or income. Then the arithmetic average of the budget share of metal i over the years t-1 and t is $\overline{w}_{it} ? \frac{1}{2}?w_{it} ? w_{i,t?1}?$.

The log-change in the price of i from year t-1 to t is defined as

$$Dp_{it} ? \log p_{it} ? \log p_{i,t?1}$$

and the corresponding quantity log-change is

$$Dq_{it} ? \log q_{it} ? \log q_{i,t?1} \quad ,$$

where log denotes the natural logarithm. When multiplied by 100, these log-changes are approximately equal to annual percentage changes.

The Divisia price index is a budget-share-weighted average of the n price log-changes,

$$DP_t ? \overset{n}{\underset{i?1}{?}} \overline{w}_{it} Dp_{it} \ .$$

This index measures the overall growth in prices or a center-of-gravity of the prices. The analogous Divisia volume index is defined as

$$DQ_t ? \overset{n}{\underset{i?1}{?}} \overline{w}_{it} Dq_{it} \, .$$

These price and quantity indexes for the world and each region are presented in the second and third columns in Tables 4 and 5.

As DP_t and DQ_t, introduced above, are weighted first-order moments of the n prices, the Divisia variances of the price and quantity log-changes are obtained respectively as the corresponding second-order moments, as

$$?_t ? \overset{n}{\underset{i?1}{?}} \bar{w}_{it} ?Dp_{it} ? DP_t ?^2 \qquad \text{and} \qquad K_t ? \overset{n}{\underset{i?1}{?}} \bar{w}_{it} ?Dq_{it} ? DQ_t ?^2 .$$

These variances, reported in columns 4 and 5 in Tables 4 and 5, measure the degree to which the prices and quantities of the individual goods change disproportionately. When all prices and quantities change equiproportionately, the variances vanish. The higher variances represent the larger dispersion of the prices and quantities across metals.

The co-movement between price and quantity consumed, that is Divisia price-quantity covariance, can be also obtained as

$$?_t ? \overset{n}{\underset{i?1}{?}} \bar{w}_{it} ?Dp_{it} ? DP_t ??Dq_{it} ? DQ_t ? .$$

Given the tendency of the consumer to substitute away from those goods with above-average price increases, we expect $?_t$ to be negative. The results are in column 6 in Tables 4 and 5. The associated correlation is $?_t ? \frac{?_t}{\sqrt{?_t K_t}}$, which is reported in the last column in Tables 4 and 5.

The Divisia variance of the budget share log-changes is defined as $?_t ? \overset{n}{\underset{i?1}{?}} \bar{w}_{it} ?Dw_{it} ? DW_t ?^2$, where $Dw_t(? \log w_{it} ? \log w_{i,t?1})$ is the log-change in the budget share of i, and $DW_t(? \overset{n}{\underset{i?1}{?}} \bar{w}_{it} Dw_{it})$ is the budget-share-weighted-average of the budget share log-changes. These variances are reported in column 7 in Tables 4 and 5.

Divisia Indexes for the Metals - Discussion

The Divisia indexes for the world are shown in Table 4, and those for the seven regions are summarized in Table 5.[3]

For the world, the mean of the Divisia price index (3.53) shows that the overall price in the metal industry tends to rise in the long run; around 3.5% per year. Note that prices are measured in nominal US dollars. Therefore, if inflation is taken into account, this 3.5% increase in average nominal prices is considered to be small. In the short term, however, the movements of the metal prices are not stable. The mean price variance of 103.05, compared to the mean quantity variance of 3.04, suggests the volatility of price is larger than the volatility of per capita consumption of the metals. Positive price indexes were found in 21 observations, while negative indexes were found in 12 observations. The largest price index was 25.14 in 1974; the smallest was -25.18 in 1987.

The Divisia quantity index shows that per capita consumption of the metals was relatively stable in both the short and long term. The mean of the quantity index is 0.58, where the largest was 9.98 in 1964 and the smallest was -11.96 in 1975. There are 21 positive and 12 negative quantity indexes.

As mentioned above, the mean of the Divisia price variance (103.05) is greater than that of the quantity variance (3.04). In fact, in every single case, the price variance exceeds the quantity variance. This result does not conform to the findings in previous studies regarding the two variances for other consumption goods (for example, Clements and Daryal, 1999; Clements, 1982; Meisner, 1979; Selvanathan, 1987 and Theil, 1975/76). The largest price and quantity variances were 498.3 in 1987 and 17.43 in 1976, while the smallest were 3.15 in 1963 and 0.07 in 1980, respectively.

The Divisia price-quantity covariance is expected to be negative since consumers tend to substitute cheaper goods for those commodities with an above-average increase in prices. However, the results do not strongly confirm this expectation. According to Table 4, 18 out of 33 covariance observations are negative while 15 are positive. The mean of the price-quantity covariance is positive (0.23). Once the covariance is standardized, the mean of the correlation between price and quantity change is negative, even if, very close to zero (-0.06). This result suggests that there is no strong inverse relationship between the movement of price and quantity.

The Divisia indexes for the seven regions also showed more or less similar results as those for the world. Table 5 summarizes the results.[4] The mean of the Divisia quantity indexes (overall growth in per capita consumption of metals) during the period from 1973 to 1993 is negative in the regions except for Asia where the mean of the index (? 100) is positive (2.83). This result is consistent with the previous finding that Asia is the only region where per capita consumption of all the metals increased over the period. Moreover, as was found for the world, in every region, the mean of the Divisia price variance exceeds that of the Divisia quantity variance.

The mean of the Divisia price-quantity covariance is negative in Europe, Latin America and the USSR, while it is positive in the rest of the regions. However, even when the mean of the covariance is negative, the annual covariances are frequently negative; five times for Europe, ten times for Latin America and nine times for the USSR.

A close look at the various Divisia indexes discloses a certain relationship between them and the level of economic development for each region. Excluding the USSR, the remaining six regions can be approximately categorized into two groups: the developed countries group comprising North America, Europe and Oceania; and the developing countries group comprising Asia, Latin America and Africa. Table 5 shows that the developed countries group has relatively lower price, quantity, and quantity variance indexes, while it has relatively higher price variance, and budget share indexes. For the covariance indexes and correlation, the results are mixed. The relatively lower price index for the developed countries indicates that they allocated relatively smaller budget for those metals whose prices grew rapidly. Developing countries, in contrast, faced higher growth in prices for the period. A similar explanation that relatively less money was allocated for the metals whose consumption grew rapidly can be applied to the lower quantity index for the developed countries.

The higher price variance indexes for the developed countries implies that, although these countries experienced relatively slow growth of metal prices, the fluctuation of prices around the mean was more severe. In other words, the metals that developed countries consumed more intensively are those for which the price fluctuated more wildly around the mean of the seven metals prices (DP_t). Overall, the variances in the budget share for the developed countries are relatively large, which indicates that the changes in the budget share amongst the metals (in other words, the change in the composition of the metals consumed) were greater for the developed countries.

This section discussed the change in price and quantity consumed of the seven metals in each region and found that regional differences, according to the level of economic development, prevailed for selected Divisia indexes. This chapter also found that the violation of the law of demand was frequently observed across all the regions. The next chapter will attempt to estimate the income and price elasticities of each metal in each region, and demonstrate that metal consumption is in disarray. Following this we embark on a discussion about the ways it might be possible, using Marshall's rules in particular, to reconcile the disarrays we discovered with traditional demand theories.

Income and Price Elasticities of the Metals

Double-Log Demand Equations

This section analyzes the price sensitivity of the consumption of metals based on the demand system used by Theil (1965). A double-log demand equation for commodity i takes the form

$$Dq_{it} \; ? \; a_i \; ? \; ?_i DQ_t \; ? \; ?_i Dp^*_{it} \; ? \; \overset{k}{\underset{j?1}{?}} \beta_{ij} d_{ij} \; ? \; e_{it} \quad {}^{5},$$

where $?_i$ is a constant term representing an autonomous trend, $?_i$ is the income elasticity, $?_i$ is the own-price elasticity, d_{ij} is the dummy variable (outlier) in year j, $?_{ij}$ is the coefficient of the dummy variable and $?_{it}$ is a disturbance term. The variable $Dp^*_{it} (? \; Dp_{it} \; ? \; DP_t)$ is the log-changes in the relative price of commodity i defined as the nominal change deflated by the Divisia index. Note that only the own-price is included in this demand equation and that this demand equation is formulated in terms of changes over time. As the first of T (=21) observations are lost in going from levels to changes, we see T-1 (=20) remaining observations to estimate the equation by (single-equation) the Least Square method. As there are seven ($i = 7$) commodities, we estimate seven demand equations for the world and for the seven major regions. The results are summarized in Table 6.[6]

Table 6 shows that, in general, income elasticities derived from the double-log demand equations are statistically significant, while price elasticities are not. It indicates the strong relationship between the changes in per capita consumption of minerals and changes in income. For the world, in the case of steel and nickel (models with constants[7]), income elasticities equals or exceeds 1 (income elasticities of steel and nickel are 1.030 and 1.286, respectively). Models with no constants give similar results as the income elasticities of steel and nickel, which are 1.024 and 1.321, respectively. Income elasticity of aluminium (with constants 0.848 and without constants 0.971), tin (with constants 0.911 and without constants 0.833) and zinc (with constants 0.945 and without constants 0.952) are close to 1, while income elasticities of copper (with constants 0.846 and without constants 0.867) and nickel (with constants 0.674 and without constants 0.615) are less than the other minerals. In contrast to income elasticities, for the whole world, no metal has significant own price elasticity.

The regional results are more or less the same as the results for the world. In most regions except Africa and Latin America, the income elasticities obtained from the double-log demand equations are statistically significant, while price elasticities are in general insignificant. In every region, the income elasticities of steel obtained from the double-log demand equations are statistically significant and they are close to or more than 1. Price elasticities are significant for only two metals, aluminium for North America and tin for Asia. However, the own price elasticity of aluminium in North America appears positive, which is contrary to our expectations and the law of demand[8].

The Long-run Elasticities

As examined, our estimation shows that the own price elasticity of the metals is insignificant. However, as pointed out by Mathur and Clark (1983) and Tilton (1984), the effect of price changes on demand should be considered in the long-run.. To take the long-run effect into consideration, the elasticities were estimated again as the following. Due to the limited number of observations, only the elasticities for the world were estimated.

$$Dq_{it} \; ? \; ?_{i} \; ? \; ?_{i} DQ_{t} \; ? \; \overset{m}{\underset{l?0}{?}} \; ?_{it?l} Dp^{*}_{it?l} \; ? \; \overset{k}{\underset{j?1}{?}} \; ?_{ij} d_{ij} \; ? \; ?_{it} \quad .$$

The lag chosen was three years (m=2), as we considered three years long enough to adjust consumption to new prices. In comparison, Mathur and Clark (1983) used 10 quarters in their study of the elasticity of substitution between selected metals. Long-run price elasticities are reported in Table 7.

We could not find any evidence, that the change of the own price affects the demand for the metal over time (for three years) except steel and aluminium, where the own price elasticities with one period of lag are significant in some cases. A 1% increase of steel price compared to the average metal price, decreases the demand for steel by about 0.03% after one year, and the same change in the price of aluminium decreases consumption of aluminium by only 0.05% after a year. All other elasticities were negative as expected, which is more in line with expectations than the results with a current price variable only; however, they are very small and still insignificant.

Implications and Summary

The Law of Demand Revisited

Utilizing the Divisia index approach, the price of metals was found to be relatively more volatile than its per capita consumption. Even when consumption decreases as a result of an increase in the price of the metal, the magnitude of the percentage change in consumption is likely to be far less than that in the price of the metal, other things being equal. The same approach also reveals, that the relationship between the price of the metals and per capita consumption of the metals is uncertain at the regional level as well as throughout the world. This indicates that an increase in the price of a metal does not always lead to a decrease in per capita consumption of the metal: per capita consumption of metals occasionally increases despite increases in the price, at least in the short-run. This disarray is confirmed by the price elasticity of metal consumption. The double-log demand equations (both with and without lags) for the world, suggest that the main determinant of the demand for the metals seems to be the overall growth in the expenditure on metals rather than the price of them.

Tilton (1983) pointed out that three factors are of particular importance in material substitution – relative material prices, technological change, and government regulations. As a result of interactions of the three factors, he asserted, sometimes the demand for a metal is not significantly affected (or material substitution does not proceed) when its own price changes. In this study, pure economic theories are used to explain this disarray in metal consumption, which serves to supplement Tilton's arguments.

The most classical analysis of demand is found in Marshall (1890), which is well summarized by Hicks (1963) and Layard and Walters (1978). Marshall's laws of demand asserted that, the own price elasticity of demand for a factor i ($?_{ii}$) varies directly with :

1. the (absolute) elasticity of demand for the product the factor produces ($?_{D}$);
2. the share of the factor in the cost of production[9] (v_i);
3. the elasticity of supply of the other factor ($?^{S}$); and
4. the elasticity of substitution between the factor in question and the other factor (s_{ij}) (Layard and Walters, 1978, p.260).

In a two-factor production model, Hicks (1963), showed that the own-price elasticity of a factor is

$$\left|?_{ii}\right| ? \frac{\left|?^{D}\right| s_{ij} ? ?^{S}[v_{i}\left|?^{D}\right| ? (1 ? v_{i})s_{ij}]}{?^{S} ? [v_{i}s_{ij} ? (1 ? v_{i})\left|?^{D}\right|]} .$$

where subscript i is the factor i in concern and j may be regarded as a composite of all other factors. From the above formula, it follows that the (absolute value of) own-price elasticity is supposed to decrease as the elasticity of demand for the product it produces ($?_D$), the share of the factor (v_i), the elasticity of supply of the other factor ($?^S$), and the elasticity of substitution (s_{ij}), decrease. An investigation of all the parameters would provide some clues as to how one might understand the observed disarray in metal consumption.

Metal Consumption in Disarray and the Law of Demand

Considering that, in general, the products, which use the metals we discussed in this paper as inputs, are necessities rather than luxuries, the price elasticity of demand for the product ($?_D$) would not be large.

It is also considered that the share of metal in producing final goods (v_i) would not be large. The share of metal in producing final goods can be found in the input-output coefficients. The input-output coefficients are different across economies and over time, however, in general, they show that input coefficients for metals are small. For example, Seo (1995) found that, based on 1990 data for Korea, input coefficients for steel for most industries that used steel intensively, were extremely low. His study showed that the value of steel used to produce $1 value of each product was $.11 for general machinery, $.07 for automobiles, $.05 for construction and $.02 for electric and electronic appliances. In their comprehensive input-output analysis of the Western Australian economy, Clements and Qiang (1995) also showed that the portion of metals was extremely small across all 43 industries they considered, including those industries which used metals relatively intensively such as construction, road transport and general mechanics and equipment. Becker (1976) considered the case in the UK and found that the direct steel component of the value of motor vehicles was 0.10 in 1968, which recently would have dropped much further. Tin may be regarded as the most important input of cans, however, Demler (1984) reported that total cost of tin accounted for only 2.3% of the total production cost of one can. Another study by Tilton (1983), concerned with tin consumption, showed that tin constitutes between 18 to 35 percent of the final cost of producing organotin stabilizer, while, at later stages of production, tin's portion of the total cost becomes increasingly smaller, accounting for 1 percent or less of the final price of PVC plastic pipe.

The elasticity of substitution between the metals and other factors (s_{ij}) are considered small. It is unlikely that the degree of substitution between metal and other factors such as labour or capital would be high. Tilton (1983) argued that inter-materials competition and substitution was becoming more intense over time as the number of materials increases and the properties of existing materials were enhanced to permit them to penetrate new markets. However, this kind of substitution is mainly driven by technological change rather than by relative prices. Material substitution has been empirically explored for disaggregated industries or products such as battery electrodes (Holmes, 1990), electrical conductor industry (Mathur and Joel, 1983) and the insulated cable markets (Valdes, 1987). Most of these studies found that substitution between metals was limited to some selected metals only, prices played a limited role in material substitution, and that usually the process of substitution progressed over a long period. Copper and aluminium may be highly substitutable metals, hence their elasticity of substitution has been the most frequently examined. For example, Slade (1980) investigated copper-aluminium substitution in five disaggregated sectors and concluded that the short-run elasticities were relatively small or insignificant, while the long-run elasticities of substitution could be larger for some sectors. Mathur and Clark (1983) also estimated long-run elasticity of substitution between copper and aluminium and found that it was very large (larger than unity in the long-run) for an industry with a high level of disaggregation, such as electrical conductors. However, this result would not undermine our argument that the elasticity of substitution for the entire industry should not be high, as the high elasticity they estimated was confined to selected and highly disaggregated industries only. Contrary to the above-mentioned findings, Valdes (1987) also examined substitution between copper and aluminium in the insulated cable market, which is also highly disaggregated, and found that relative prices have no significant effect on the substitution patterns.

The effect of the elasticity of supply of the other factor $(?^{S})$ is the only remaining uncertainty in determining the own price elasticity $?_{ii}$. The elasticity of supply for other (substitutable) metals is often assumed as infinite from a specific industry's point of view (for example, see Slade, 1980; Mathur and Clark, 1983). However, it is questionable whether the elasticity of supply can be assumed as infinite for the whole economy. If we consider the whole market for a certain metal, it might be more plausible to suggest that the supply of the metal is not significantly affected by the volatility of short-run price changes. In this case, where the elasticity of supply of the other factor $(?^{S})$ is sufficiently small, the own price elasticity $?_{ii}$ can be rewritten as

$$\frac{1}{\left|?_{ii}\right|} ? \frac{v_i}{\left|?^{D}\right|} ? \frac{1 ? v_i}{s_{ij}},$$

where the own price elasticity would be small taking into account that the second term (a substitution effect) of the right side of the equation would be large. The elasticity of factors (metals) for the whole industry has not yet received wide attention and needs further research.

Overall, while the numerator of the own price elasticity equation, (in general), consists of either second- or third-order multiplication of the parameters, the denominator consists of first- and second-order multiplication of the same parameters, where these parameters are considered to be very small. This result implies that the own price elasticity should be very small, as reported in tables 6 and 7, and the effect of price changes on consumption is necessarily limited.

Summary

In this paper we provided an account of why the disarray of metal consumption has been observed throughout the late 20th century. If we take into consideration that the sizes of all the parameters possibly changes over time, and are in general very small, the own price elasticity should be correspondingly small and vary over time. This might result in the insignificance of price elasticities as indicated by our results. As long as the relevant elasticities and shares ($?^{S}$, v_i, s_{ij} and $?_{D}$), as discussed above, vary but do not change dramatically in the future, we expect that the own-price elasticity of the metals discussed in this paper will remain insignificant or, if significant, will remain insignificantly small.

Appendix: Data Sources

Consumption Data

The source of the steel consumption data is the Steel Statistical Yearbook (various issues) by the International Iron and Steel Institute, Brussels, Belgium. Data for other metals are from Metallstatistik (1976-1992) by Metallgesellschaft Aktiengesellschaft, Frankfurt Am Main, Germany. Steel in this study is defined as apparent crude steel consumption (= Production + Imports - Exports, for each country), aluminium as primary aluminium consumption, copper as refined copper consumption and lead as refined lead consumption. Consumption of nickel, tin and zinc are taken directly from the data source.

The metal consumption data for the world is available from 1960 to 1993, whereas the regional consumption data could only be collected from 1972 to 1993 (the regional data from 1960 to 1971 is not available). The data from 1960 to 1971 for the world is taken from Tilton (1990). The data for 1972 onwards is taken directly from the sources.

As tin consumption data for 1960 and 1961 is not available, the production data for these two years are substituted for the consumption data. For the tin market, the production/consumption volume is relatively small compared to other metals, such as steel and copper, and the difference between these volumes is also minimal. The source of tin production for 1960 and 1961 is the Statistical Yearbook (1962) produced by the Statistical Office of the United Nations, United Nations, New York

Price Data

The sources for the price data include Commodity Trade and Price Trends (1993) by The International Bank for Reconstruction and Development/The World Bank, The Johns Hopkins University Press, Washington D.C., Metal Statistics 1994 (1994) by American Metal Market, Chilton Publications, New York and The Times.

The prices for crude steel are not readily available since producers rarely sell steel in the form of crude steel. Instead, they develop it into steel products such as wire and roll bar, and trade both domestically and internationally. In most cases, the trade in crude steel occurs only when a producer is overstocked and decides to sell crude steel in order to clear stock. Therefore, prices from such trades do not reflect normal market conditions. In our analysis, the price of Hot-Rolled Steel Bars is used for the following two reasons. First, as a form of primary steel products, Hot-Rolled Steel Bars are quite close to crude steel. Therefore, it is believed that the price of Hot-Rolled Steel Bars accurately reflects the price/cost of crude steel. Second, the data for the price of Hot-Rolled Steel Bars is readily available and the easy accessibility of data is useful for our comparative demand analysis.

The annual average price data for aluminium, copper, lead, nickel, tin and zinc were taken where available from the spot price traded on the London Metal Exchange (LME). For the metals stated above, where the LME's price was not available, the next appropriate sources were chosen. The list, with the detailed sources of the price data, is available from the authors on request.

Population Data

The source of the population data is the Demographic Yearbook (1962-1995) published by the Statistical Office of the United Nations: Department of Economic and Social Affairs, United Nations, New York .

The regional categorisation is basically in line with geographical groupings with the exception of the four points listed below:

?? Middle East countries, such as Afghanistan and Iran, are included in Asia.

?? North America consists of the US and Canada, while other countries in the North and South American continents are categorised as Latin America.

?? Hawaii, a state of the US, is included in North America rather than Oceania.

?? From 1960 to 1992, neither Asia nor Europe includes the former USSR. After 1993, the UN changed their categorisation by spreading the population of the republics of the former USSR over Asia and Europe and no longer recognized the population of what was formerly the USSR as an independent category. As a result, there was a huge increase in the population of Europe and Asia from 1992 to 1993. To maintain the consistency of the analysis, the population of each republic of the former USSR was collected in 1993. Then the populations of Asia and Europe were reduced accordingly, so that the figures do not include the population of the former USSR. The sum of each republic's population in 1993 was shown as the population of the USSR in that year.

Endnote

1. The title of this paper is inspired by Johnson's comprehensive and seminal book entitled World Agriculture in Disarray (1973). However, the topics and methods in this paper are completely different from those in the book.

2. Tilton (1989) examined the demand for five metals (aluminium, copper, steel, nickel and zinc) in North America for 1950-1987 and explained the declining share of world demand. However, his investigation was based on the intensity of use rather than the relationship between price and consumption.

3. It might be worthwhile to investigate the distribution of relative price and consumption changes to understand the stability of the tendency. In every region, none of the metals seem to have normally distributed frequencies of relative price. They seem to have a rather U-shaped distribution. For the frequency distribution of relative consumption, only the relative consumption of steel in the regions except for Oceania seems to be normally distributed. For the frequency of the relative consumption of other metals, they seem U-shaped or to have a rectangular distribution. More detailed discussion is found in Takashina (1996).

4. Table 5 reports means of various indexes for each region. More detail information on the indexes for each region is available from the authors on request.

5. Time trends might be an important factor affecting the relative changes in quantity demanded as the relative price or income changes. As all the terms in the equation to be estimated are differenced once, a constant term $?_i$ represents the coefficient for time trends. Tables 6 and 7 present the results from estimation without a constant as well, which implies that the time trend is not included in the equation with level data. As shown, the elasticities in each case are not significantly different. Dummy variables were used for the world to take into consideration that some outliers would affect the estimation, including the first oil shock period. For each metal, two to four year-dummies were arranged. The estimation reports that,

except lead, all the other metals consumption was seriously affected by the oil shock and then recovered since 1976. More detailed outcomes that are not reported in this paper are available from the authors.

6. All of the estimation equations show relatively high goodness of fit and are free of serial correlation problems, except for steel and copper, where the Autoregresive method (AR(1)) was used to correct serial correlation. More detailed information is available from the authors.

7. Constant terms, which show autonomous trends as discussed in footnote 5, are not reported in Table 6 for simplicity. In brief, for the world, there are two metals (aluminium and tin) where the constant terms are statistically significant. The constant term of aluminium is 2.209 with a p-value of 0.3%. This indicates that the changes in per capita consumption of aluminium has a tendency to increase by approximately 2.2% per year if the changes in the price of aluminium is equalled to the overall price change in the metal industry. On the contrary, the constant term of tin is -2.533 with a p-value of 0.0%. This shows that the changes in per capita consumption of tin tends to decrease by approximately 2.5% per year if the changes in the price of tin are the same as the overall price change in the metal industry. For the regions, constant terms obtained from the double-log demand equations are generally not statistically significant except for steel, aluminium and nickel in Europe, lead in Asia and tin in Africa. The results for constants terms are available on request from the authors.

8. Wu (1998) used a different equation from the one employed in this paper, and included the prices of all other metals in the model to find the substitutional effects. In most cases, the substitution was found to be insignificant.

9. Marshall's proposition 2 needs modification, as shown in Layard and Walters (1978). They demonstrated that the second proposition only holds if the elasticity of product demand exceeds the elasticity of substitution.

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TABLE 1

ANNUAL AVERAGE PRICE OF METALS

(Unit: Nominal US dollars per metric tonne)

Year	Steel	Aluminium	Copper	Lead	Nickel	Tin	Zinc	Total
1960	125	500	677	198	1,631	2,196	247	141
1961	125	470	633	176	1,711	2,447	214	140
1962	125	435	644	154	1,762	2,471	185	140
1963	127	444	646	174	1,742	2,507	212	142
1964	131	493	968	278	1,742	3,408	324	152
1965	131	489	1,290	317	1,735	3,893	311	157
1966	130	479	1,530	262	1,739	3,574	282	159
1967	131	484	1,138	229	1,936	3,331	273	153
1968	135	457	1,241	240	2,075	3,126	262	158
1969	145	581	1,466	289	2,363	3,428	287	173
1970	154	540	1,413	304	2,846	3,673	295	181
1971	174	435	1,076	252	2,932	3,501	312	195
1972	157	432	1,071	305	3,080	3,770	376	180
1973	185	663	1,805	439	3,373	4,828	883	225
1974	238	944	2,067	590	3,825	8,201	1,226	288
1975	252	690	1,244	408	4,570	6,870	739	281
1976	250	862	1,406	451	4,974	7,582	710	288
1977	280	991	1,300	620	5,203	10,762	583	320
1978	309	1,045	1,379	670	4,610	12,908	597	350
1979	309	1,632	2,025	1,202	5,986	15,458	741	377
1980	357	1,755	2,165	895	6,517	16,775	759	426
1981	374	1,250	1,734	721	5,883	14,159	851	423
1982	380	978	1,476	543	4,753	12,826	742	419
1983	446	1,471	1,595	425	4,674	12,988	759	494
1984	487	1,231	1,373	444	4,742	12,273	904	525
1985	531	1,039	1,412	385	4,828	11,539	774	562
1986	531	1,144	1,367	409	3,861	6,161	760	562
1987	377	1,592	1,858	596	5,125	6,690	799	437
1988	380	2,582	2,584	656	14,252	7,052	1,268	482
1989	432	1,920	2,810	667	12,960	8,534	1,657	524
1990	450	1,649	2,659	823	8,966	6,085	1,515	528
1991	454	1,280	2,333	555	8,105	5,595	1,109	515
1992	385	1,270	2,310	547	7,015	6,109	1,256	451
1993	407	1,133	1,889	405	5,231	5,100	961	456

TABLE 2

PER CAPITA CONSUMPTION OF METALS - WORLD

(Unit: Kilograms per capita)

Year	Steel	Aluminium	Copper	Lead	Nickel	Tin	Zinc	Total
1960	111.748	1.391	1.588	0.875	0.098	0.054	1.029	116.782
1961	114.251	1.465	1.658	0.882	0.105	0.054	1.055	119.468
1962	114.133	1.576	1.651	0.895	0.101	0.063	1.075	119.495
1963	120.234	1.700	1.715	0.923	0.104	0.064	1.129	125.867
1964	133.211	1.859	1.862	0.978	0.125	0.065	1.227	139.327
1965	137.665	2.024	1.885	0.969	0.131	0.064	1.244	143.981
1966	140.851	2.271	1.927	0.994	0.139	0.064	1.273	147.520
1967	144.941	2.275	1.818	0.972	0.138	0.061	1.264	151.468
1968	151.970	2.545	1.880	1.053	0.141	0.062	1.353	159.004
1969	161.458	2.723	2.009	1.080	0.142	0.063	1.440	168.916
1970	161.964	2.749	2.007	1.078	0.159	0.062	1.388	169.407
1971	156.266	2.888	1.969	1.086	0.142	0.061	1.404	163.815
1972	167.012	3.107	2.100	1.102	0.153	0.061	1.515	175.050
1973	179.339	3.535	2.264	1.159	0.170	0.066	1.616	188.150
1974	181.078	3.615	2.136	1.136	0.183	0.063	1.551	189.762
1975	162.337	2.887	1.876	1.199	0.146	0.053	1.255	169.754
1976	167.566	3.492	2.111	1.281	0.165	0.058	1.428	176.101
1977	164.887	3.525	2.196	1.332	0.155	0.055	1.403	173.553
1978	169.304	3.603	2.237	1.297	0.165	0.055	1.480	178.141
1979	173.624	3.688	2.271	1.302	0.173	0.053	1.469	182.581
1980	162.211	3.452	2.119	1.218	0.160	0.050	1.397	170.607
1981	157.565	3.242	2.118	1.172	0.148	0.047	1.349	165.640
1982	141.984	3.103	1.957	1.134	0.142	0.044	1.289	149.653
1983	142.550	3.285	1.942	1.127	0.149	0.044	1.349	150.446
1984	149.943	3.366	2.077	1.142	0.166	0.046	1.375	158.114
1985	148.942	3.360	1.987	1.121	0.163	0.044	1.342	156.959
1986	146.313	3.376	2.051	1.119	0.162	0.044	1.359	154.424
1987	147.040	3.485	2.075	1.119	0.169	0.045	1.366	155.299
1988	153.095	3.476	2.063	1.130	0.169	0.046	1.411	161.391
1989	150.168	3.464	2.110	1.122	0.167	0.047	1.379	158.457
1990	146.190	3.385	2.045	1.059	0.162	0.044	1.316	154.201
1991	136.658	3.442	1.977	0.967	0.149	0.040	1.228	144.461
1992	131.906	3.508	1.972	0.940	0.137	0.036	1.181	139.680
1993	132.556	3.325	1.981	0.928	0.145	0.037	1.193	140.164

TABLE 3

PER CAPITA CONSUMPTION:OF METALS – SEVEN REGIONS

(Unit: kilograms per capita)

Year	Steel	Aluminiun	Copper	Lead	Nickel	Tin	Zinc	Total
				Asia				
1972	56.508	0.855	0.606	0.225	0.051	0.025	0.524	58.794
1973	66.370	1.065	0.728	0.240	0.061	0.028	0.558	69.051
1974	64.074	0.955	0.586	0.257	0.063	0.025	0.513	66.473
1975	59.523	0.899	0.551	0.285	0.047	0.022	0.424	61.751
1976	57.309	1.124	0.667	0.279	0.061	0.023	0.505	59.968
1980	69.607	1.117	0.709	0.312	0.061	0.020	0.519	72.346
1985	75.845	1.191	0.783	0.341	0.065	0.020	0.595	78.840
1990	88.064	1.565	1.040	0.373	0.081	0.027	0.670	91.820
1993	103.448	1.755	1.178	0.410	0.084	0.025	0.686	107.586
				Europe				
1972	422.132	7.354	6.222	3.743	0.404	0.212	4.306	444.373
1973	444.826	8.340	6.554	3.893	0.449	0.220	4.657	468.938
1974	452.381	8.941	6.692	3.998	0.511	0.222	4.613	477.359
1975	397.545	7.667	6.144	4.356	0.412	0.193	3.729	420.046
1976	439.082	9.096	6.621	4.198	0.477	0.193	4.229	463.895
1980	416.979	9.843	7.064	4.305	0.506	0.179	4.591	443.467
1985	362.776	9.937	6.820	4.166	0.542	0.160	4.299	388.702
1990	370.950	10.659	7.260	3.974	0.632	0.141	4.391	398.006
1993	283.152	9.294	6.398	3.218	0.553	0.112	4.014	306.740
				North America				
1972	455.578	13.789	6.788	3.218	0.510	0.180	4.223	484.286
1973	483.032	15.862	7.233	3.429	0.569	0.190	4.495	514.810
1974	472.124	16.229	6.636	3.586	0.610	0.171	4.016	503.372
1975	379.006	10.353	4.619	4.023	0.420	0.140	2.741	401.301
1976	406.983	13.830	5.800	3.965	0.453	0.163	3.521	434.715
1980	343.384	12.825	5.581	3.228	0.412	0.131	2.738	368.300
1985	317.252	11.539	5.902	3.095	0.378	0.103	2.788	341.056
1990	287.377	11.103	5.472	3.286	0.329	0.094	2.630	310.291
1993	285.271	12.121	5.762	3.230	0.337	0.085	2.878	309.683
				Latin America				
1972	107.234	1.512	1.275	0.897	0.018	0.037	0.998	111.971
1973	121.937	1.626	1.309	1.023	0.037	0.047	1.062	127.040
1974	144.349	1.877	1.481	1.092	0.042	0.045	1.131	150.017
1975	131.338	1.873	1.399	1.078	0.040	0.042	1.034	136.803
1976	116.196	1.773	1.640	1.158	0.051	0.045	1.099	121.963
1980	149.104	2.455	2.038	1.073	0.070	0.055	1.433	156.228

1985	69.810	2.549	1.597	1.034	0.059	0.043	1.371	76.462
1990	55.155	2.541	1.273	0.680	0.051	0.041	1.224	60.966
1993	66.738	2.529	1.558	1.016	0.056	0.030	1.212	73.139

TABLE 3 (Cont.)

PER CAPITA CONSUMPTION: CONTINENTS

(Unit: kilograms per capita)

Year	Steel	Aluminium	Copper	Lead	Nickel	Tin	Zinc	Total
Oceania								
1972	431.733	6.540	5.584	3.475	0.178	0.188	6.312	454.010
1973	387.573	8.500	6.568	3.917	0.243	0.223	6.553	413.578
1974	426.029	9.742	5.861	4.445	0.230	0.225	6.335	452.866
1975	339.190	7.052	4.652	4.581	0.110	0.176	4.271	360.033
1976	336.273	8.491	5.518	4.373	0.182	0.182	4.600	359.618
1980	299.261	11.061	5.657	3.543	0.209	0.148	5.052	324.930
1985	265.840	12.924	5.032	2.752	0.148	0.112	4.276	291.084
1990	243.615	8.269	4.800	2.492	0.065	0.054	3.935	263.231
1993	236.679	13.093	5.371	2.396	0.061	0.011	5.268	262.879
Africa								
1972	25.190	0.219	0.182	0.138	0.009	0.011	0.198	25.945
1973	26.126	0.294	0.226	0.143	0.013	0.011	0.238	27.051
1974	35.263	0.296	0.237	0.196	0.015	0.011	0.265	36.284
1975	37.192	0.283	0.218	0.160	0.015	0.009	0.260	38.138
1976	34.301	0.287	0.185	0.156	0.012	0.009	0.244	35.195
1980	35.851	0.369	0.258	0.202	0.011	0.007	0.290	36.988
1985	32.966	0.367	0.163	0.183	0.018	0.006	0.247	33.950
1990	26.114	0.352	0.149	0.180	0.015	0.005	0.235	27.050
1993	25.183	0.334	0.149	0.163	0.017	0.003	0.214	26.063
USSR								
1972	488.883	5.827	4.153	2.258	0.403	0.073	3.065	504.661
1973	517.564	5.920	4.400	2.400	0.400	0.076	3.360	534.120
1974	545.849	6.151	4.365	2.778	0.417	0.083	3.571	563.214
1975	553.063	6.196	4.784	2.745	0.451	0.090	3.529	570.859
1976	571.341	6.550	4.845	2.713	0.469	0.089	3.605	589.612
1980	567.283	6.981	4.906	3.019	0.491	0.094	3.887	586.660
1985	563.642	6.272	4.677	2.796	0.495	0.113	3.584	581.579
1990	528.256	5.536	3.460	2.249	0.398	0.069	3.183	543.152
1993	280.742	4.117	1.911	0.695	0.222	0.050	1.146	288.884

TABLE 4

DIVISIA MOMENTS: WORLD

Year	Price Index (? 100)	Quantity Index (? 100)	Price Variance (? 10000)	Quantity Variance (? 10000)	Price-Quantity Covariance (? 10000)	Log-Change in Budget Share Variance (? 10000)	Price-Quantity Correlation
1961	-0.88	2.48	9.17	0.91	-1.40	7.28	-0.48
1962	-0.47	0.33	6.78	4.57	-2.72	5.92	-0.49
1963	1.28	5.13	3.15	0.61	-0.05	3.66	-0.04
1964	7.64	9.98	137.50	1.70	-10.22	118.76	-0.67
1965	2.97	3.18	75.07	2.31	-7.00	63.39	-0.53
1966	0.88	2.72	40.57	3.86	-1.27	41.88	-0.10
1967	-2.87	1.58	90.14	8.01	24.93	148.01	0.93
1968	3.52	4.92	8.25	2.48	-3.49	3.75	-0.77
1969	8.72	6.02	22.66	0.70	0.37	24.10	0.09
1970	4.66	0.38	18.66	1.90	2.08	24.72	0.35
1971	6.99	-3.06	159.71	4.43	-16.05	132.05	-0.60
1972	-8.00	6.60	32.24	0.55	-1.31	30.17	-0.31
1973	22.47	7.45	233.99	1.77	4.78	245.31	0.23
1974	25.14	0.26	28.88	5.42	3.86	42.01	0.31
1975	-1.82	-11.96	335.35	14.13	28.97	407.41	0.42
1976	1.21	4.85	35.81	17.43	22.71	98.65	0.91
1977	10.30	-1.19	48.02	2.78	-3.98	42.83	-0.34
1978	9.13	2.55	9.63	0.74	-1.04	8.28	-0.39
1979	7.49	2.32	259.37	0.73	-5.11	249.88	-0.37
1980	12.22	-6.76	42.97	0.07	-0.38	42.28	-0.22
1981	-0.40	-3.12	139.25	1.83	5.96	153.01	0.37
1982	-1.57	-9.69	62.58	3.39	-14.08	37.80	-0.97
1983	16.34	0.75	58.89	2.03	6.35	73.62	0.58
1984	6.17	4.94	58.23	1.01	1.68	62.61	0.22
1985	6.80	-0.83	39.67	0.56	0.93	42.09	0.20
1986	-0.15	-1.46	26.01	1.05	-0.43	26.21	-0.08
1987	-25.18	0.73	498.30	0.53	13.25	525.33	0.81
1988	10.68	3.19	456.20	2.85	-30.49	398.07	-0.85
1989	7.96	-1.44	174.43	1.29	-6.40	162.93	-0.43
1990	0.82	-2.80	73.18	0.26	0.73	74.91	0.17
1991	-2.99	-6.05	80.09	4.87	-13.05	58.86	-0.66
1992	-13.54	-3.07	44.77	2.95	6.77	61.26	0.59
1993	1.13	0.18	91.21	2.48	2.84	99.36	0.19
Mean	3.53	0.58	103.05	3.04	0.23	106.56	-0.06

TABLE 5

DIVISIA MOMENTS: COMPARISON ACROSS REGIO

Rankings	Price Index (? 100)	Quantity Index (? 100)	Price Variance (? 10000)	Quantity Variance (? 10000)	Price-Quantity Covariance (? 10000)	Log-in Budg Vari (? 10
1	**Africa** **4.48**	**Asia** **2.83**	OceaniaOceaniaN.America 173.38	59.16	Oceania**Asia** 5.65	238.7
2	**Asia** **4.43**	**Africa** **-0.02**	N.America 162.78	**L.America** **33.84**	**Africa** **5.48**	N.Am 192.5
3	**L.America** **4.42**	Europe -1.46	Europe 155.20	**Africa** **20.57**	Oceania**L.America** 3.11	**174.0**
4	USSR 4.41	**L.America** **-1.68**	**L.America** **147.43**	N.America 18.43	**Asia** **2.31**	Europ 148.1
5	OceaniaN.America 4.40	**Asia** -2.03	USSR **113.21**	USSR 11.55	**Asia** -1.21	**127.3**
6	N.America 4.38	OceaniaUSSR -2.24	**Asia** 91.56	**L.America** **9.53**	**Africa** **-3.62**	**121.4**
7	Europe 4.30	USSR -2.68	**Africa** **89.88**	Europe 4.49	Europe -5.77	USSF 100.6

NOTE: Developing countries groups are in bold. The USSR, which is difficult to group, is in highlig

TABLE 6

INCOME AND PRICE ELESTICITIES

	World	Asia	Europe	Nth. America	Ltn. America	C
				Income Elasticity		
Steel	1.030***	1.048***	1.065***	1.070***	1.135***	
	1.024***	1.042***	1.084***	1.071***	1.140***	
Aluminium	0.848***	0.689**	1.027***	0.697***	0.281*	
	0.971***	0.783***	0.888***	0.687***	0.244	
Copper	0.846***	0.685**	0.587***	0.903***	0.576**	
	0.867***	0.766***	0.539***	0.890***	0.555**	
Lead	0.674***	0.070	0.192	0.100	0.454**	
	0.615***	0.240	0.210	0.096	0.441**	
Nickel	1.286***	1.156**	1.444***	0.615***	0.701	
	1.321***	1.104***	1.306***	0.624***	0.621	
Tin	0.911***	0.935***	0.643***	0.538***	0.162	
	0.833***	0.743**	0.728***	0.562***	0.165	
Zinc	0.945***	0.526**	0.888***	0.759***	0.200	
	0.952***	0.512**	0.831***	0.763***	0.185	
				Price Elasticity		
Steel	-0.012	0.058	- 0.001	0.068	0.028	
	-0.013	0.054	0.010	0.069	0.029	
Aluminium	0.004	0.082	0.016	0.175**	0.042	
	-0.009	0.077	0.034	0.177**	0.047	
Copper	-0.025	0.059	0.005	0.042	0.058	
	-0.025	0.045	0.010	0.040	0.052	
Lead	-0.006	- 0.040	- 0.008	0.056	- 0.029	
	0.001	- 0.057	- 0.008	0.056	- 0.032	
Nickel	-0.047	0.036	- 0.080	- 0.045	0.087	
	-0.049	0.037	- 0.078	- 0.044	0.069	

Tin	-0.064	- 0.160**	- 0.091	0.031	0.126
	-0.053	- 0.143**	- 0.082	0.043	0.128
Zinc	-0.020	0.015	- 0.017	0.062	0.043
	-0.020	0.016	- 0.008	0.061	0.044

NOTE: ***,** and * denote significance at the 1, 5 and 10% levels respectively. The fi estimation with a constant term while the second row is without a constant term.

TABLE 7

PRICE ELASTICITIES IN THE LONG-RUN – WORLD
(1961-1993)

	$?_{t}$	$?_{t-1}$	$?_{t-2}$
Steel[1]	-0.006	-0.033**	-0.006
	-0.009	-0.028*	–0.013
Aluminium	-0.005	-0.052*	-0.035
	-0.019	-0.053	–0.047
Copper[1]	-0.008	-0.011	-0.007
	-0.007	-0.008	-0.011
Lead	-0.005	-0.019	-0.010
	-0.003	-0.020	-0.010
Nickel	-0.055	-0.014	-0.030
	-0.058	-0.031	-0.029
Tin	-0.068	-0.042	-0.031
	-0.050	-0.031	-0.023
Zinc	-0.003	-0.032	-0.001
	-0.003	-0.031	-0.002

NOTE: The first row for each metal is the result from estimation with a constant term while the second row is without a constant term.
** and * denote significance at the 5 and 10% levels respectively.
Superscript 1 denotes that the elasticities were estimated using the autoregressive method (AR(1)) to correct autocorrelation. All other estimations were conducted by the OLS.