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ESTIMATING PRICE ELASTICITIES OF RAW MATERIAL EXPORTERS*

I.

Demand elasticities for minerals, metals, and commodities in general usually presented are unbelievably low (cf. e.g. the surveys by Stern/Francis/Schuhmacher 1976; or UNCTAD 1974). If demand were actually as inelastic as these results purport, the whole conflict over commodity policy during the 1970s would have been a silly mistake: instead of heated discussions in international fora the South could simply have raised prices, benefitting from inleastic demand, and solving the conflict in its own favour.

Raw material exporters in the South have, in fact, repeatedly tried to raise prices, particularly after 1973/74 in attempts to "follow the OPEC example". As history proves, all such actions have failed. Apparently the typical Southern commodity exporter does not face the situation described by usual estimates. Thus a new approach reflecting reality more closely is imperative. This paper is going to propose a new method of estimating, which infers demand reactions from present and future possibilities of substitution rather than extrapolating past experiences. It solves the contradiction between non-existent pricing power and elasticity estimates, which must apparently yield high values to correspond to the facts. I should like to add that the methodological deliberations presented here were initially developed within the framework of a new approach to North-South trade relations (Raffer 1987; 1987a). As this concept of estimating is new, the author is especially grateful for comments and critiques.

II.

Roughly twenty years ago Staffan B. Linder (1967) proposed a way of estimating demand elasticities of exporting Southern countries that takes market shares into account, which he considered more suitable for estimating a single country's elasticity. His formula was later recommended as especially useful by B. Balassa (1971, p. 333; 1975, p. 372) as it allows taking into account the reactions of the country's competitors. Linder's formula is, in slightly changed notation

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$$\eta_i = \frac{\eta_w}{s_i} - \frac{e_r s_r}{s_i} \qquad (1)$$

where η_i, η_w are elasticities of demand for country i's and the world's exports respectively, s_i is the share of i in global production, s_r is the share of the rest of the world, and e_r is the supply elasticity of the rest of the world. Very few estimates have been obtained by using the Linder formula so far, but all showed highly elastic demand of buyers (v. Raffer 1987, pp. 123ff).

Linder's formula, though a great achievement, needs some improvements. First, Linder's analysis is restricted to other countries rather than taking all possible kinds of substitution into account. Second, a single market price is assumed, which seems to be too strong an assumption. If we assume different prices the reactions of other sources of supply depend on changes in the exporter's price alone. Thus cross-elasticities should be used. Third, as the reaction of buyers will vary in dependence of the increases in price, arc-elasticities rather than point elasticities must be used. While a relatively tiny change from the same price might not engender much reaction, a noteworthy change surely will. The higher the attempted price increase, the more strategies of substitution will become economically viable. Rather than clinging to mathematical elegance, a concept that does not abstract from the importance of the sizes of changes must by applied.

The pq-curve would, of course, have to be estimated differently. Due to insufficiency of data the part above the observed price levels would have to be found by taking substitution possibilities into account. It would have to be estimated at what price substitution becomes economically viable and likely to be adopted. This could only be done by a team of economists and technicians. My proposed formula for estimating the price elasticity η_i of an exporter (or: group of exporters) considering price increases is

$$-|\eta_i| = \frac{-|\eta_{wi}|}{s_i} - \frac{1}{s_i}\left(\sum_{j=1}^{m} e_{rij} s_{rj}\right) \qquad j \neq i \qquad (2)$$

where η_{wi} is the cross elasticity of global demand and the e_{rij} are cross elasticities of supply of other sources to price changes by i, s_i and s_{rj} denote the shares of i and other sources j in global demand respectively.

The elasticity of i's exports as defined above is measured from a demand curve drawn for a specified period of time (e.g. 2 or 3 years), since the elasticity is not independent of time. Furthermore, any such curve, estimated for a raw material and/or country (group of countries) is historically unique and only applicable to a given historic situation, as technolgies and the use of raw materials change. It thus measures the bargaining power of sellers - or the lack of it - under given conditions, at a specified time, and by considering reactions that will occur during a specified

period of time. Available information should thus be used to obtain workable predictions for an exporter that tries to judge the reactions of its buyers vis-à-vis price changes. These buyers are intermediaries in international markets, mostly transnational corporations, well informed and with a good knowledge of the market for the exported commodity. As functioning Southern cartels have never existed for non-fuel commodities, intermediaries may react to attempted price increases on a country by country base. Usually they can more easily abstain from buying a particular country's supply than the exporter can afford not to sell.

III.

The e_{rij} which have to be estimated separately, represent the other sources of supply from which country i's export-good can be substituted. These sources are:

- other countries or regions (country substitution)
- other products (commodity substitution)
- recycling
- ocean reserves
- technical progress
- stocks.

The importance of these alternative sources will, of course, vary with the time-period for which the reaction is assessed. Thus, stocks or idle capacity within another country will be a very important factor in the short run, in contrast to e.g. technical progress, which gains importance in the long run.

Country Substitution was already introduced by Linder (1967). It is the shifting of demand away from an exporter that tries to raise its price (or refuses to lower it). A 100 per cent offtake will not be necessary to bring a country back to the ruling price level, because no Southern country can afford to forgo a substantial part of its export revenues for some months.

Commodity Substitution: Most raw materials can be substituted by other products, e.g. copper by aluminium, plastics of fiberglass, tinplate by electrolytic chrome-coated steel, plastics, glass or aluminium etc. Commodity substitution touches on a common problem in economics, namely the question how to define a good. In his paper on the concept of monopoly A. P. Lerner (1934, pp. 167f) suggested to take "substitutability at the margin" as the criterion: "If any quantity of goods or complex of goods and services can be substituted at the margin for any other quantity of goods and services (and therefore have the same market value), then they are both equal quantities of the same commodity." Without going as far as Lerner did - to call a wireless of £10 and £10 of contributions to charity "equal quantities of the same commodity" if the spender is indifferent between them - all products which are able to replace the commodity in question in one or more uses must be considered in the elasticity formula. Thus technical possibilities determine the responsiveness of commodity substitution. To take technical possibilities of substitution already existing

into account, and to estimate at what prices for the export product which technical possibilities of substitution become viable, specialised engineers are needed. As Maizels (1984, p. 31) points out, the price of the synthetic substitute often becomes the upper limit to the price of the natural product. Equally, the ultimate form of commodity substitution, when a commodity is not needed any longer because a back-stop technology becomes viable puts an upper limit to possible price-strategies. Such technologies are based on lean and effectively inexhaustible resource bases, such as kaolin clays in the case of bauxite or laterite in the case of iron. The technicians in the team would have to find out whether and at what price such technologies might become operable.

Recycling and the viability of *Ocean Reserves* would as well have to be assessed by technicians in a similar way. Increased shares of recycling in total consumption would also decrease the shares of primary producers in total demand.

For long-run estimates likely changes in technology should be included. *Technical progress* in production saving commodity inputs is significantly dependent on prices and on the size of changes in prices.

Stocks are the most important short-run instrument to stop attempts to raise prices. While other forms of substitution are either limited by the supply elasticity of other producers (which might be quite high if idle capacity exists) or need some time to develop their full impact, stocks can be used immediately. Being large enough relative to the supply offered by the price- increasing exporter, they allow an infinitely elastic reaction by intermediaries. They mean economic power and temporary independence from producers. Gabor (1977, p. 2) describes the effect of stocks on the tabacco market as a "steadying influence": as tobacco manufacturers keep stocks approximately equal to two years' requirements, producers know that they can afford to withhold purchases should they consider the price too high, buying normally in small quantities only to avoid pushing up the market price.

Stock fluctuations might neutralise considerable shortfalls of sales by producers, thus reconciling small changes in global consumption with big offtakes at the producing country- intermediary level. Even during the so-called "first oil crisis" the market was not tight enough to prevent oil companies from bringing high-cost producers in line with the general level by shifting away from these sources. These offtakes were quite substantial, "of the order of 50 to 60 per cent" according to Jaidah (1982, p. 3). Also, in the 1980s stock movements contributed to the decline of the oil price. In the case of tin, where the share of the South is considerable, the US Strategic Stockpile alone could easily establish any price it might wish in international markets.

Table 1: The importance of cooper stocks
(Measured in relation to yearly copper production in the periphery and in selected PCs)

	1977	1978	1979	1980	1981	1982	1983	1984
Western* stocks unwrought copper (1,000 metric tons)	2334.9	1884.8	1447.4	1340.9	1440.8	1928.7	1869.0	1442.2
Ratio of Western stocks to peripheryt mine production‡	1.0610	0.8678	0.6714	0.6048	0.6326	0.7985	0.7591	0.5853
Selected PC-producers' yearly mine production as percentage of Western stocks‡								
Chile	29.35	35.67	47.72	51.77	48.77	41.86	43.72	58.14
Peru	9.17	12.98	17.84	17.78	14.78	12.01	11.21	16.41
Philippines	7.59	9.08	13.12	14.76	13.64	9.84	9.44	10.52
Zaire	13.41	14.62	17.59	22.28	22.77	16.95	17.47	22.57
Zambia	18.26	22.17	25.88	28.88	26.50	17.85	20.11	25.46

Source: *World Metal Statistics*, published by the World Bureau of Metal Statistics, various issues.
*From the total given in the source, stocks in PCs have been subtracted; stocks of blister and anode copper, as well as of refined copper of commercial stocks and strategic stockpiles have been added up. To allow the adding up of blister and anode copper with refined copper the former stocks were multiplied by 0.97. The West is defined as UNCTAD-developed plus Namibia, as decision making processes in this country are definitely not in the hands of PC-decision makers. Due to the data situation, socialist countries are not included and "World Stocks" in the source are renamed "Western Stocks" as no data for the East are given.
†Defined as Group of 77 plus non-UNCTAD
‡To make the "recoverable copper content of ores and concentrates" as provided by the source comparable to stocks of refined copper the former was multiplied by 0.65. Obviously this is only a rough calculation for the purpose of illustrating dimensions, as the conversion factor will vary depending on technologies used. For his helpful advice in this matter I am indebted to Mr G. Wernsperger.

Quoted from: Raffer (1987a, p. 708).

The problem of stocks is illustrated more closely at the example of copper. Table 1 shows the relations between copper stocks, as published in *World Metal Statistics,* and mine production in the periphery, as well as in selected peripheral countries. Ratios of well over 50 % between Western stocks and periphery mine production underline the importance of these stocks. In other words, in the unlikely event if all Southern producers stopped selling, the West could have drawn more than half a year's copper inputs from these stocks alone. Considering the dependence of copper exporters in the South on their export commodity (c.f. Labys 1980, p. 91) these ratios also show power relations in international markets quite clearly.

Table 1, on the other hand, shows values too low for actual stocks, as the source only summarises available information,and details on stocks of semi-manufactures

are available only for the U.S. In a study for the IBRD Radetzki (1977) tried to estimate copper inventories. After illustrating the problematic nature of existing data, Radetzki tries to "guesstimate" unreported cooper stocks, including unfabricated metal or metal-containing products. His findings are quite interesting. While, e.g., apparent changes in inventories showed an increase or 0.8 million metric tons in 1975 (excluding socialist countries), Radetzki estimated a reduction of invisible stocks of nearly 0.9 million metric tons, which amounted to around 15 % of Western production in that year. Considering that inventories at the beginning of the year might have been that much higher than the quantity documented in the statistical material, and comparing that difference to the output of even major Southern producers, their lack of bargaining power becomes very obvious.

It is no surprise that reliable data are not available. Apart from the purely technical difficulties in collecting them, the interest of those controlling stocks in providing precise information is certainly limited: data on stocks reveal power relations.

Finally, the *specific position of the exporter* will certainly influence pricing decisions. Especially desperate need for foreign exchange might lead to exports below the going price, even below production costs, and might make buyers more price conscious, thus more eager to use their stocks as an instrument of bargaining. The debt-crisis e.g. has led to what Senator Bill Bradley called so aptly "desperation exports" in a speech to the National Press Club: attempts to increase revenues by lowering one's price. Clearly, the more exporters embark on such a strategy, the less likely it is to work. Furthermore, demand reactions to price cuts, especially in the short run, are not unlikely to be less elastic than in the case of increases over what intermediaries consider "normal" prices. Special marketing ties, high concentration of exports, or information on markets or ore grades are other factors influencing the pricing capabilities of an exporter, as well as other factors enumerated by Labys (1980) and Maizels (1984). So far, however, I have not yet found a promising way of integrating these factors formally into elasticity formula (2).

IV.

By adding up likely substitutions from different sources when and if the export price is increased, the likely decrease in the quantity demanded is inferred. Low elasticities for price reductions, as indicated by usual results, are not unlikely to combine with much more elastic reactions by intermediaries to attempted price increases.

The price to which intermediary demand reacts is what it costs the intermediaries to buy one unit of the export good. The important point of measurement is not the geographic frontier, but where the product leaves the periphery by entering the sphere of a foreign (transnational) intermediary. Geographically this can happen within the exporting country. In the case of minerals and metals, prices actually received by the exporter are difficult to estimate. Terms of long term contracts are usually unknown, and individual country prices calculated by complicated formulae are usually kept secret. Labys (1980, p. 54) also concludes: "Given such a wide

range of prices the price analyst has severe problems in determining the reference or equilibrium price for a particular market." In other words: the pet of economists, the uniform price for one good ruling in one market does not exist. Available information suggests on the contrary that different countries receive different prices for the standardised unit of the product. This is the reason, why Linder's assumption of one world market price had to be dropped, and cross elasticities are better able to describe reality.

The price actually received by exporters can be better represented with the help of the "retained value" concept. Brodsky/Sampson (1980) define returns to domestic factors as

$$RV_1 = L_d^* + K_d^* + M_d^* + R^* \qquad (3)$$

where

L_d^* is the sum of all payments to domestic labour (net of taxes)
K_d^* the sum of payment to domestic capital (net of taxes)
M_d^* the domestic value added component of the intermediate input
R^* sum of total government revenue attributable to the export activity.

RV_1 represents total returns to domestic factors of production plus total funds accruing to the government. It is a gross concept, as it does not take costs incurred into account.

Quite often the exporting country has to provide costly infrastructure. In the past transnationals had used to build their own infrastructure, but this burden has been increasingly shifted upon exporting countries. As such shifts are simply a way of changing actually paid prices a net-retained-value concept is necessary. Dividing RV_1 by the exported quantity renders the gross benefit per unit. Getting less RV_1/unit and incurring no costs is evidently the same as getting a higher RV_1/unit and having to shoulder investments costing exactly the difference per unit. Therefore a net concept, where costs purely incurred to be able to export are deducted, is preferable, namely

$$(RV_1 - \text{costs}) / \text{Quantity} \qquad (4)$$

which is the price actually received by the exporting country, or the costs per unit actually incurred by the buyer.

V.

Point elasticities and iso-elastic functions, both rather popular in econometrics, pose further problems. Iso-elasticity might be more elegant than relevant, as it is easy to imagine that a 25 % price increase triggers different reactions, depending on whether the initial price (say, of fuel) was 50 cents or 50 dollars per unit. As neither price nor quantity variations are infinitely small but normally quite discernible in

practice the concept of arc-elasticity has to be adapted and used for estimating. This concept nearly forgotten by economists because of its mathematically less elegant character, is much more realistic. The important and - to my knowledge - only debate on this matter took place between Allen (1934) and Lerner (1933, 1934a) in the 1930s. Lerner also names what I consider an essential reason for the repression of the arc-concept: "Mathematically there seems to be some aesthetic objection to the use of arc elasticity" (Lerner 1933, p. 42), an objection repeated later, when Lerner (1934a, p. 230) called the arc-elasticity "perhaps repugnant to the mathematician".

The problems criticised by the authors stem simply from the fact that the two elasticities have different properties. Thus, arc elasticities yield different values, depending on whether one measures upwards or downwards. Furthermore, the point elasticity is always equal to one for a constant outlay curve, but the arc elasticity never is.

Lerner initially advocated measuring all changes in the same direction, either as increases or decreases. This would correct the fact that according to whether a rise or a fall is considered, different values are obtained. The change from 3 to 4 is either 33,3 % or 25 %, depending on from which side it is seen. To Lerner (1933) both methods are correct and a satisfactory index as there is no "true" arc elasticity, and it is only a matter of choosing a scale. Obviously this reasoning is wrong. If we suppose any causality between changes in prices and quantities - as the concept of elasticity logically does - it cannot be a question of whether to start from the higher or lower end, or of how to avoid different values for rises and falls, but only of how to grasp the causal relation. The question of where the base should be, or actually *must* be, can thus be only solved by looking at the Cartesian product (p, q) from which the price change started. Increases and decreases from this point must be treated as increases or decreases if a correct picture is to emerge. If one starts by assuming the logical chain away the whole arithmetics will be wrong from the start. It is difficult to understand why the simple fact that a change of one unit - say, from three to four - expressed in percentages is different depending on whether the percentage is taken from 3 or 4, met so much criticism. This is a common phenomenon, nowadays known to any VAT-ridden taxpayer.

Both authors concurred that, if constant outlay were to be separated from unit elasticity, the measure used should not be called "elasticity" (Lerner 1933, p. 41; Allen 1934, p. 227). No logically stringent reason why constant outlay must always and generally be connected with unity was given. There is none. The authors start by defining the concept of elasticity in general by the properties of the specific and unrealistic case of point elasticities, then asking whether the general concept can be reconciled with them. They tried to adapt the general case to conditions that are only fulfilled in this special case - a grotesque turning of the tables of logical reasoning.

This becomes especially evident when Lerner (1934a, p. 230) stresses that it is "indeed unnecessary to know for the purpose of obtaining the elasticity which is the 'base' end of the arc". For someone, whose income and economic welfare depends on the correct forecast of the reactions of the market - be it a firm or an exporting country - this base is evidently important, and also given. The only logically correct way of defining the arc elasticity is thus

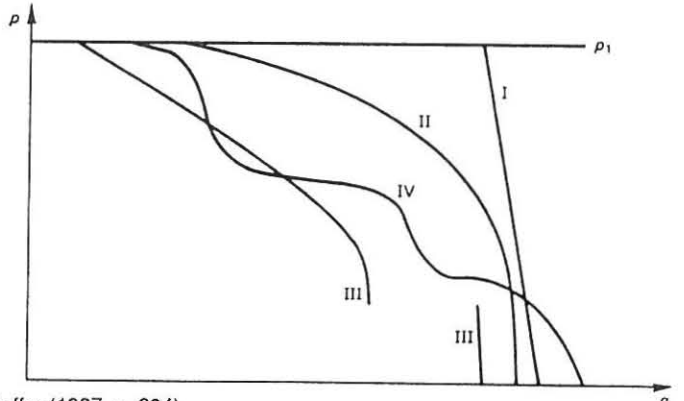
$$\frac{p_1}{x_1}\left(\frac{x_2 - x_1}{p_2 - p_1}\right) \qquad (5)$$

if we stick to Allen's notation, and if the index 1 characterises the situation prior to the change, while 2 characterises the result after the change. This is, by the way, the definition Gabor (1977, p. 11) recommends in his more marketing-oriented book on pricing as well. What is of importance to someone who actually wins his/her bread by selling, is how the market reacts to changes from the status quo. If we respect the logical line of causality, no problem of uniqueness appears.

The arc elasticity formula which emerged out of the Allen/Lerner discussion, taking averages as the base, was finally advocated because it solves both the problems of symmetry and satisfies the constant outlays restriction. Since then it has been with us, practically forgotten, except by some textbooks that mention it briefly, sometimes in a footnote. Advanced economics, and econometrics have stuck to the point concept, once the concept of the arc had been sacrificed at the altar of formal elegance. Therefore it was necessary to explain and defend a useful arc concept which provides the only logically correct method of estimating elasticities.

A country eager to increase its price must try to estimate its own pq-curve, which in turn depends on its share, the substitutability of its exports, existing stocks etc. If this curve for a given time and given circumstances is drawn, it is possible to estimate reactions due to different changes in prices; the room for price-manoeuvres can be guessed that way. Similarly the curve for one product (e.g. copper) could be estimated. Demand curves for specific commodities, countries or groups of countries might, for example, have one of the shapes drawn for illustrative purposes in Figure 1. Curve I shows the case where demand is relatively inelastic until the backstop technology (at price p_1) is reached.

Figure 1



Source: Raffer (1987, p. 204).

Curve II shows a smoother change from inelastic to elastic responses until the backstop technology is reached. III, on the other hand, shows a rapid drop at a certain price, where, e.g., one or some ways of using this particular commodity can be substituted at once, while it is still needed for other purposes but gradually substituted as price increases. An example for such discontinuity might be crude oil. At some price where other fuels (e.g. gasohol) become economically viable a reduction in total demand appears likely, but it would still be needed in branches such as chemical industry. IV describes a demand with some phases of substitution before the backstop stage is reached.

VI.

The method outlined here is a new approach trying to measure the possibilities for price increases for countries depending on revenues from raw material exports. As going estimates focus on "business as usual" their results are not necessarily incompatible with the usual results. Also, the curve is likely to be rather inelastic downwards. This method is, of course, also open to the objections to single estimations that are not done within a global model. Furthermore, the identification problem arises. If changes are big, shifts of curves are more likely. For the price strategist, though, not more than a reasonable way of forecasting the new quantity after a price change is important. What an exporter wants to know is the concrete reaction to price changes at a given point of and during a specified period of time. In the case of a country dependent on raw material exports it would be important to estimate how foreign exchange revenues are likely to develop after a price increase. For these purposes, it is hoped, the proposed method might be of some help.

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