PROBLEMS OF QUALITY VARIATION, INTERNATIONAL SUBSTITUTION, AND DYNAMIC ADJUSTMENTS IN PRIMARY TRADE: THE CASE OF TEA

S. MAJUMDAR

A. *Introduction*

ESTIMATION OF elasticities is a popular preoccupation with empirical economists working in the field of international trade. Activity in this area was particularly hectic in the last two decades with many commodities studied and analyzed, experiments made on various models, and many alternate estimates reported. But, few yielded results that gave sufficient reward to researchers to sustain them in further work. Tea is a commodity which had long eluded attempts to meaningfully estimate demand and supply elasticities of trade. Econometric experiments on tea probably began with Dutta[1] who, in 1965, claimed some success in measuring the price sensitivity of Indian tea demand in the United Kingdom. Dutta's work was succeeded by a spate of quantitative estimates[2] of various parameters of tea trade-flow. But, these studies generally failed to report "good" estimates, and succeeding works were at best marginal improvements on their predecessors. Naturally, serious thinking went into pinpointing the causes of these failures, and, various factors were suggested. All works cited so far used theoretical frameworks in their empirical analysis which are essentially derived from partial-equilibrium static trade-theoretic models. Noting this, some economists argued—rather forcefully[3]—that the incorporation of the global inter-

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[1] Dutta's estimates [7] seem to contain some errors—probably due to what we might call "unfortunate oversight"; I repeated Dutta's equations with data from the same sources and obtained different results. For a discussion on this, see my Ph.D. dissertation [18]. Peera reported some corrected versions of Dutta's equations in 1971 [21], and Peera's corrections corroborated our comments on Dutta's estimates.

[2] Ball and Agarwala [1], Bhattacharyya [2], Cohen [4], Da Costa [6], Dutta and Nargund [8], FAO [10] [11], Kappagoda [17], Manoharan [19], MRCI [20], Roy [22], Roy [23], Sarkar [24], Shome and Ullah [25].

[3] We take the liberty of quoting the letter written to me by Dutta on January 8, 1970: "I cannot see any big problem of identification in any single equation model, unless you seem to suggest things which are not explicitly included in your model. Multicollinearity is, of course, the problem. I did not claim any escape from the issue, but reported, as far as possible the best results, given the constraints of the severity of multicollinearity.

relationships into an empirical model should yield better results.[4] This shortcoming of the existing models prompted me to formulate a simultaneous model of the world tea economy [18, Chap. 2], but, the estimated results were disastrous. Obviously, errors either crept into the suggested structure of the model or into the set of crucial assumptions underlying the model.

The kingpin of analysis and estimation of elasticities in all previous models so far as well as in my simultaneous model is an assumption that teas produced in two different countries were "perfect substitutes" for each other. An examination of the "quality variation" in the tea crop and methods of quality standardization, however, reveals that such a flat hypothesis of perfect substitution is untenable with this crop, and, therefore, models based on an assumption of perfect substitutability are guilty of serious mis-specification of the tea economy's true state and are likely to generate misleading information even if, by chance, they turn up statistically plausible parameter-estimates. The second shortcoming of these models is their failure to take into account the dynamic processes of adjustment operating in the tea markets—the presence of which invalidates the use of "static" frameworks in an empirical analysis. This paper attempts to throw some light on these two neglected but important aspects of world tea consumption and trade.

B. *Quality and Substitution: Some Theoretical Observations*

Tea is always consumed in "blends," and the preparation of these blends for consumption holds the key to understanding the tea economy. It may suffice to quote the following: "The grades into which tea is sorted in producer's factories are not sold as such to consumers. Retail tea, whether sold loose, or, more usually, in the branded packets, is invariably a blend of different grades derived from a variety of estates, and *usually from more than a single country of origin. The blend may contain in various proportions twenty to forty different components*" (emphasis added) [9, p. 173]. Process of blend-preparation necessarily brings an element of "complementarity" in tea trade, and the role of prices, especially for "quality teas," in determining international substitution of tea produced in different countries becomes secondary, subject to quality-factors influencing prices of different grades and their combinations. It will be evident from the following discussion that "high quality" teas from different "growths" have distinctive liquoring and aromatic characteristics and it is difficult to substitute one high quality tea from a particular growth for another.

Quality variations in tea crop necessitate blending to maintain a stable supply of standard quality tea to the consumer. A blend contains one major constituent

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I am not certain if such...single equation models are the best research design with respect to foreign trade studies. I have convinced myself that a fresh look should be taken at designing and specifying simultaneous equation models for studying the export-import structure...based on quarterly data."

[4] Importance of explicit formulation of dynamic structures was also recognized and some attempts to quantify such processes through inclusion of "lagged dependent variables" in the model were made. But, again, these were not very satisfactory.

usually a high or medium quality tea coming from a particular growth and a particular region; but the same blend may contain "fillers" coming from different growths in different countries. The quality teas differ significantly in flavor, aroma, and liquoring characteristics, and consumers usually have a well-established preference for one or another quality tea. Substitution of one quality tea in a blend for another is not usually possible without changing the basic characteristics of the blend. Fillers (i.e., neutral teas which do not change or hamper the basic character of a quality blend) are often mixed with the quality tea to enhance the characteristics of the quality tea or to reduce the production cost of such a blend. Demand for a particular filler is thus derived from demand for the quality tea with which the filler goes well and fluctuates with that demand, no matter where the quality or the filler tea were produced.

Blending and associated problems of substitution with different teas becomes even more complicated because the same tea reacts differently to regional differences in water-characteristics and atmospheric humidity giving different liquoring and flavoring qualities. An experienced tea-taster and planter writes that in

> soft water areas it is usual to use heavy, thick liquoring teas, such as orthodox-manufactured malty Assam and Java teas; soft water brings out the best in them, indeed, even poorer-quality teas from the same growths would benefit. There are, however, certain teas which are unsuitable in these areas for a variety of reasons. green teas react unfavourably; and thin liquoring teas are wasted. It follows, there-China Keemum, Darjeeling, high-grown Ceylon and South Indian teas have a tendency to loose their bouquet; C.T.C. and Legg-cut[5] become brassy; Japanese and China fore, that the latter teas derive the utmost benefit from hard water, while on the strength.
> thick liquoring teas hard water has the reverse effect of not bringing out their
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> The public takes for granted the fact that it can buy packets of tea at the same price week after week, and even year after year, without appreciating how much work this entails. For apart from the variation in quality, blenders must also take into account fluctuations in availability and rises and falls in prices. Then it is vital to know which teas to blend together. Particular care has to be taken with teas of fine quality, as it would be a waste to blend two very stringent teas together.
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> The same principle of good basic blending applies equally to the less expensive, medium and low-quality packets, for although in these schedules the high-priced flavoury teas are not added, these blends still have the attributes of body, strength, flavour and colour which result from good all-round blending. Preference for one company's tea rather than another's is purely a matter of personal taste. Blenders make every effort to maintain a constant standard, and ensure that the public is given teas which are comparable to those of their competitors by tasting each other's blends all the time.
>
> It is said that seven years are needed to train a tea taster, this time being spent buying Indian and Ceylon teas in London and other terminal markets abroad, and studying the art of blending. Perhaps the greatest factor which makes it such a long training is that it is only possible to note the seasonal variations in quality of each growth as and when they become available. At the end of this training period

[5] There are three methods of manufacturing black tea: (a) orthodox, (b) C.T.C., and (c) Legg-cut.

one could certainly know how to buy and blend teas, but it is always necessary to keep up with the newly developed gardens and changes in style of manufacture, and there is always more to learn. [3, pp. 38–40]

Some basic conclusions can be drawn from discussions on factors affecting quality of tea and their implications for standardization of blend-quality.[6] First, there is a significant positive relationship between the quality of a particular variety[7] of tea and the region in which it is usually grown. For example, the best varieties of "Assam dark-leaved" plants do not yield equally high quality tea if grown elsewhere in the world.[8] This constraint on supply of different varieties obviously has a large bearing on international substitution of teas from different regions and of different qualities. Secondly, to enhance the character of a quality tea, it becomes imperative sometimes to mix it with low quality neutral teas (fillers) which may come from areas other than that supplying the quality one and this necessarily brings in elements of complementarity in tea trade.

C. *Determinants of Substitutability: Basic Characteristics of Tea from India, Sri Lanka, and Africa*

Assam teas are generally an ideal base for a good quality blend with their strong, malty flavor and good color. But, at the same time, it is also known that "a very fine Assam with a very fine Ceylon would mean only that one would detract from the other, so it follows that the better quality blends have a pronounced flavour of one of the main growths only and many of packers accordingly label their blends Indian, Ceylon and Darjeeling" [3, p. 38]. In contrast to the "orthodox-Assam," i.e., teas manufactured by the orthodox method, mentioned above, Assam teas made by the C.T.C. method are

teas with a strong, coloury liquor which are the basis of the quick-brew blends introduced in the early 1950's.

The Dooars district produces teas having smooth, mellow, full-bodied liquors of good colour, and they help to bind together all the teas used in a blend, though some of these teas are made by a process which differs from the Orthodox method and are known as Legg-cut teas. . . .The autumnal teas from this district have a distinctive flavour and strength unique in character.

Darjeelings are renowned for their muscatel flavour and aroma; the high-grown Ceylon, from districts where the leaf grows slowly, have an incomparable fragrance, fine flavour and rich golden colour; and there is always a good demand for mid-country Ceylon with their full, rich, flavoury liquors.

South Indian teas, especially when grown in the higher districts of Tranvancore [*sic*] and Nilgiri, have an aromatic quality much sought after in certain markets. Other districts provide useful, bright-liquoring medium teas, but without the fullness of North Indian varieties, and are sometimes used in blends in place of similar-tasting Ceylon.

Indonesian teas from Java and Sumatra are consistent in quality and appearance

[6] For a detailed discussion see [18, Chaps. 3 and 4].

[7] Tea plants can be broadly subdivided into nine main varieties or *jats,* as they are called in tea jargon.

[8] For illuminating discussions on these aspects, see [13, p. 26] [9] [3].

throughout the year, and the high-grown teas from these growths have a flavour somewhat similar to those from corresponding elevations in South India and Ceylon. African teas are being used in blends in greater quantities as their quality improves year by year.

After the basic requirements of body, flavour, pungency and colour have been met, it may be found that the blend is averaging out at too high a price, and to counteract this, quantities of neutral, sound-quality teas are added, known as fillers, which will not damage the character and flavour of the blend. These are available from most growths, particularly the marginal districts of North India and Africa, the low-grown teas from Ceylon, and teas from Indonesia and Argentina. They usually have a good black leaf and coloury liquor, but without any distinctive flavour. Although the fillers are regular components and necessary to blends, they must be used with discretion. An excessive proportion would detract from the strength, body and flavour, thereby wasting the qualities of the expensive tea. [3, pp. 37–38]

D. *Substitution and Prices*

Blenders and packers work (a) to substitute one "quality type" from one growth with another and (b) when creating new blends, if there is a rise in the auction price of certain quality teas, blends with them become relatively less remunerative than those without. Table I gives data on tea prices for selected years from 1951 to 1969 in London, Calcutta, Cochin, Colombo, and Nairobi auctions which deal respectively with teas from all countries: North India, South India, Sri Lanka, as well as Kenya, Uganda, Tanzania, Malawi, Congo, Mozambique (P.E.A.), and other minor tea-producing countries in Africa. Data reveal the following trends: (a) During 1951–69, prices of North India, and Sri Lanka teas in London auctions had a tendency to stagnate, while those of South India and Africa declined. The fall in African tea prices in this market was much more pronounced than for South Indian tea. (b) Domestic tea prices in India were characterized by a steady rise for both North Indian and South Indian teas, and for teas for export as well as for domestic consumption. This rising trend was markedly contrasted by declining trends in tea prices in Colombo and Nairobi.

In view of the higher rate of rise in Indian tea prices compared to Sri Lankan and African prices in domestic auction, and the lower rate of fall of average prices of Indian tea compared to that for Sri Lankan and African types in London auctions, blenders and packers in the U.K. market might have been trying to promote blends of other-than-Indian teas. Such action by U.K. blenders might have been initiated by the fact that most own tea plantations in India, Sri Lanka, and Africa. The political climate in India and Sri Lanka in the last two decades might have forced them to reappraise long-term policies, and look for a "safer" region to reinvest earnings from tea production and trade. An analysis of the ownership pattern in Indian tea plantations clearly shows a shift from British to Indian ownership over the last two decades [20] [15]. British tea planters have been moving away from India (and probably also from Sri Lanka) and probably establishing in relatively new tea-growing regions in Africa [27]. If this is true, then, from the point of view of long-term interests and from considerations of

TABLE I
PRICES OF INDIAN, SRI LANKA, AND AFRICAN TEAS

	1951	1958	1961	1965	1967	1968	1969
London auction (pence/lb.):							
North India	43.90	58.92	55.99	52.30	53.74	48.66	45.30
South India	42.44	45.85	46.39	44.81	42.48	42.26	34.40
Sri Lanka	46.05	59.15	55.51	51.15	52.33	49.30	48.50
Africa	49.04	40.60	43.04	44.34	40.60	44.11	32.20
Domestic auction*							
Calcutta† (rupees/lb.):							
Leaf:							
For export	1.83	2.18	2.11	2.47	2.72	2.49	2.69
For domestic consumption	1.23	1.56	1.71	—	—	—	—
Dust	1.69	1.99	2.20	2.32	2.30	2.32	2.35
Cochin† (rupees/lb.):							
Leaf:							
For export	1.97	2.10	2.12	2.21	2.62	2.41	2.35
For domestic consumption	1.85	1.92	—	—	—	—	—
Dust	1.79	1.56	2.02	2.06	2.30	2.14	2.14
Colombo (rupees/lb.)	1.90	1.73	1.93	1.83	1.58	1.83	1.61
Nairobi‡ (shillings/lb.)	—	2.95	3.19	3.28	3.21	2.71	2.33

Sources: [16, 1967] [16, 1969, pp. 48–51].
* Sri Lanka rupee=18 d. up to October 18, 1967, and=16.8 d. thereafter;
Indian rupee=18 d. up to June 5, 1966,
=11.43 d. from June 6, 1966 to October 18, 1967, and
=13.3 d. thereafter; and
excluding export and excise duties and cesses.
† From 1962, no distinction is made between teas sold for export and teas sold for domestic consumption in India. The quantities of dust tea sold for export, if any, were insignificant.
‡ Auctions began in November 1956, but averages are not available until 1958.

the prices of African teas which are cheaper than both Indian and Sri Lanka teas, British blenders and packers would try to promote blends with more African teas in an attempt to motivate new generation tea drinkers to drink the quick-brewing and strong-liquored African teas rather than the highly aromatic but light-liquored teas from India and Sri Lanka. Nevertheless, Sri Lanka, throughout the fifties and sixties, had a price advantage over India in both London and domestic auction markets and the likely adverse trends in the U.K. consumer tastes might have primarily hit Indian teas. Another reason that Indian blends might suffer is, despite the rising production costs of Indian quality blends, the British government consistently refused permission during these years to blenders and packers to raise their retail prices [3, pp. 90, 158], thus motivating the introduction of new cheaper blends to substitute for the high-priced quality blends. Similar substitution may have been made by blenders not only in the United Kingdom, but in other markets as well and the following report of a tea expert testifies to this: "One [blender] admitted that he had generally reduced the percentage of Indians in his blends over a 5-year period [in Canada] without changing the basic character. I believe the same is true in the U.S.A. market where Indian imports have lost grounds to East Africa and Indonesia" [12, p. xi].

A simple model explaining the Indian share of the total imports for Sri Lanka and Indian teas into the United Kingdom by means of a ratio variable of respective prices and the U.K. income is given here:

$$\frac{X_t^i}{X_t^i+X_t^{sl}} = \underset{(34.086)}{1.00238} - \underset{(0.02941)(0.00021)\ (0.025)}{0.000005}\frac{p_t^i}{p_t^{sl}} - \underset{(0.00145)\ (11.676)}{0.01688}\ Y_t^{uk}, \qquad \text{(D1)}$$

$$\bar{R}^2=0.89696, \quad F=70.115, \quad DF=(2,14),$$

$$S=0.0172, \quad DW=2.0161, \quad (\text{Period}=1952\text{–}71),$$

where

X_t^i = U.K. imports from India, 10^6 lbs, year t;

X_t^{sl} = U.K. imports from Sri Lanka, 10^6 lbs, year t;

p_t^i = weighted average prices of North Indian and South Indian teas in London auctions (weights are respective teas sold);

p_t^{sl} = price of Sri Lanka teas in London auction market;

Y_t^{uk} = U.K. income, 10^9 £, deflated by the cost of living index in the United Kingdom (1958 = 100).

X_t^i and X_t^{sl} denote imports "retained" for internal consumption in the United Kingdom after subtracting "re-exports" from total imports.

The adverse trend operating against Indian imports into the United Kingdom is self-revealing in equation (D1) providing indirect evidence for the hypothesis that U.K. blenders might have substituted Indian blends in the U.K. market by "new" blends containing cheaper teas from "growths" other than Indian.

E. *Determinants of Substitution between Different Quality Teas from India, Sri Lanka, and Africa in the U.K. Market*

Substitution of high quality teas like Darjeeling with its distinctive characteristics is not easy. On a priori grounds, substitution is likely mostly in the medium to low quality range.

North Indian teas have a wide range in price: some the highest, others the cheapest in the world. Generally, Sri Lanka has three types of tea: "High-grown," the best quality, and "Medium-grown" and "Low-grown" which are common varieties. Most African tea prices are lower at auction than the best Indian and Sri Lankan varieties, and, therefore, quality-wise, African teas are of medium to low quality. However, African prices may be low at auction due to Africa's late entry into the world tea trade and the newness of African teas for world consumers. African teas are generally produced from bushes developed from newly developed clones and are made by the C.T.C. method giving them quick-brewing and high-liquoring properties generally suitable for instant tea and tea bags. They are fast in gaining popularity with consumers in the Western countries. In contrast, a large portion of tea produced in India and Sri Lanka is still made by orthodox methods.

Tables II and III compare prices for tea from different regions at London and

TABLE II

ANNUAL AVERAGE PRICES OF TEA SOLD AT LONDON AUCTIONS

(Pence/lb.)

Origin	1967	1968	1969
North India:			
Excise zone I	44.1	43.1	33.2
Excise zone II	48.8	45.3	38.1
Excise zone III	76.4	—	—
Excise zone IV	55.4	49.8	47.7
South India:			
Excise zone I	—	40.2	32.6
Excise zone II	—	42.3	33.6
Excise zone IV	—	49.4	55.5
Ceylon:			
High-grown	54.4	50.6	51.6
Medium-grown	51.1	48.8	46.1
Low-grown	43.2	43.7	37.4
Kenya	52.1	48.7	48.2
Uganda	48.4	43.0	40.0
Tanzania	50.3	46.3	43.4
Malawi	36.4	40.6	28.1
Congo	38.6	41.1	35.8
Mozambique	30.6	39.3	25.9

Source: [16, 1970, p. 48].

TABLE III

ANNUAL AVERAGE PRICES OF TEA SOLD IN AUCTIONS IN PRODUCING COUNTRIES
(Excluding Export and Excise Duties and Cesses)

(Rs./lb.)

Auction Center	1962	1963	1964	1965	1966	1967	1968	1969
Calcutta:								
Leaf:								
Assam	2.53	2.40	2.25	2.44	2.62	2.71	2.47	2.66
Cachar	1.96	2.05	1.94	2.14	2.21	2.23	2.01	2.17
Darjeeling	3.37	3.23	3.46	3.92	4.34	4.60	4.38	5.08
Dooars	2.10	2.12	2.03	2.25	2.28	2.36	2.17	2.22
Terai	2.08	2.15	2.03	2.25	2.27	2.40	2.15	2.29
Dust:								
Assam	2.36	2.24	2.20	2.36	2.46	2.35	2.40	2.45
Cachar	1.92	2.08	1.98	2.23	2.28	2.17	2.04	2.07
Dooars	2.01	2.10	2.03	2.26	2.28	2.23	2.22	2.19
Terai	1.87	2.02	1.96	2.22	2.24	2.23	2.14	2.18
Cochin:								
Leaf	2.08	2.11	2.16	2.21	2.20	2.62	2.41	2.35
Dust	1.70	1.93	2.01	2.06	2.06	2.29	2.14	2.14
Colombo:								
High-grown	2.25	2.08	2.14	2.10	2.01	1.99	2.10	1.98
Medium-grown	1.67	1.57	1.63	1.70	1.50	1.51	1.72	1.44
Low-grown	1.59	1.55	1.51	1.67	1.38	1.21	1.65	1.39

Source: [16, 1970, pp. 50–51].

domestic auctions. Table II gives a fair idea of quality types of teas from different countries. Of all African varieties, Kenya teas are the most expensive and are comparable price-wise with Medium-grown Sri Lanka and medium-quality Indian teas. Different zones in India generally produce different quality teas. But zone-wise data on Indian tea prices in London are available only from 1967 on and are, therefore, inadequate for an analysis of substitution.

In the empirical studies below, data are used on the prices of various "regional growths" from North and South India sold in Calcutta and Cochin (Table III). A study of London (Table II) and domestic auction prices (Table III) for various "growths" shows clearly that the four following broad quality-groups of teas are sold there:

(1) Very high quality: Only Darjeeling teas are in this group.
(2) High quality: Assam and some High-grown Sri Lanka teas comprise this group.
(3) Medium quality: Cachar, Dooars, Terai, Cochin Leaf, some Sri Lanka High- and Medium-grown, and African teas belong to this group.
(4) Low quality: All other varieties.

A word of caution: all prices above are averages of the total prices for a group and are only broadly representative of qualities. Each group has a wide quality-range, and prices are evened out by averaging. Some High-grown Sri Lanka teas are equal in price to the best Darjeeling varieties. Similar statements hold true for many other types. Further, since the method of averaging does not take into account any weight for different grades of tea, quality-representations by such average prices are at best a crude first approximation.

A more formidable difficulty in estimating equations for different quality is that separate figures for region-wise teas sold in these auctions are not available. In the absence of these, shares of *all* North or South Indian teas in total sales in London auctions have been used to represent different quality-grades of tea, the underlying assumption being that the shares of the different grades remain more or less fixed in their total supplies as the latter moves up or down in more or less fixed proportion to total output. Since fluctuations in production are never drastic in India and Sri Lanka, this assumption may not be totally inappropriate.

The empirical study seeks to explain substitution between different quality types of four tea groups.

Group 1: North India versus Sri Lanka.
Group 2: South India versus Sri Lanka.
Group 3: South India versus Africa.
Group 4: Sri Lanka versus Africa.

Group 1 experiments have four equations:

$$\frac{\text{North India}}{\text{North India}+\text{Sri Lanka}}=f\left(\frac{\text{Darjeeling price}}{\text{High-grown price}},\ \text{Time}\right). \qquad \text{(E1)}$$

$$\frac{\text{North India}}{\text{North India}+\text{Sri Lanka}}=f\left(\frac{\text{Assam price}}{\text{High-grown price}},\ \text{Time}\right). \qquad \text{(E2)}$$

$$\frac{\text{North India}}{\text{North India}+\text{Sri Lanka}}=f\left(\frac{\text{Cachar price}}{\text{Medium-grown price}},\ \text{Time}\right). \quad \text{(E3)}$$

$$\frac{\text{North India}}{\text{North India}+\text{Sri Lanka}}=f\left(\frac{\text{Dooars price}}{\text{Medium-grown price}},\ \text{Time}\right). \quad \text{(E4)}$$

The left side denotes the ratio of respective sales in million kgs. in London.

Group 2 experiments are as follows:

$$\frac{\text{South India}}{\text{South India}+\text{Sri Lanka}}=f\left(\frac{\text{Cochin Leaf price}}{\text{High-grown price}},\ \text{Time}\right). \quad \text{(E5)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Sri Lanka}}=f\left(\frac{\text{Cochin Leaf price}}{\text{Medium-grown price}},\ \text{Time}\right). \quad \text{(E6)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Sri Lanka}}=f\left(\frac{\text{Cochin Leaf price}}{\text{Low-grown price}},\ \text{Time}\right). \quad \text{(E7)}$$

In Groups 1 and 2, the prices are as of respective domestic auctions.

Group 3 reports the following functions:

$$\frac{\text{South India}}{\text{South India}+\text{Africa}}=f\left(\frac{\text{London South India price}}{\text{London African price}},\ \text{Time}\right). \quad \text{(E8)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Kenya}}=f\left(\frac{\text{London South India price}}{\text{London Kenya price}},\ \text{Time}\right). \quad \text{(E9)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Uganda}}=f\left(\frac{\text{London South India price}}{\text{London Uganda price}},\ \text{Time}\right). \quad \text{(E10)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Tanzania}}=f\left(\frac{\text{London South India price}}{\text{London Tanzania price}},\ \text{Time}\right). \quad \text{(E11)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Malawi}}=f\left(\frac{\text{London South India price}}{\text{London Malawi price}},\ \text{Time}\right). \quad \text{(E12)}$$

$$\frac{\text{South India}}{\text{South India}+\text{Mozambique}}=f\left(\frac{\text{London South India price}}{\text{London Mozambique price}},\ \text{Time}\right). \quad \text{(E13)}$$

Group 4 has only one equation:

$$\frac{\text{Sri Lanka}}{\text{Sri Lanka}+\text{Africa}}=f\left(\frac{\text{London Sri Lanka price}}{\text{London African price}},\ \text{Time}\right). \quad \text{(E14)}$$

F. *Results and Conclusions from Substitution Experiments*

Results are summarized in Tables IV, V, and VI. The fourteen estimated equations can be categorized into two groups depending on their general characteristics. The first group consists of equations (E1) through (E4) and equations (E11) through (E13). The coefficient of the price-ratio variable, in each of the equations, comes out with a wrong positive sign indicating mis-specification of the model. The Durbin-Watson statistic is inconclusive in case of equation (E1),

TABLE IV

SUBSTITUTION EXPERIMENTS WITH MEDIUM QUALITY TEAS

(Equations: E5, E6, and E7)

(Period: 1952–71)

Equation Number	Independent Variables*			$\bar{R}^2$ F (DF)	S DW
	Constant	Price-Ratio	Trend		
(E5)	0.4420	−0.1192	−0.0093	0.7737	0.0412
	(0.0425)	(0.0544)	(0.0022)	33.473	0.5237
	(10.396)	(2.192)	(4.239)	(2,17)	
(E6)	0.3625	−0.0023	−0.0126	0.7098	0.0467
	(0.0348)	(0.0279)	(0.0019)	24.237	0.3348
	(10.402)	(0.081)	(6.696)	(2,17)	
(E7)	0.4071	−0.0645	−0.0098	0.7554	0.0429
	(0.0338)	(0.0632)	(0.0023)	30.333	0.3639
	(12.034)	(1.781)	(4.233)	(2,17)	

* Figures in parentheses in the first line under the coefficients are the standard error, and in the second line the t-ratio.

TABLE V

SUBSTITUTION EXPERIMENTS WITH MEDIUM QUALITY TEAS

(Equations: E8, E9, and E10)

(Period: 1952–71)

Equation Number	Independent Variables*			$\bar{R}^2$ F (DF)	S DW
	Constant	Price-Ratio	Trend		
(E8)	0.7543	−0.0296	−0.0296	0.8634	0.6810
	(0.2368)	(0.1831)	(0.0039)	61.072	0.9138
	(3.185)	(0.161)	(7.557)	(2,17)	
(E9)	1.5003	−0.2593	−0.0492	0.8608	0.1051
	(0.2493)	(0.2078)	(0.0056)	59.751	0.4169
	(6.019)	(1.248)	(8.693)	(2,17)	
(E10)	1.2091	−0.0782	−0.0268	0.5723	0.1265
	(0.3018)	(0.2518)	(0.0062)	13.712	0.2059
	(4.006)	(0.311)	(4.310)	(2,17)	

* Figures in parentheses in the first line under the coefficients are the standard error, and in the second line the t-ratio.

and indicates the presence of positive autocorrelation in equations (E11), (E12), and (E13). Significantly, the first four equations, i.e., (E1) through (E4) in this group, relate to the so-called quality teas, prices of which are, in general, higher than the other teas sold in the auctions. The last three equations, i.e., equations (E11), (E12), and (E13), on the other hand, are for the "lowest grades" sold at auction. No substitution between teas falling in these two categories, i.e., of high quality and low quality teas, is indicated by experiments reported in Table VI.

In contrast, the case for medium quality teas is significantly different. The second group, with equations (E5) through (E10), represents these medium

TABLE VI

SUBSTITUTION EXPERIMENTS WITH HIGHEST AND LOWEST QUALITY TEAS
(Equations: E1, E2, E3, E4, E11, E12, and E13)

(Period: 1952–71)

Equation Number	Independent Variables*			$\bar{R}^2$ / F / (DF)	S / DW
	Constant	Price-Ratio	Trend		
(E1)	0.7277	0.1901	−0.0252	0.6012	0.0827
	(0.0665)	(0.0806)	(0.0067)	15.325	1.1024
	(10.940)	(1.354)	(3.752)	(2,17)	
(E2)	0.6218	0.1924	−0.0184	0.7602	0.0642
	(0.0566)	(0.0509)	(0.0025)	31.109	1.8743
	(10.986)	(3.783)	(7.351)	(2,17)	
(E3)	0.6482	0.1901	−0.0213	0.8725	0.0468
	(0.0329)	(0.0294)	(0.0019)	66.027	1.8822
	(19.707)	(6.474)	(11.094)	(2,17)	
(E4)	0.6806	0.1671	−0.0222	0.8472	0.0512
	(0.0329)	(0.0295)	(0.0022)	53.670	2.2354
	(20.671)	(5.670)	(10.221)	(2,17)	
(E11)	1.1562	0.0092	−0.0315	0.7183	0.1136
	(0.0581)	(0.0161)	(0.0044)	25.220	0.2770
	(19.902)	(0.572)	(7.090)	(2,17)	
(E12)	0.7263	0.0859	−0.0196	0.5756	0.0993
	(0.1918)	(0.1511)	(0.0040)	13.883	0.8220
	(3.788)	(0.568)	(4.976)	(2,17)	
(E13)	0.9061	0.0961	−0.0313	0.7477	0.1075
	(0.2450)	(0.1798)	(0.0043)	29.148	0.8936
	(3.698)	(0.534)	(7.337)	(2,17)	

* Figures in parentheses in the first line under the coefficients are the standard error, and in the second line the t-ratio.

quality teas sold in auctions. In each of these equations, price has the correct sign, although the level of statistical significance varies from equation to equation. It is significant to note that price-ratio is important in equation (E5) representing the substitution between Cochin Leaf tea and Sri Lanka High-grown tea. Furthermore, time trend is accompanied by statistically significant negative coefficients in all equations indicating that market trends for these teas were operating against India in the last two decades. In prices these two varieties of teas, Cochin Leaf and Sri Lanka High-grown, are close to each other (Table III), which provides with a quantitative assertion of the statement that South Indian teas, especially those grown in higher altitude districts, are sometimes used for a similar-tasting Sri Lanka.

Experiments with South India/Sri Lanka medium quality substitution, as shown in equations (E8), (E9), and (E10), tell a similar story (Table V). It appears that Kenyan teas are probably the best substitutes for South Indian Leaf teas. U.K. blenders might have mainly been substituting South Indian with Kenya teas and, to some extent, with other African varieties. Again, the price differentials be-

tween Kenyan and South Indian Leaf varieties are the least of all other combinations. Results in this group have, however, to be interpreted with caution since the price-ratio variables have correct signs but low levels of significance. Moreover, the Durbin-Watson statistic indicates presence of autocorrelation in all three equations. But, the equations are acceptable on other statistical criteria: values of $\bar{R}^2$ are reasonably high, and the standard error of estimates is low.

G. *Factors Affecting Quality and Problems of Supplying Quality and Common Teas*

What has not been realized, or at least recognized, by empirical econometricians in fitting equations to trade data is that the supply of quality and common tea may not be dependent on the same factors, that supply curves of the two broad categories may exhibit divergent characteristics and that problems with the two varieties may not be identical and may need separate treatment. A brief analysis below of factors affecting quality and determining the output of different quality-grades bring the last point into sharp focus.[9]

Quality depends on three factors:

(1) The *"jat"*[10] of the tea plant, which determines the overall or basic quality of the bush.

(2) Climatic or seasonal factors such as rainfall, temperature, etc., which determine, in a given tea bush of a particular *jat,* the quality of tea from different "flushes" produced by that bush. (Tea is plucked from a bush at an interval of seven to fourteen days throughout a tea season,[11] when, after each picking, new flushes appear.[12] Quality of tea picked from the same bush varies from flush to flush due to these factors.)

(3) Size of tea leaves picked in a flush. (Depending on leaf-size, different quality-grades of tea are produced from the same flush.)

Quality variation in tea, thus, can be classified under three headings:

(1) inter-*jat,*

[9] For a detailed analysis, see [18, Chap. 3].

[10] "The planter does not speak of varieties, forms, types, races, agrotypes, ecotypes (groups of plants which have adapted themselves to their surroundings) or cultivars [*sic*] selected from such. He uses the vague term *jat*...for any group, although agrotype might perhaps be a better term. Tea seed is sold under the name of the estate on which it is grown, and this is also spoken of as the *jat* of the seed, but here the term has no botanical significance unless the true *jat* or agrotype name is linked with it" [13, p. 8].

[11] The tea season varies from eight months to a year depending on the length of the monsoon. In North India, the season is from March/April to October/November, i.e., it starts three to four months before and ends three to four months after the peak monsoon of July/August. In South India and Sri Lanka which has two monsoons, tea is picked throughout the year. But, in East Africa, the season is limited to eight months from October to May.

[12] "The first growths of the season, known as new season tippings, are plucked to allow further growths, and these, known as flushes, are plucked every seven to fourteen days. Pluckings...made in this way...(during the whole tea-season)... are known as new season's tippings, first flush, second flush, quality, rains, autumnal and end-of-season teas" [3, p. 16].

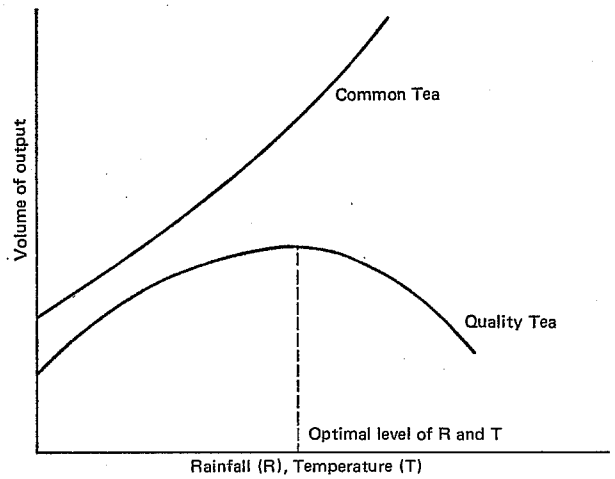
(2) inter-flush, and
(3) intra-flush.

These variations can be called primary, secondary, and tertiary, respectively.

The significant positive relationship between quality of a *jat* and region in which it is usually grown is important.[13] Inter-flush (or secondary) variation in quality occurs due to fluctuations in climatic factors like rainfall, temperature, humidity, etc. In general, quality tea is produced when temperature is not high nor rainfall excessive. Rises in temperature and rainfall bring in "heavy flushing" periods with an accompanying decline in quality. Production of common or plain teas from a bush rises with heavy flushing due to increased temperature and humidity (Figure 1).

Usually, there are two quality-periods in a tea season preceding and following the rains. Early monsoon (second and quality flushes) and post-monsoon

Fig. 1. Output of Quality and Common Teas and Climatic Factors

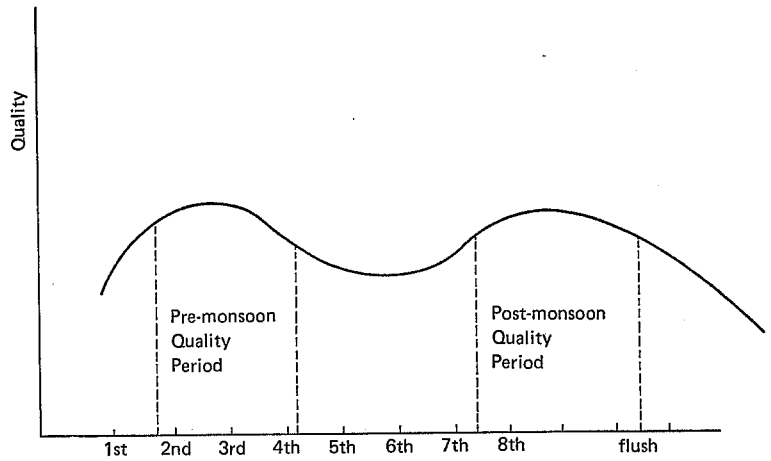


[13] "The extreme type of China bush grows with difficulty in the plains of Assam, although the bigger leaved China varieties and the so-called China-hybrid thrive, but the average yield and quality are markedly below the standard reached by the average Assam plant.

"In the Darjeeling area of the Himalayas, which in the spring produces very fine, flavoury tea, the bushes are China-hybrid, and the Assam type, although it does well there, fails to produce the full hill flavour. On the other hand, hybrid bushes from Darjeeling grown in the plains of Assam also fail to reproduce the full hill flavour. It may thus be concluded that Darjeeling teas owe their character partly to the type of bush and partly to the climate.

"The China-hybrid is common in Ceylon and Mauritius, and plants were taken from these countries to Nyasaland many years ago. The Assam plant certainly grows well in Ceylon, although whether the mixed Assam type would maintain the quality and flavour for which Ceylon teas are noted is doubtful. In South India, where the climate closely resembles Ceylon, all the Assam types do well and are in general use, but South Indian teas have not the quality of those of Ceylon. The China-hybrid tea in Nyasaland is now looked upon as a handicap and new openings are with the Assam and Burma types. Similarly in the rest of Eastern Africa, from Southern Rhodesia to Kenya, the large-leaved plant is favoured" [13, p. 26].

Fig. 2. Inter-Flush (Seasonal) Fluctuations in Quality



(autumnal flushes) periods generally improve the overall quality of tea from the bush (Figure 2).

Intra-flush (or tertiary) quality variations depend on the size of leaves picked. Generally, the most tender, smallest leaves picked from a flush produce the best quality tea or first quality of the flush. To ensure this, the normal practice is to pick the topmost "two leaves and a bud" in any plant shoot. But, even if this practice is strictly observed, leaf-size varies and so does quality. Green leaves are, therefore, sorted and shifted mechanically according to leaf-size during the first stage of manufacture, and then separated into first, second, third, and subsequent qualities. These are then separately processed to yield black teas of different quality from that flush. At the final stage, each quality-type is sorted out according to grades: leaf, broken, fannings, and dust as shown in Table VII.

Quantum of production from a flush may vary by changing the intensity of plucking. If coarser leaves below the first two leaves and a bud are picked, output increases but there is an increased proportion of lower quality or common teas in total output. Production of quality tea in a flush, thus, remains more or less the same (Figure 3).

Three inferences can be drawn from the foregoing discussion:

TABLE VII

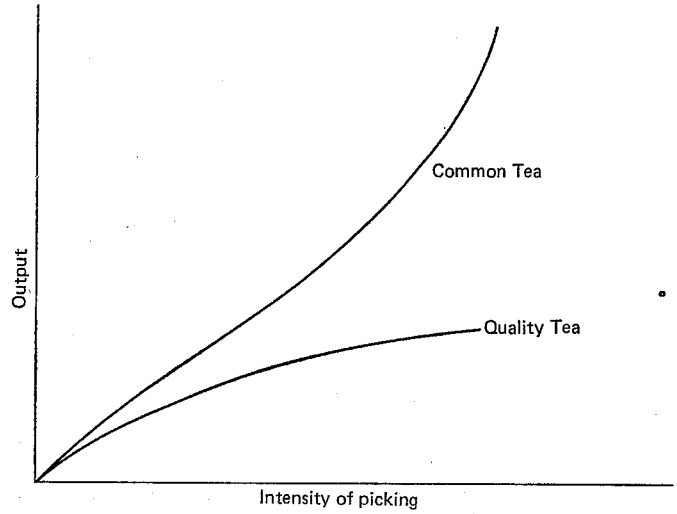
QUALITY-TYPES AND GRADES OF TEA FROM A FLUSH

Qualities	Grades			
	Leaf	Brokens	Fannings	Dust
1st	F′, O, P	F′, B, O, P	F′, B, O, P, F	—
2nd	O, P	B, O, P	B, O, P, F	No. 1
3rd	P	B, P	P, F	—
4th	P, S	B, P, S	F	No. 2

Source: [3, p. 19].

Note: F′=flowery, O=orange, P=pekoe, B=brokens, F=fannings, S=souchong.

Fig. 3. Intra-Flush Variation in Output and Picking Intensity



First, supply of quality tea is likely to be relatively price-inelastic in the short run, as compared to common tea which is likely to have a higher supply fluctuation in response to price change in the market.

Second, production of quality tea is likely to suffer more from seasonal fluctuations than with common varieties of tea.

Third, the question of tea substitution from different countries is not a straightforward one. Since most high quality teas have distinguishing characteristics—Darjeeling, for example, is renowned for its muscatel flavor and greyish liquor, Assam for thick body and strong malty taste, and High-grown Sri Lanka for aromatic fragrance and a rich golden yellow color, substitution between quality teas is not easy. Blenders can substitute a quality tea from one source with one from another source only if consumer taste changes in favor of the latter, which is a long-term process. As a short-run palliative to increasing production cost of a high quality blend, blenders may substitute the first quality of a particular type with the second or subsequent qualities of the same tea, braving, of course, the risk of adverse consumer reaction to a deterioration in quality of the blend.

H. *Price Movement and Tea Disposal in the London Auction Market: A Pointer for Substitution Possibilities*

London auctions handle a large part of the total world export. Table VIII gives data on disposal and prices of tea in the London auction market which reveal that the disposal of Indian tea through London auction has of late been declining with a compensatory rise in "ex-garden sales" in India, primarily meant for domestic consumption. This indicates that Indian producers may have been getting relatively better prices in domestic markets than in the London market over the past decade. Price data for Indian, Sri Lanka, and African teas sold in London and domestic auctions support this view (Table IX and X). From a

TABLE VIII

DISPOSAL OF INDIAN TEA: 1966–71

(Million kg)

Year	Output	Sale in Calcutta/Cochin Auction		Sales in London Auction		Direct Exports to U.K. & Others		Direct Ex-Garden Sale	
		Quantity	% of Output	Quantity	% of Output	Quantity	% of Output	Quantity	% of Output
1966	376	223	59.41	67	17.74	11	2.98	75	19.87
1967	384	220	57.23	81	21.15	14	3.59	69	18.03
1968	402	241	59.92	77	19.05	12	2.92	73	18.11
1969	394	252	64.12	41	10.38	10	2.58	90	22.92
1970	418	238	56.94	51	12.25	15	3.58	114	27.23
1971	433	247	57.09	43	9.88	17	4.01	126	29.02

Sources : Tea Board of India, *Tea Statistics, 1970–71*, p. 26; idem, *Tea Statistics, 1971–72*, p. 27.

TABLE IX

INDEX OF PRICES OF TEA SOLD IN LONDON AND DOMESTIC AUCTIONS

(1958=100)

Year	North India		South India		Sri Lanka		Africa		Indonesia
	London	Calcutta	London	Cochin	London	Colombo	London	Nairobi*	London
1952	61.0	63.6	72.3	76.2	78.0	100.0	54.2	—	87.0
1953	73.7	90.9	90.2	90.5	81.2	111.8	96.1	—	123.3
1954	108.7	140.9	136.2	133.3	107.3	152.9	139.2	—	176.9
1955	108.0	95.5	117.0	109.5	108.6	129.4	110.3	—	116.0
1956	103.6	109.1	112.7	104.8	108.6	129.4	110.3	—	116.0
1757	96.1	95.5	98.5	90.5	78.0	111.8	94.6	—	95.7
1958	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1959	81.7	104.5	97.2	104.8	102.7	117.6	93.8	100.0	90.7
1960	100.5	109.1	104.1	100.0	101.2	117.6	104.7	113.3	104.0
1961	95.1	95.5	101.3	100.0	93.7	111.8	105.9	106.7	100.8
1962	102.9	109.1	96.3	100.0	94.4	111.8	96.1	103.3	74.7
1963	94.6	104.5	94.8	100.0	88.3	105.9	96.6	103.3	69.9
1964	92.7	100.0	100.2	104.8	90.9	105.9	99.0	100.0	66.7
1965	88.8	113.6	97.8	104.8	86.4	105.9	109.1	110.0	n.a.
1966	88.5	118.2	91.3	104.8	86.0	94.1	103.7	100.0	n.a.
1967	91.2	122.7	92.8	128.6	88.3	94.1	100.0	106.7	63.9
1968	82.7	113.6	92.4	114.3	83.3	105.9	108.6	90.0	n.a.
1969	76.9	122.7	75.1	114.3	81.9	94.1	79.3	76.7	n.a.

Sources: [16, 1969] [16, 1970].

* Nairobi auction began in 1958.

comparison of London and Calcutta/Cochin prices of North/South Indian teas, during the fifties, price movements in London and domestic auctions for Indian teas were similar in magnitude and direction, but, in the sixties, the trends contrasted—domestic auction prices steadily rose while London prices at best stagnated. This explains the declining shipment of Indian tea by producers to the London market. But, the fall in London tea prices per se cannot be easily

TABLE X

ACTUAL ANNUAL AVERAGE PRICES OF TEA SOLD IN LONDON (Pence/lb.), CALCUTTA, COCHIN, COLOMBO (All Rs./lb.), AND NAIROBI (Sh./lb.) Auctions

Year	North India		South India		Sri Lanka		Africa		Indonesia
	London	Calcutta	London	Cochin	London	Colombo	London	Nairobi*	London
1952	35.9	1.4	33.1	1.6	46.2	1.7	22.0	—	34.7
1953	43.4	2.0	41.3	1.9	48.1	1.9	39.0	—	49.2
1954	64.0	3.1	62.4	2.8	63.5	2.6	56.5	—	70.6
1955	63.6	2.1	53.6	2.3	64.3	2.2	44.8	—	46.3
1956	61.0	2.4	51.6	2.2	64.3	2.2	44.8	—	46.3
1957	56.6	2.1	45.1	1.9	46.2	1.9	38.4	—	38.2
1958	58.9	2.2	45.8	2.1	59.2	1.7	40.6	3.0	39.9
1959	48.1	2.3	44.5	2.2	60.8	2.0	38.1	3.0	36.2
1960	59.2	2.4	47.7	2.1	59.9	2.0	42.5	3.4	41.5
1961	56.0	2.1	46.4	2.1	55.5	1.9	43.0	3.2	40.2
1962	60.6	2.4	44.1	2.1	55.9	1.9	39.0	3.1	29.8
1963	55.7	2.3	43.4	2.1	52.3	1.8	39.2	3.1	27.9
1964	54.6	2.2	45.9	2.2	53.8	1.8	40.2	3.0	26.6
1965	52.3	2.5	44.8	2.2	51.2	1.8	44.3	3.3	—
1966	52.1	2.6	41.8	2.2	50.9	1.6	42.1	3.0	—
1967	53.7	2.7	42.5	2.6	52.3	1.6	40.6	3.2	25.5
1968	48.7	2.5	42.3	2.4	49.3	1.8	44.1	2.7	—
1969	45.3	2.7	34.4	2.4	48.5	1.6	32.2	2.3	—

Source: See Table IX.

explained. International competition from Sri Lanka and Africa may be one reason. Note that Sri Lanka teas were priced higher than Indian teas all through the fifties in the London auction market, while the situation in the sixties reversed when Sri Lankan prices were always lower than Indian prices. African teas were always priced lower than either Indian or Sri Lankan varieties.

It may be argued that blenders, faced with a lower supply of Indian quality teas in the London market—generally high quality tea is shipped to London—had to buy their supply from Calcutta and Cochin markets where prices were rising because of (a) domestic demand pressure in India and (b) international competition. This might have raised the blender's costs of production of Indian blends relative to production cost of blends containing Sri Lanka or African teas. Prices of Sri Lanka and African teas had fallen in London and domestic auctions over the last two decades. This situation was especially significant for British blenders and packers who, despite their system of "resale price maintenance" [4, pp. 113–21] for retailers in the domestic market, could not increase prices for any of their blends as they wished. In fact, the British government had twice refused permission to blenders and packers who wanted an increase in retail prices [3, pp. 98, 158] of certain blends.

Blenders and packers might, therefore, have resorted to either or both of the following two courses of action to offset any rise in the cost of production of Indian blends: (1) substitution of Indian teas with teas from other suppliers and/or (2) substitution of first quality with second quality of the same Indian teas.

I. *Blenders' Substitution of Quality with Common Indian Tea: Some Empirical Evidence*

Data on quality and common teas are not easy to compile. Although separate price series for Darjeeling, Assam, Dooars, Cachar, Terai, etc. are available, no sales figures for these teas are recorded in official statistical documents. In the absence of such data, proxies for quality and common are used in the analysis.

In quality, North Indians are generally superior to South Indian teas. In London as well as domestic auctions, North Indian teas are priced higher than South Indian varieties (Tables IX and XI). Price differentials between the North and South Indian leaf and dust teas sold in Calcutta and Cochin auctions give an idea of the overall qualitative difference between crops from these regions. In the absence of specific data on sales and prices of different quality-grade teas, one may assume that the North Indian teas are a quality variety, and the South Indian teas common type. This assumption is definitely debatable if one thinks of the distinctive characters of North and South Indian teas as such. However, they are taken only as proxies for two quality-grades of teas for this analysis. Auction demand functions for these two types of teas are estimated and reported below.

Two simple models are utilized in the empirical exercise:

$$Y_t^q = f_1(p_t^q,\ Z_t), \tag{I1}$$

$$Y_t^c = f_2(p_t^c,\ Z_t), \tag{I2}$$

where

Y_t^q = export share of quality (i.e., North Indian) tea in total output of quality tea, year t;

Y_t^c = export share of common (i.e., South Indian) tea in total output of common tea, year t;

P_t^q = ratio of prices of leaf to dust teas sold in Calcutta auction, year t;

TABLE XI

ANNUAL AVERAGE PRICES OF NORTH INDIAN AND SOUTH INDIAN TEAS IN DOMESTIC AUCTION

(Rs./lb.)

Year	Calcutta Auction		Cochin Auction	
	Leaf	Dust	Leaf	Dust
1951	1.83	1.23	1.97	1.79
1955	2.09	1.27	2.30	1.95
1960	2.42	1.96	2.13	1.96
1961	2.11	1.71	2.12	2.02
1962	2.39	2.22	2.08	1.70
1963	2.34	2.18	2.11	1.93
1964	2.25	2.13	2.16	2.01
1965	2.47	2.32	2.21	2.06
1966	2.60	2.39	2.39	2.06
1967	2.72	2.30	2.62	2.29
1968	2.49	2.32	2.41	2.14
1969	2.69	2.35	2.35	2.14

Sources: [16, 1967] [16, 1970, pp. 48–50].

P_t^c=ratio of prices of leaf to dust teas sold in Cochin auction, year t; and Z_t=time trend, year t.

Leaf tea prices are taken as export prices, and dust tea prices domestic prices.

If the theoretical conjecture about international blenders' substitution of quality Indian teas by common Indian teas is true, then these two models should fulfil the following a priori constraints on their coefficients:

(a) $dY/dP<0$ for both models,
(b) $dY^q/dZ<0$ for model (I1),
(c) $dY^c/dZ>0$ for model (I2).

Empirical results are reported in Table XII.

TABLE XII

BLENDERS' AUCTION DEMAND FOR QUALITY AND COMMON TEAS FROM INDIA: 1952–1971

Dependent Variable: Share of Exports in Output	Independent Variables*			$\bar{R}^2$ / F (DF)	S / DW
	Constant	Relative Price	Trend		
Quality tea	0.7211	−0.2793	−0.0028	0.4880	0.0261
	(0.1003)	(0.0923)	(0.0010)	10.055	0.9118
	(7.190)	(3.025)	(2.774)	(2,17)	
Common tea	0.3902	−0.1839	0.0122	0.9244	0.0242
	(0.1127)	(0.0867)	(0.0014)	117.173	1.7291
	(3.462)	(2.122)	(8.890)	(2,17)	

* Figures in parentheses in the first line under the coefficients are the standard error, and in the second line the t-ratio.

These two equations suggest, first of all, that a secular rise in demand by international blenders for common Indian teas has taken place over the last two decades. In contrast, a secular fall in demand by the international blenders for quality Indian teas has been observed. On account of the fact that total world demand for tea in absolute volume did not go down during this period, the contrasting trends in demand for quality and common teas may imply that international blenders have been substituting Indian quality teas either with quality teas from other sources like Sri Lanka and East Africa, or with second quality of the same variety of Indian tea. But, it has already been noted that for various reasons substitution between quality teas from different sources is difficult. Quality teas have distinctive characteristics and strong consumer preference is associated with each. Experiments on international substitution between different quality types from different countries reported here do not suggest that substitution between high quality teas from different sources was taking place. There is evidence, on the contrary, to support the view that international substitution had indeed been taking place between medium quality teas from different growths. If this is true, then it indirectly substantiates the hypothesis that blenders might have been substituting second quality Indian teas for the first quality of the same variety

Indian teas in Indian blends. This, as pointed out, has special significance for a country like the United Kingdom where consumer preference for a particular blend has been built over a long time and would take time to change.

Prices appear to affect the demand for quality more than for common teas. Price elasticities of demand evaluated at the mean values of the variables, however, turn out to be inelastic both for quality as well as for common teas.

ELASTICITIES OF DEMAND

	Price	Time
Quality tea	−0.80336	−0.00084
Common tea	−0.67482	+0.0444

Lastly, these equations point to an element of speculation in case of quality-tea-buying from auctions. Since U.K. buyers generally go for high quality teas and since supply of such teas in the London market from India has been declining, U.K. blenders buy quality teas from London and domestic auctions in India simultaneously. Blenders' demand for quality tea in domestic auctions is dependent on the expected supply of quality teas to the London auction. A tea auctioner's report on U.K. buying in Calcutta auction says: "U.K. buyers naturally took less when they realised that more spot teas would be available in the London auctions" [26, p. 22]. The presence of such speculative behavior implies that simple regression models as applied to quality teas are likely to be only a partial representation, if not a mis-specification, of reality. Empirical results also corroborate this view. From statistical considerations, the equation for quality teas is unsatisfactory: $\bar{R}^2$ is low, and the Durbin-Watson statistic is inconclusive. In contrast, the equation for common teas is quite satisfactory on statistical criteria.

J. *Dynamic Adjustment Processes in Tea Imports and Consumption*

Three factors necessitate dynamic adjustments in tea imports and consumption. First is the importer's requirement to maintain an optimal stock to even out the effects of fluctuations in auction prices. This is stock adjustment by importers. Second, dynamic processes are sometimes initiated by the adjustment mechanism between auction and retail prices. In the United Kingdom, there is, on one hand, the "resale price maintenance" system in retail markets where blenders and packers fix a statutory price below which retailers are not expected to sell; on the other hand, there is resistance by the government to any move by blenders to raise retail prices [3, pp. 98, 158]. These impediments to fluctuations in auction prices being quickly translated into fluctuations of consumer prices give rise to processes of lagged adjustment.

Third, blenders and packers in the United Kingdom might have been substituting quality Indian teas in Indian blends with common varieties of Indian teas bringing a deterioration of overall quality in Indian blends which would have set in motion an adverse trend among seasoned consumers of these blends in the United Kingdom. But, set patterns in consumption habits would prevent an immediate shift of consumers from Indian to other blends. The shift would

be made only after a certain lag in time resulting in a dynamic response pattern of consumers to the situation.

There are many problems in estimating a dynamic setup for consumption from which some sort of quantification of habit adjustments is possible. First, in any such dynamic setup, the use of stocks is essential, but data on stocks in retail channels are generally not available. Second, data on retail prices of tea in most importing countries are not available. Demand functions are thus constrained to use auction prices, which, at best, reflect the behavior of auction demand. Although, auction demand is only derived demand, yet, due to the presence of exogenous distortions in market structure consequent to controls like resale price maintenance, auction prices are poor substitutes for retail prices in consumption functions. In countries where systems like resale price maintenance are not in force, fluctuations in auction prices are, of course, likely to be reflected in retail prices.

Let us denote

M_t = imports for consumption, year t, physical units, adjusted for stocks in bonded warehouses and re-exports;

Y_t = national income of the importing country, national currency units, year t;

P_t = weighted average price of tea in London auction market, year t.

The basic dynamic model used in the analysis is adapted from Houthakker and Taylor [14], and described by the three equations:

$$M(t)=a+bS(t)+cY(t)+eP(t), \tag{J1}$$

$$\dot{S}(t)=M(t)-W(t), \tag{J2}$$

$$W(t)=dS(t). \tag{J3}$$

where $S(t)$ is a state variable representing the effects of all past experiences on present demand and d is the constant rate of depreciation.

The sign of the state variable determines the nature of the dynamic adjustments. $b>0$ implies habit adjustments and $b<0$, stock adjustment. If there are no dynamic adjustments, b should be zero.

The model is in continuous time and contains $S(t)$ which is unobservable. To estimate the model, Houthakker and Taylor reduce it, through a series of algebraic manipulations, to a discrete estimating equation which contains only observable magnitudes M_t, Y_t, and P_t:

$$M_t=B_0+B_1M_{t-1}+B_2\Delta Y_t+B_3Y_{t-1}+B_4\Delta P_t+B_5P_{t-1}\,. \tag{J 4}$$

Original parameters, a, b, c, d, and e, can be computed back from the B-coefficients.

Another variation of the dynamic model used by Bergstrom [14] has been used in the analysis but is not detailed here.

These dynamic demand models have not taken the substitution effects between tea and coffee into consideration as the estimation procedure is iterative and hence cumbersome and time-consuming. The coffee price has been used only in the following static import demand functions to see if any substitution between tea and coffee has been taking place:

$$M_t = B_0 + B_1 Y_t + B_2 P_t + B_3 P_t^c, \tag{J5}$$

$$M_t = B_0 + B_1 \text{ Log } Y_t + B_2 \text{ Log } P_t + B_3 \text{ Log } P_t^c, \tag{J6}$$

$$\text{Log } M_t = B_0 + B_1 \text{ Log } Y_t + B_2 \text{ Log } P_t + B_3 \text{ Log } P_t^c, \tag{J7}$$

where P_t^c = wholesale coffee prices in the New York spot market, U.S.$/1b., year t.

London auction prices have been used in the analysis. A weighted average price series for the following five regions has been computed: (1) North India, (2) South India, (3) Ceylon, (4) Africa, and (5) Malaysia. For each of these five regions, data on tea sold in London auction are available. So total money earnings of the suppliers can be calculated. These money earnings are used as weights. African prices are simple averages of tea prices from Kenya, Uganda, Tanzania, Malawi, Southern Rhodesia, Cameroon, Congo, and Mozambique (P.E.A.).

Price and income are deflated by the cost of the living index of the importing country. The P_t-series is deflated by the relevant importing country's cost of living index.

Demand functions for nearly fifty countries have been estimated and are reported elsewhere.[14] Economy of space, however, limits us to reporting demand functions for only two countries: (1) United Kingdom and (2) United Arab Republic. These two are chosen because they are expected to exhibit decisively contrasting tea-import behavior due to inherent economic differences.

1. *The United Kingdom*

The high per capita intake of tea and the slow growth of imports in relation to growth in population indicate that in a high income country like United Kingdom tea consumption has probably reached a saturation level, and is determined primarily by the pattern of habit and taste set through long association. And economic demand-determinants, income and price, may not have much significance at least in the short run. Empirical studies support this view. Estimated models[15] are:

With only income variable on the right side

$$M_t = 57.5013 + 0.2752 M_{t-1} + 0.0528 \, \Delta Y_t + 0.0825 \, Y_{t-1}. \tag{J8}$$
$$(2.6264) \quad (1.0535) \quad (0.0852) \quad (0.8970)$$

$$\bar{R} = 0.0560, \quad F = 1.0168, \quad DF = (3,14),$$

$$U = 0.0264, \quad S = 5.5031, \quad DW = 1.8885.$$

Parameters of the original model:

$$a = 12.6143, \quad b = 6.0126, \quad c = 0.0181, \quad d = 7.1495,$$

$$S_y = 0.0216, \quad L_y = 0.1358 \text{ (income elasticities)}.$$

Similarly, with only the price variable, the estimated equation is as follows:

$$M_t = 65.3452 + 0.3348 \, M_{t-1} - 0.0277 \, \Delta P_t - 0.0470 \, P_{t-1}. \tag{J9}$$
$$(2.5786) \quad (1.3400) \quad (0.2489) \quad (-0.5286)$$

[14] See [18, Chap. 5].

[15] Figures in parentheses below coefficients are t-ratios.

$\overline{R}=0.1902$, $F=0.8138$, $DF=(3,14)$,
$U=0.0269$, $S=5.6104$, $DW=1.9318$.
$a=8.7489$, $b=10.1946$, $c=-0.0630$, $d=11.1914$,
$S_p=-0.0063$, $L_p=-0.0703$ (price elasticities).

Based on standard statistical criteria, both equations (J8) and (J9) are not good.

However, this is not, in itself, a very disappointing result. Nor does the low R reduce the importance of these equations since they reveal a very interesting feature of tea-drinking habits in the United Kingdom.

One should look carefully at the values of b and d coefficients obtained from equations (J8) and (J9). They are:

Equation 1 (with only income)
$b=6.0126$
$d=7.1495$

Equation 2 (with only price)
$b=10.1946$
$d=11.1914$.

Evidence of habit formation is very strong. The coefficient b, turns out to be positive with unusually high values in both equations. The values of d, the rate of depreciation, are also very high. This value of d denotes that the habit changes very fast. It should be noted that in both these functions, values of d are higher than those of b.

2. *United Arab Republic*

The United Arab Republic was chosen since, in contrast to the United Kingdom, static, rather than dynamic, demand models may explain U.A.R. tea imports better. In a developing country, the possibility of large-scale stock adjustment may be ruled out. Nonetheless, U.A.R. per capita consumption of 1.805 lbs. per year (average for 1951–68) suggests there may be some habit-formation in this country.

As expected, a static linear model with both income and price gives the best fit:

$$M_t=73.7169+0.4487\,Y_t-0.3439\,P_t. \qquad \text{(J10)}$$
$$(3.4286)\ (4.5741)\ (-2.1852)$$

$\overline{R}=0.8758$, $F=24.0571$, $DF=(2,13)$,
$U=0.0480$, $S=10.1427$, $DW=2.4890$.
$S_y=0.5294$ (income elasticities),
$S_p=-0.3269$ (price elasticities).

To test for habit formation, experiments with dynamic models yield the following equation:

$$M_t=73.4094+0.0054\,M_{t-1}+0.4463\,Y_t-0.3429\,P_t. \qquad \text{(J11)}$$
$$(2.7005)\ (0.0201)\qquad (2.8188)\ (-1.9892)$$

$\overline{R}=0.8637$, $F=14.7022$, $DF=(3,12)$,
$U=0.0480$, $S=10.5935$, $DW=2.4987$.
$a=73.0143$, $b=0.0215$, $c=0.4439$,
$d=2$, $e=0.3411$,
$S_y=0.5238$, $L_y=0.5925$ (income elasticities),
$S_p=-0.3241$, $L_p=-0.3276$ (price elasticities).

Obviously, these equations suggest that the static equation is the more specious. In fact, the dynamic term, M_{t-1}, in (J11) has no significance at all. The value of the b coefficient shows a slight formation of habit and habit seems to decline very rapidly, as indicated by a relatively higher value of d compared to b. Another feature of the functions is the low demand elasticity. Inclusion of coffee price does not improve the fit, nor does coffee price have a significant coefficient.

K. *Summary of Conclusions and Suggestions for Further Study*

Conclusions from this study are straightforward. First, the empirical econometrician's catchall assumption of perfect substitution ignoring quality-distinction in a commodity can seriously distort the analysis. There is enough evidence with tea to suggest that commodity categorization in terms of supply source cannot be taken as an adequate indicator for quality-gradation and country-disaggregation may not at all be a reliable procedure for substitution experiments. The experiments here show that there is significant difference between the trade pattern of quality and common teas, and one can argue that the problems of substitution of these two varieties are related to different sets of factors. All studies on tea have disregarded this important aspect and one cannot take their elasticity-estimates as reliable guides for policy action. Secondly, depending on the importing country, the trade pattern may vary significantly from commodity to commodity. Trade adjustments of a high-income country in the face of changing international offerings of and demand for a commodity are likely to be vastly different from those of a low-income country. Commodities also differ from each other; some are necessities, some luxuries and some others addiction-inducing beverages. For this last variety, habit may be an important determinant; but habit formation depends on a variety of factors like average level of personal income and exposure of the population to the beverage. Nonetheless, it is important to realize that for such a commodity, models formalizing static reaction-patterns may be a mis-specification and the resulting bias may be concealed due to chance occurrence of high correlation between time-series having strong monotonic trends. Explicit estimation of dynamic parameters is unavoidable under such situations. Our experiments on tea, reported elsewhere more fully, provide such results.

It should be pointed out at this stage, however, that there is ample scope to improve the reported results in many ways. The quality-experiments have all been done on proxy variables—a procedure which is only a second-best alternative and had to be used due to the non-availability of primary quality data. Quality

data on production and export can be obtained from unpublished sources provided that the researcher is prepared to spend sufficient time, energy, and funds in such a pursuit. This is an important area for further research. Market research in important importing countries may be another fruitful pursuit to take up. The two countries reported here bring out the structural differences in import patterns clearly enough to underline the need for such studies. There are many other aspects peculiar to traditional commodities of which tea is one, like the changing structure of international ownership and problems of production and domestic demand in the producing countries which have earned only passing mention in this paper. All these problems can claim full-time attention from the researcher.

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