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COMMITTEE ON COMMODITY PROBLEMS

INTERGOVERNMENTAL GROUP ON TEA

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A DEMAND ANALYSIS FOR THE TEA MARKET

I. INTRODUCTION AND OBJECTIVES

1. At its last session, the Intergovernmental Group on Tea recommended that a review of demand elasticities for the world tea market be carried out with the view to gaining some insights into factors affecting consumption in major tea markets as well as updating the elasticity coefficients used in the FAO world tea model. This document presents the major findings of a demand analysis undertaken by the Secretariat, and discusses follow up actions needed to improve the results in light of the limited data availability. This analysis should be considered as a work in progress.

2. Several factors influence the demand for tea, including the traditional price and income variables, demographics such as age, education, occupation, and cultural background. In an earlier analysis of the United States tea market the Secretariat found that both income and prices had little impact on consumption, but demographic factors did. The study also revealed that health had a greater influence on tea consumption which led the Group to recommend strengthening consumer awareness of the health benefits of tea consumption through an international generic promotion programme.

3. The analysis outlined in this paper[1] employs a system of equation approach, rather than a single equation method to estimates elasticities. The Almost Ideal Demand System (AIDS) was used for the estimation of tea demand. The demand analysis in this document involves five tea markets, India, Japan, the UK, the United States and China. The next section of the paper describes the methodology used for the demand analysis, discusses some key results and findings. The last section reports on some policy implication and proposes some follow up action.

[1] This paper was developed in collaboration with Dr Stathis Klonaris, Agricultural University of Athens, Department of Agricultural Economics & Rural Development

II. DEMAND ANALYSIS

A. MODEL FRAMEWORK

4. During the last two decades, consumer demand analysis has moved toward a system(s)-wide approach. Numerous algebraic specifications of demand systems now exist, including the linear and quadratic expenditure systems, the Working model, the Rotterdam model, translog models, and the Almost Ideal Demand System (AIDS). The AIDS, developed by Angus Deaton and John Muellbauer in the late 1970s, has been widely applied in demand analysis for agricultural products. The model encompasses several properties which satisfy some of the theoretical requirements of demand analysis. The linear approximate version of the AIDS (LA/AIDS) is relatively easy to estimate and interpret. In addition, homogeneity and symmetry restrictions depend only on the estimated parameters and are therefore easily tested and/or imposed. Finally, it has a functional form which is consistent with known household-budget data.

5. In this analysis, two types of elasticities were calculated. First, the marshallian elasticities, which answer the question of "what is the effect of price change on tea consumption?" Second, the Hicksian elasticities were computed to explore whether the goods under examination were complements or substitutes. This distinction occurs because Marshallian elasticities are gross elasticities and include the income effect for a given level of beverages expenditure. Model specification and derivation are shown in the appendix of this paper.

B. DATA FOR THE DEMAND ANALYSIS

6. The Secretariat had initially hoped to build a comprehensive demand system, which would cover both complements and substitutes for tea, demographic characteristics for each of the major market covered, retail prices, and other preference shifters. Unfortunately, it was impossible to gather all this information. The analysis was therefore restricted to three products of the beverages group, namely, black tea, green tea, and coffee. The results showed the relationship between green tea, black tea and coffee for each of the selected market.

7. The demand system is estimated using FAO world tea database, while information on the coffee market were sourced from the International Coffee Organisation (ICO). The analysis used yearly data, with time series spanning from 1980 to 2009. Due to data limitation on retail prices, the empirical investigation utilized the import and export unit values for black and green tea as a proxy for retail prices (depending on the trade position of a country) as well as FAO composite price index when neither import nor export unit values were available. Thus, for India, time series data concerning the exporting unit values for black tea and the importing unit values for green tea were used instead of retail prices. With respect to Japan, the FAO tea composite price was employed instead of retail prices for black tea and the exporting unit values for green tea instead of retail prices for green tea. For the empirical model of the UK, import unit values for black tea were employed. For the US, the FAO composite tea price index was used instead of black tea retail prices, while for China the import and export unit values for black and green tea were used, respectively. Finally, time series concerning coffee retail prices and quantities were collected from the ICO.

C. EMPIRICAL RESULTS

India

8. Estimates for the demand system for India, based on equation 4 described in Appendix 1, are presented in table 1. The parameters of the deleted equation were obtained through the adding-up condition of demand parameters. Estimated elasticities are reported in table 2 and are evaluated at midpoints. Theoretical restrictions, such as homogeneity and symmetry, were imposed. Most of the parameter estimates were significant at the 1 percent level, suggesting a significant influence of prices on budget share. The sign of price and expenditure were consistent with the theory, and their magnitudes were within the expected range.

Table 1: Estimated coefficients for AIDS model in India

Equation	α_i	γ_{i1}	γ_{i2}	γ_{i3}	β_i
Black Tea	0.868***	0.047***	-0.007**	-0.041***	-0.132***
	(0.0083)	(0.0055)	(0.0032)	(0.0030)	(0.2057)
Green Tea	0.005	-0.007**	0.007***	0.001	-0.009
	(0.005)	(0.0032)	(0.0032)	(0.0015)	(0.0113)
Coffee	0.127***	-0.041***	0.001	0.039***	0.141***
	(0.0052)	(0.0030)	(0.0015)	(0.0020)	(0.0133)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5%. ***=significant at 1%

Table 2: Marshallian and expenditure elasticities for India

	Commodity	Black Tea	Green Tea	Coffee
Price elasticities e_{ij}	Black Tea	-0.818***	-0.992**	-0.905***
		(0.0228)	(0.4935)	(0.0663)
	Green Tea	1.230	-0.985***	-0.978***
		(1.6419)	(0.0106)	(0.0906)
	Coffee	-2.989***	-0.043	-1.778***
		(0.2783)	(0.2251)	(0.0523)
Expenditure elasticity n_i		0.860***	-0.304	4.107***
		(0.0217)	(1.7305)	(0.2930)

Numbers in parentheses are standard errors*=significant at 10% **=significant at 5% ***=significant at 1%

9. Expenditure elasticities for black tea and coffee were positive and statistically significant indicating that these commodities are normal goods, meaning that incremental increases in total expenditures for the beverages group would lead to increases in expenditures on black tea and coffee. Also, the empirical results for India indicated that black tea had an expenditure elasticity that was clearly less than 1, while coffee had expenditure elasticity largely above 1. These findings suggested that as households' expenditure on group non alcoholic beverages increased, consumers tended to spend proportionately less on black tea and more on coffee.

10. The uncompensated price elasticity (Marshallian) of coffee was more than one (-1,78), highlighting the elastic characteristic of coffee in India. In contrast, the price elasticities of black and green tea appeared less that 1 (-0.81 and -0.98 respectively) which meant that both products were price inelastic. This indicated that a uniform decrease in prices would change the share of each item in favour of coffee.

Table 3: Hicksian elasticities for India

Commodity	Black Tea	Green Tea	Coffee
Black Tea	-0.002	-0.0003	0.002
	(0.0058)	(0.0034)	(0.0031)
Green Tea	-0.044	0.021	0.022
	(0.4935)	(0.3499)	(0.2254)
Coffee	0.049	0.003	-1.8566***
	(0.066)	(0.0325)	(0.0442)

Numbers in parentheses are standard errors*=significant at 10% **=significant at 5% ***=significant at 1%

11. The uncompensated cross-elasticities showed complementary relationships. However, these were gross elasticities and included the income effect for a given level of non-alcoholic beverages expenditure. Looking at the compensated cross price elasticities (Table 3), only coffee own price compensated elasticity was statistically significant and thus there was no evidence for complementary or substitution relationships between the commodities under examination.

Japan

12. Green tea consumption in Japan has been steadily declining since the 70's from more than 100 000 tonnes to almost 90 000 tonnes in 2010. On the other hand, coffee consumption has been growing steadily at a rate of 1.2 percent per year between 2000 and 2010. Black tea consumption has been slowly rising after several years of stagnant growth, and now accounts for almost 17 500 tonnes. The demand analysis that follows refers to three non-alcoholic beverages (black tea, green tea and coffee) and covers the period between 1990 and 2009.

Table 4: Estimated coefficients for AIDS model in Japan

Equation	α_i	γ_{i1}	γ_{i2}	γ_{i3}	β_i
Black Tea	0.271***	0.019***	-0.015***	-0.004*	-0.018***
	(0.0479)	(0.0022)	(0.0028)	(0.0021)	(0.0036)
Green Tea	1.755***	-0.015***	0.183***	-0.168***	-0.119***
	(0.4664)	(0.0028)	(0.0229)	(0.0224)	(0.0355)
Coffee	-1.026**	-0.004*	-0.168***	0.172***	0.138***
	(0.4588)	(0.0021)	(0.0224)	(0.0221)	(0.0349)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5%.

13. Estimates for the coefficients of equation 4 are presented in Table 4. All of the parameters were significant at the 5 percent level, underscoring the influence of prices on the budget shares. The sign of price and expenditure elasticities were consistent with the theory, and their magnitudes was within the expected range.

Table 5: Marshallian and expenditure elasticities for Japan

	Commodity	Black Tea	Green Tea	Coffee
Price elasticities e_{ij}	Black Tea	0.236*	0.177***	-6.797***
		(0.1393)	(0.0414)	(1.7236)
	Green Tea	-0.951***	-0.698***	-0.719***
		(0.1815)	(0.0299)	(0.1144)
	Coffee	-0.261*	-0.830***	-1.323***
	Black Tea	(0.1344)	(0.1010)	(0.0323)
Expenditure elasticity n_i		-0.172	0.436***	1.178***
Expenditure elasticity		(0.2297)	(0.1677)	(0.0452)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

14. Expenditure elasticities for green tea and coffee were statistically significant at 5% level, and had a positive sign which indicated that these products were normal goods. Expenditure elasticity on black tea was not significant, despite the recent positive trend in black tea consumption. Also, the empirical results indicated that green tea had an expenditure elasticity equal to 0.43, while coffee that of coffee was 1,17. These findings suggested that as household expenditure of non alcoholic beverages expanded, consumers tended to spend proportionately less on green tea and more on coffee. The uncompensated price elasticity for green tea was estimated to be -0.69, while for coffee it was -1,32 indicating that a uniform decrease in prices would change the share of green tea in favour of coffee. The uncompensated cross-elasticities showed mix results between black tea and green tea. However, these were gross elasticities and accounted for the income effect for a given level of non-alcoholic beverages expenditure. Looking at the compensated cross price elasticities (Table 6), black tea and coffee were found to be substitutes while black tea and green tea were complements.

Table 6: Hicksian elasticities for Japan

Commodity	Black Tea	Green Tea	Coffee
Black Tea	0.233	-0.748***	0.515***
	(0.1378)	(0.1812)	(0.1343)
Green Tea	-0.055***	0.074	-0.019
	(0.0134)	(0.1084)	(0.1059)
Coffee	0.015***	-0.005	-0.449***
	(0.0027)	(0.0289	(0.0286)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5%.

United Kingdom

15. The demand analysis for the UK covered two commodities (black tea and coffee) for the period between 1990 and 2008. The estimated parameters are presented in Table 7. The estimated uncompensated and expenditure elasticities were evaluated at midpoints and reported in Table 8. All the estimated coefficients were significantly different from zero at the 5 percent level, suggesting budget shares display a high level of responsiveness to price changes. Black tea was found to be inelastic since the uncompensated elasticity had a value below 1, indicating that a uniform decrease in prices would change the share of black tea in favour of coffee. The uncompensated elasticity for coffee

was relatively high, reflecting the different characteristics of the market. The relatively higher expenditure elasticity for coffee also underlined the heterogeneity of the market.

Table 7: Estimated coefficients for AIDS model in UK

Equations	α_i	γ_{i1}	γ_{i2}	β_i
Black Tea	1.934**	0.149***	-0.149***	-0.122**
	(0.7006)	(0.0296)	(0.0296)	(0.0572)
Coffee	-0.934	-0.149***	0.149***	0.122**
	(0.7006)	(0.0296)	(0.0296)	(0.0572)

Numbers in parentheses are standard errors*=significant at 10% **=significant at 5%.

Table 8: Marshallian and expenditure elasticities for UK

	Commodity	Black Tea	Coffee
Price elasticities e_{ij}	Black Tea	-0.325**	0.126
		(0.0964)	(0.1775)
	Coffee	0.598***	-1.082***
		(0.1012)	(0.0844)
Expenditure elasticity n_i		0.547**	1.167***
		(0.2117)	(0.0783)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

16. Expenditure elasticities for black tea and coffee were statistically significant at the 5 percent level and had positive signs as expected for any normal goods. Also, the empirical results for UK indicated that black tea had an expenditure elasticity equal to 0.55, while coffee had an expenditure elasticity equal to almost 1.17. These results suggested that as household expenditure of non alcoholic beverages group increased, consumers tended to spend proportionately less on black tea and more on coffee.

Table 9: Hicksian elasticities for UK

Commodity	Black Tea	Coffee
Black Tea	-0.716***	-1.283***
	(0.1095)	(0.1095)
Coffee	-0.065	-1.934***
	(0.0405)	(0.0405)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

17. Also, the uncompensated cross-elasticities showed substitutability between black tea and coffee in the UK. However, these were gross elasticities and included the income effect for a given level of non-alcoholic beverages expenditure. Looking at the compensated cross price elasticities (Table 9), it is concluded that black tea and coffee can be considered as complementary goods, being influenced in the same manner by changes in the total expenditure on the beverages group.

United States of America

18. The empirical demand analysis for tea consumption in United States covered the period between 1990 and 2008. Due to data limitations on retail prices, demand quantities of other commodities within the group non-alcoholic beverages such as green tea, soft drinks, fruit juices were not covered. The AIDS model included two products, namely black tea and coffee. The estimated parameters are presented in Table 10. All the coefficients were statistically significant at the 1 percent level. The compensated price elasticities reported in Table 11 suggest that black tea is price inelastic, while coffee is price elastic. This means that a uniform decrease in prices would change the share of black tea in favour of coffee.

Table 10: Estimated coefficients for AIDS model in USA

Equations	α_i	γ_{i1}	γ_{i2}	β_i
Black Tea	0.172*	0.028***	-0.028***	-0.008
	(0.0920)	(0.0068)	(0.0068)	(0.0067)
Coffee	0.827	-0.028***	0.028***	0.008
		(0.0068)	(0.0068)	(0.0067)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5%.

19. According to the results on the expenditure elasticities, as households' expenditure on the non alcoholic beverages group rose, consumers spent proportionately less on black tea. Also, the uncompensated price elasticity of black tea was evaluated at -0.39 and for coffee, it was found to be -1.02, indicating that a uniform decrease in prices would change the share of black tea in favour of coffee.

Table 11: Marshallian and expenditure elasticities for USA

Commodity	Black Tea	Coffee
Black Tea	-0.393**	0.125
	(0.1430)	(0.1350)
Coffee	0.599***	-1.022***
	(0.1433)	(0.0102
Expenditure elasticity n_i	0.837***	1.008***
	(0.1409)	(0.0072)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

20. Finally, the uncompensated cross-elasticities showed a substitutability relationship between black tea and coffee in the US market. This results was further supported by the values of the compensated cross price elasticities (Table 12).

Table 12: Hicksian elasticities for USA

Commodity	Black Tea	Coffee
Black Tea	-0.448***	0.353**
	(0.1434)	(0.14341)
Coffee	0.077***	-1.982***
	(0.0071)	(0.0714)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

China

21. The analysis for China covered the period between 1996 and 2009, and included two commodities, namely black tea and green tea.

Table 13: Estimated coefficients for AIDS model in China

Equations	α_i	γ_{i1}	γ_{i2}	β_i
Black Tea	-2.171***	0.072	-0.072	0.174***
	(0.4145)	(0.0573)	(0.0573)	(0.0319)
Green Tea	3.171	-0.072	0.072	-0.174***
		(0.0573)	(0.0573)	(0.0319)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

22. The estimated parameters are reported in Table 13. Not all the parameter were statistically significant, suggesting that results should be taken with some caution. The expenditure elasticities in Table 14 confirmed that both products were normal goods. The findings indicated that if households' expenditure on the non-alcoholic group expanded, consumer would tend to spend proportionally more on black tea and less on green tea.

Table 14: Marshallian and expenditure elasticities for China

Commodity	Black Tea	Green Tea
Black Tea	-0.637	-1.206***
	(0.4349)	(0.2043)
Green Tea	0.563	-0.909***
	(0.4267)	(0.0787)
Expenditure elasticity n_i	2.297***	0.800***
	(0.2382)	(0.0368)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

23. The uncompensated price elasticity for black tea was found to equal -0.64, while that for green tea was -0.91, indicating that a uniform decrease in prices would change the share for black tea in favour of green tea. The cross price uncompensated elasticities showed that black and green tea in China were substitutes. The compensated elasticities (Table 15) also confirmed the substitutability between black tea and green tea. More analysis is required to confirm these results, by looking, for example, at cross sectional data.

Table 15: Hicksian elasticities for China

Commodity	Black Tea	Green Tea
Black Tea	-1.072***	0.928***
	(0.0000)	(0.0000)
Green Tea	0.072***	-1.928***
	(0.0000)	(0.0000)

Numbers in parentheses are standard errors. *=significant at 10% **=significant at 5% ***=significant at 1%

III. CONCLUSION AND FOLLOW UP

24. Applying a demand system approach and using the latest available database for the world tea market, the analysis of demand for tea in selected markets indicated that both black tea and green tea were price inelastic. Price elasticities (Marshallian) for black tea varied between -0.32 and -0.80, which means that a 10 percent increase in black tea retail prices would lead to a decline in demand for black tea between 3.2 percent and 8 percent. Estimates for prices elasticities (Marshallian) for green tea ranged between -0.69 and -0.98. Similarly, a 10 percent increase in green tea retail prices will lead to a decline in the demand for green tea ranging between 6.9 percent and 9.8 percent.

25. The findings suggested that if household expenditure on non-alcoholic beverages increases, consumers tended to spend proportionally more on coffee and less so on green and black tea. Moreover, the uncompensated cross-elasticities showed that, in general, tea and coffee were substitutes. Earlier studies conducted by the Secretariat covering the United States and the Russian markets indicated that coffee consumption had limited substitution effect with tea consumption, which was in contradiction with the results of this study. However, the US study did not account for green tea in the analysis. Additional data is needed to further explore and validate the relationship between coffee and tea. Results can also be improved by using cross sectional data, as opposed to time series, but this requires the availability of comprehensive food consumption surveys, which include returns on beverage expenditures and consumption.

26. Further, results for China indicated that green tea and black tea substitute each other. This result carries some useful implications regarding the promotion of black tea in China. However, this conclusion need to be taken with some caution, as further analysis is called for at this stage.

27. The findings also carry some useful suggestion regarding the promotion of tea. Since prices and incomes have relatively smaller impact on the consumption of tea, marketing efforts should focus on demographic differences amongst consumers, but also increased accessibility through improved visibility, and retailing. Priority should also be given to create incentives for investment in innovative technologies, especially at the consumer level, as demonstrated by the coffee industry.

28. Although some changes could be expected due to changing market conditions, such as increased “out of home” consumption through the opening of major coffee retail outlets, and the impact of generic promotion, more analysis is required utilizing comprehensive information of all competing beverages in order to establish the nature and magnitude of the changes in consumer choices, if any. Also, better data and a dynamic specification might give more reliable results. Indeed, the use of proxies for retail prices may lead to underestimation of the elasticities. If such analysis should continue, the Group is requested to provide the information required to undertake the analysis.