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EXPLAINING THE APPARENT INSIGNIFICANCE
OF INCOME GROWTH

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1. Introduction

Previous econometric work on the U. S. demand for cocoa has yielded a puzzling result: that the income elasticity is either zero or negative. This is surprising because, across countries, per capita cocoa demand is highly correlated with per capita income¹. Cocoa is viewed by many as a luxury good, whose income elasticity would be expected to be positive and relatively high. Yet, if this econometric result is correct, it has discouraging implications for the cocoa-producing countries and for the growth of cocoa demand.

Here we address this puzzle, using some previously omitted variables, such as the price of confectionery and the percentage of children in the population. When these additional variables are included in the equation for per capita cocoa demand, the puzzling result disappears: income is statistically significant and its elasticity is about 0.25. This means that per capita demand *will* grow over time, even though not as rapidly as income. In addition, the percentage of children will be increasing over the next decade, and this will have a further positive effect on per capita demand. And, due to population growth, *total* demand will grow more rapidly than per capita demand.

¹ The correlation coefficient between the logarithms of these variables is 0.92.

2. Background: Data and Previous Literature

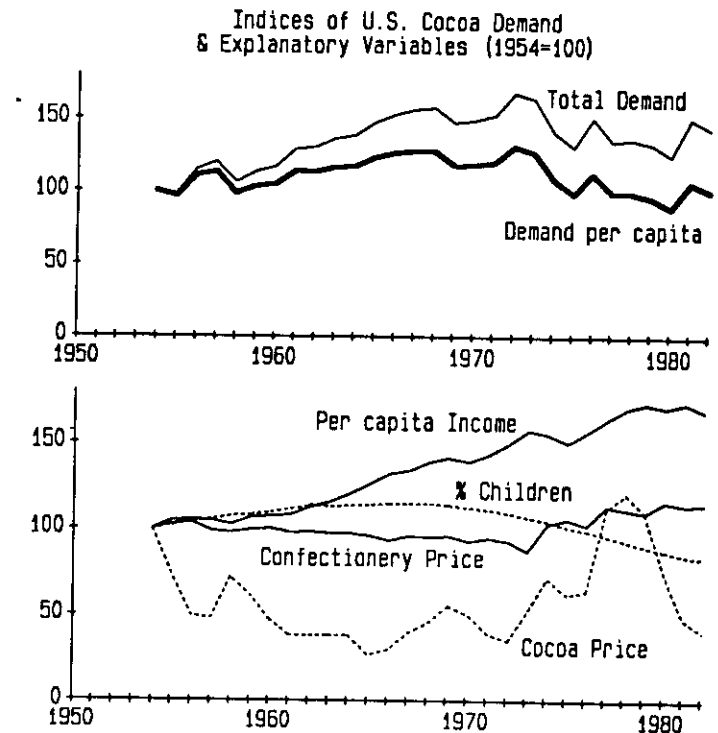
Figure 1 depicts indices of U. S.

cocoa demand and the main explanatory variables; each of the indices starts at 100 in 1954. The top half shows total demand and per capita demand. Total demand increased until the early 1970's; since then it has declined somewhat, to a level slightly above that in 1954. Per capita demand has also followed the same pattern, and it is now at about the level it had been in 1954.

The bottom half of Figure 1 depicts indices of the main explanatory variables: the real prices of cocoa and confectionery, the percentage of children in the population, and per capita income. The period of increasing per capita demand (mid-1950's to late-1960's) roughly coincides with the period of the increasing percentage of children; both variables have declined since the late 1960's. Also important has been the price of confectionery, which increased significantly in the mid-1970's.

Previous econometric studies concluded that changes in income do not have any positive effect on cocoa demand in the high income countries. For example, Behrman(1965) estimated cocoa demand elasticities in five leading consuming countries. He came to the conclusion that cocoa is an inferior commodity in the Netherlands, the U.K. and especially the U. S.; that is, the demand for cocoa decreases as income increases. He found the U.S. income elasticity to be negative and statistically significant, with a value of

Figure 1



at least -1.6 . In addition, he found that countries with higher per capita incomes tended to have lower income-elasticities of demand.

Among other studies, Weymar(1968) had come to the conclusion that, for the high income countries, income is an insignificant factor in the demand for cocoa. That same conclusion had been arrived at by the Food and Agricultural Organization(1961) and by Adams and Behrman(1976)².

Such results could follow from consumer satiation. But an alternative explanation of sluggish growth in cocoa demand had been proposed by Amoa(1965): that it is caused by input substitution in the manufacture of confectionery. Confectionery manufacturers are substituting other inputs in place of cocoa: sugar, or milk, or nuts, or fats and oils.

In Figure 2, we graph the input composition of confectionery over the period 1954-82: the percentage shares by weight of cocoa, sugar (and other sweeteners), nuts, fats & oils, and other inputs. Changes in the share of cocoa are most highly correlated with changes in the share of sugar; the correlation is much lower with nuts, fats & oils, and other inputs.³ To illustrate this substitution between sugar and cocoa in the manufacture of confectionery, Figure 3 shows these percentages of sugar and cocoa for the years from 1954-82.

² Their results suggested that the low-income developing countries have an income elasticity greater than the middle-income centrally-planned economies, which in turn have an income elasticity greater than the high-income developed countries. Such results were later confirmed by Akiyama and Duncan(1983).

³ The correlation coefficients of changes in the cocoa share in confectionery, with respect to changes in the share of various inputs, are as follows: sugar $-.79$; fats & oils $-.12$; nuts $-.16$; and other inputs $-.10$.

Figure 2

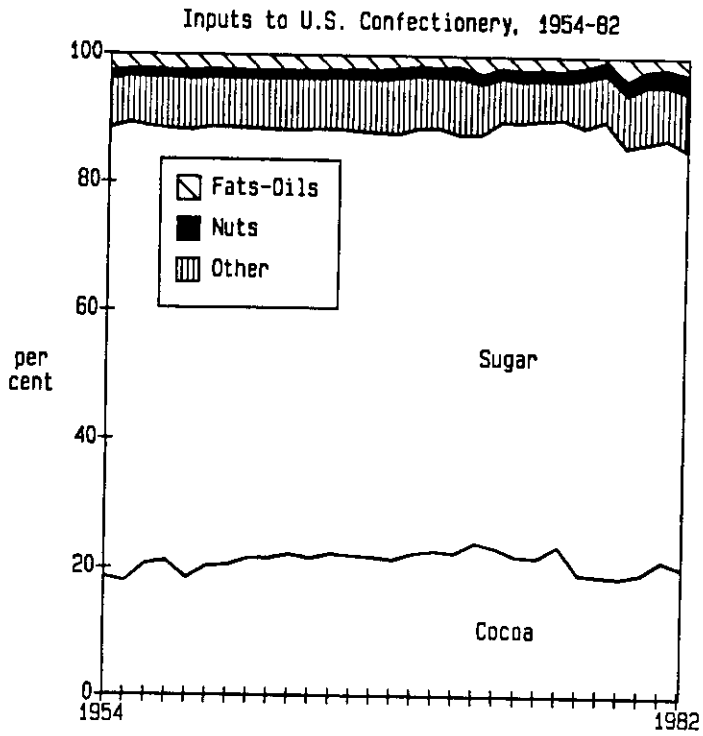
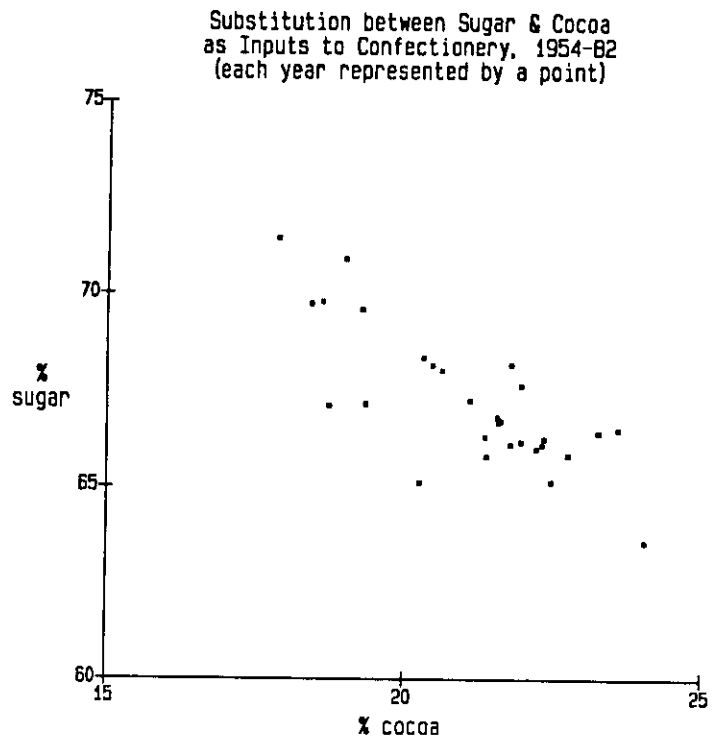


Figure 3



3. The Model and the Econometric Results

Given the apparent insignificance of income growth, our approach to the problem hinges on bias in the functional specification of the model, specifically the omission of two important variables in the cocoa demand equation: the percentage of children in the population and the price of confectionery. Such misspecification problems have been well documented in the literature⁴.

We use demographic variables to help explain the puzzle noted above. This has some precedent in the literature, such as the papers by Salathe(1972) and Sexauer(1972). To the extent that the age composition or geographical distribution of the population influence a dependent variable, the only justification for their omission is that they are time invariant or that they do not change rapidly enough to be significant. But if these factors do change over time, then a way must be found to incorporate their influence; otherwise the results will be valid only at the time of estimation. The problem usually encountered is how to model these demographic factors⁵. We introduce demographic factors directly into the equation and let them vary with time.

Below we shall estimate equations for the percentage share of cocoa in confectionery, and for the per capita demand for confectionery and for cocoa⁶. We employ a common functional form, a multiplicative equation, with an error term that is normally distributed with zero mean and constant variance; we linearize it by taking the logarithms

⁴ For conditions under which an omitted variable will produce bias, and the consequences, see Lee(1982) and Goldfeld(1972).

⁵ See Lewbell(1985) for a discussion of this problem.

⁶ The complete model is described in detail in Andoh(1986). Also discussed there is the identification issue for the demand equations being estimated.

of both sides. One characteristic of this specification is that the estimated coefficients directly measure the elasticities of the variables. The maximum available data sample for all three equations includes 1954-82.

We expect a positive sign for the coefficient of income, assuming that cocoa and confectionery are not inferior goods. Likewise, we also expect a positive coefficient for the percentage of children in the population, if cocoa and confectionery are consumed disproportionately by children.

3.1 The Percentage Share of Cocoa in Confectionery

In Table 1 we present regression results for an equation explaining the percentage share of cocoa in confectionery, as a function of the prices of cocoa and other inputs.

This is an attempt to address the question of whether sugar, milk, nuts, and fats and oils are complements or substitutes for cocoa in the manufacture of confectionery⁷. In all cases, the cocoa-price coefficient is negative as expected and significant. The sugar-price coefficient (in equation #1-2) is positive, as expected for a substitute, and very close to being statistically significant. Likewise in equation #1-3 for the price of milk. The coefficient for the price of fats and oils is positive but insignificant, and for nuts is negative but insignificant.

From these results we conclude that the percentage share of cocoa in confectionery is largely explained by the prices of the cocoa and the other inputs. Sugar and milk are the main substitutes for cocoa in the manufacture of confectionery.

⁷ Similar work had been done by Weymar(1968).

Table 1
Equations for Percentage Share of Cocoa in Confectionery
 Sample Period: 1954-82
 (t-statistics in parentheses)

equation number	Coefficients						Autoregr. Correction	Adjusted R ²	Durbin- Watson Statistic	Standard Error of Regr.
	Constant	Price Cocoa	Price Sugar	Price Milk	Price Fats & oils	Price Nuts				
#1-1	3.593 (24.67)	-0.158 (-37.1)					0.535 (2.63)	.604	2.10	.048
#1-2	3.674 (28.08)	-0.162 (-4.54)	0.046 (1.94)				0.378 (1.74)	.634	1.99	.046
#1-3	3.748 (25.55)	-0.174 (-5.13)		0.110 (1.85)			0.277 (1.25)	.612	1.81	.047
#1-4	3.613 (23.30)	-0.169 (-3.52)			0.025 (0.59)		0.536 (2.58)	.593	2.08	.049
#1-5	3.609 (8.12)	-0.159 (-3.51)				-0.006 (-0.04)	0.534 (2.55)	.587	2.10	.049
#1-6	3.847 (10.48)	-0.180 (-4.76)	0.037 (1.28)	0.066 (0.88)	0.014 (0.31)	-0.030 (-0.22)	0.252 (1.05)	.599	1.81	.048

All variables in logarithms

3.2 The Demand for Confectionery

In Table 2 we present regression results for the per capita demand for confectionery, as a log-linear function of the price of confectionery, per capita income and the percentage of children in the population. If only price and income are included (equation #2-2), then the signs of these coefficients are correct but they are not statistically significant. The results of this regression (#1-2) are little better than for the equation without per capita income (equation #1-1).

But when the percentage of children is added to the equation (#2-3), it has the expected sign and is statistically significant. Moreover, the income coefficient increases dramatically, to .317, and becomes statistically significant⁸. These results presage those for the demand for cocoa. The elasticity of per-capita confectionery demand is $-.20$ with respect to its own price, $.32$ with respect to income, and $.67$ with respect to the percentage of children in the population.

Table 2
Equations for Per Capita Confectionery Demand
Sample Period: 1954-82
(t-statistics in parentheses)

equation number	Coefficients				Adjusted R ²	Durbin-Watson Statistic	Standard Error of Regr.	
	Constant	Price Conf.	Income per cap.	% Child-ren				
#2-1	4.024 (6.65)	-0.308 (-1.96)			0.818 (7.41)	0.78	1.96	0.035
#2-2	4.649 (3.87)	-0.309 (-1.88)	0.120 (0.64)		0.830 (6.92)	0.78	1.94	0.036
#2-3	6.352 (7.74)	-0.201 (-1.13)	0.317 (3.03)	0.673 (3.05)	0.552 (2.69)	0.81	1.64	0.032

All variables in logarithms

⁸ The linear versions of these equations had the same qualitative results.

3.3 The Demand for Cocoa

In Table 3 we present regression results for the per capita demand for cocoa, as a log-linear function of several explanatory variables. Regressing demand on cocoa price (equation #3-1) and also on income (equation #3-2) represent a common specification in the literature, and they yield the usual results. Price has the expected negative sign and is statistically significant, while income has the expected positive sign but is very small (.071) and is not statistically significant. This is the same result as that in the literature cited above.

However, adding the percentage of children to the equation (#3-3) improves the results dramatically; the Adjusted R^2 is much higher, and the income coefficient is more than twice as large and also becomes significant. The percentage of children has the expected sign and it is statistically significant.

Using the confectionery price instead of the percentage of children (equation #3-4) yields similar and improved results. Including both of these variables (equation #3-5) has similar results, but the Adjusted R^2 increases only slightly. We shall use this equation (#3-5) in the following section for making projections through the year 2000.

Other specifications were examined but none were satisfactory⁹.

⁹ Linear specifications of these models were examined, and they had the same qualitative properties as the results described. Other explanatory variables were also utilized, but none of these was satisfactory. Among those examined (either singly or in combination) were the prices of sugar, milk, fats & oils, and nuts. We also examined the effect of geographic distribution (the percentage of population in the North), insofar as demand might be related to climate and the low melting point of chocolate (see the report by Purdon for the U.S. Department of Commerce); but the results were not satisfactory. Also examined were lagged adjustment models in which the lagged dependent variable or lagged price were used as explanatory variables.

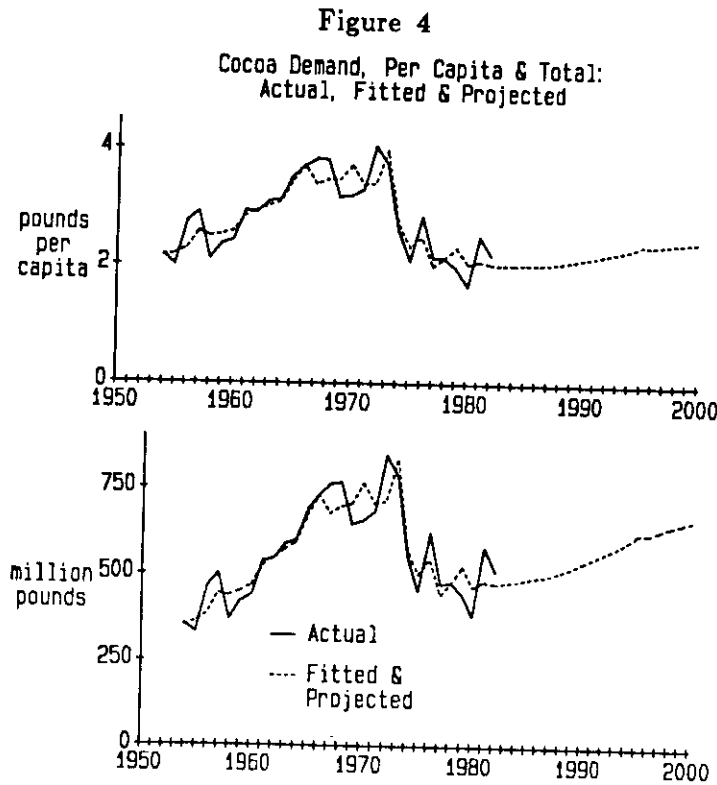
Table 3
Equations for Per Capita Cocoa Demand
 Sample Period: 1954-82
 (t-statistics in parentheses)

equation number	Coefficients					Adjusted R ²	Durbin- Watson Statistic	Standard Error of Regr.	
	Constant	Price Cocoa	Income	% pop. Child- ren	Price Confect- ionery				Autoregr. Correction
#3-1	0.42 (0.8)	-0.09 (-2.1)	0.016 (0.2)				0.08	0.71	0.0996
#3-2	0.94 (0.8)	-0.06 (-1.1)	0.11 (0.5)			0.66 (4.1)	0.41	1.86	0.0797
#3-4	3.40 (6.1)	-0.04 (-1.54)	0.265 (3.6)	1.01 (6.6)			0.65	1.73	0.0611
#3-3	0.48 (1.7)	-0.06 (-2.6)	0.21 (3.8)		1.29 (5.1)		0.75	1.87	0.0517
#3-5	1.43 (1.95)	-0.05 (-2.2)	0.24 (3.9)	0.33 (1.4)	-0.97 (-3.5)		0.76	1.89	0.0508

All variables in logarithms

4. Projections to year 2000

In Figure 4 we graph projections of cocoa demand to the year 2000, under the following assumptions: constant real prices of cocoa and of confectionery, 2.0% annual growth in per capita income, and standard assumptions about growth in population and changes in the percentage of children¹⁰. We also plot actual demand and fitted demand, for both per capita and total demand, for the historical period. Due to growth both in income and the percentage of children in the population, *per capita* demand is projected to grow by about 12% by year 2000; and *total* demand is projected to grow by about 30%.



¹⁰ See U.S. Bureau of the Census, *Current Population Reports*.

5. Conclusions

The results of this paper illustrate the importance of omitted variables for explaining the per capita demand for cocoa, especially the price of confectionery and the percentage of children in the population. When these are taken into account, the estimated effects and statistical significance of income and cocoa price are consistent with our expectations. Instead of the income elasticity being negative or statistically insignificant, its value is between 0.20 and 0.26 and it is significant. The cocoa-price elasticity is relatively low (-0.05), especially compared with the confectionery-price elasticity of the demand for cocoa (-1.0 or greater).

These results are moderately encouraging for the growth of U.S. cocoa demand. With modest income growth and with constant real prices for cocoa and confectionery through the year 2000, total cocoa demand can be expected to grow by about 30%. Certainly this would be a significant reversal from the declines of the 1970's.

Appendix A: Data Sources

Per capita demand for cocoa, measured in pounds, is cocoa bean grindings adjusted by net imports or exports of cocoa products and chocolate, converted into bean equivalent¹¹. These are available from Gill and Duffus. The series are then deflated by the midyear population of the U.S. to arrive at a per capita figure.

The real cocoa price (in 1967 \$) is the unit value of cocoa (also from Gill and Duffus) in U.S. cents per pound deflated by the U.S. Producer Price Index. For the per capita income variable, real per capita GNP divided by the midyear population is used. The ratio of the U.N. Indexes for sugar, milk, fats and oils deflated by the Producer Price Index are used to represent the prices of sugar, milk, and fats and oils. The price of nuts was represented by the real price of peanuts, from the U.S. Department of Agriculture, *Agricultural Statistics*.

The real price of confectionery (in 1967 \$) and the demand for confectionery were taken from U.S. Commerce Dept., *Confectionery Manufacturers' Sales and Distribution*.

The percentage of children is measured by the number of children aged five to fifteen years old, divided by total U.S. population. The percentage of population in the North is the population of the North divided by that of the North, the South and the West. The source of these data is the U.S. Bureau of the Census, *Statistical Abstracts of the U.S.*

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¹¹ Technically this represents the "disappearance" or "absorption" of cocoa. To the extent that the inputs into confectionery changes over time, the constancy of the conversion factors may lead to underestimation or overestimation of actual consumption of cocoa.

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