Decline in the Share of the Agricultural Product: Measurements and Explanations *

1 - Introduction

The picture that emerges when countries are grouped in ascending order on a per capita income basis is widely known.

Agriculture's share of GDP ranges from more than 40% to less than 10%: industry's share goes from less than 20% to around 40%; and the service sector shows a slight increase. The relation is much the same between the present day situation of developed countries as compared with the initial phases of their modern economic development.

The reduction in agriculture's share of product therefore constitutes the most important change in the structure of supply associated with income growth. This is such a constant phenomenon that it can be considered one of the "laws" of economics, and there is thus no need to examine it further.[1]

Yet, for the researcher who wants to extract some useful clues to the understanding of such a complex phenomenon as economic development, the search for uniformity should represent only the beginning, not the conclusion of the analysis. Further steps can be made by examining the specific factors which determine a given pattern. Furthermore, as far as a pattern is concerned, it is important to define precisely its field of application and assess the presence of factors which determine systematic deviations from the norm. These aspects have not yet been clarified satisfactorily despite the existence of important studies, in particular those by Kuznets (1971) and Chenery-Syrquin (1975), both of which constitute necessary points of reference.

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* The author is indebted to Giuseppe Canullo and Paolo Pettenati for helpful comments on an earlier draft.

[1] TEMIN (1967) is not of this opinion.

This article proposes to make a contribution in two ways. The first part focuses on the pattern of agriculture's share, both among countries and over time, while the second part considers the factors which determine the relative decline of the agricultural product.

As regards the first part, I have tried in sections 2.1 and 2.2 to single out the factors, other than income, which have contributed to the determination of systematic differences among countries in agriculture's share in product. Particular attention has been given to the role of resource endowment and relative prices. The analysis is based on two samples — one of 47 countries, the other of 30. Both the relative price of products and the endowment of natural resources are shown to influence agriculture's share. In section 2.3 the historical evolution of 9 countries is compared with the results of cross-section analysis. Previous research has shown that the decline in the share of agriculture over time is greater than appears in cross-section analysis. The phenomenon is attributed to numerous factors (*e.g.* technology, international environment, etc.) which distinguish the most recent periods from the past. These results are confirmed here, yet the difference (between the decline over time and that among countries) turns out to be smaller than shown by previous results. The main difference between this analysis and those of other authors derives from the more homogeneous measurement of the phenomena compared in this study.

Paragraph 3 contains a quantitative assessment of the factors which cause the decline of the agricultural product. Previous research has shown that such a decline is accompanied by the relative reduction in food expenditure and by technological and organizational transformations. Furthermore, it has also been shown that the relative influence of the reduction in food expenditure in Italy occurred in the first stages of development, while in the last decades technological and organizational changes have been more important. Here the analysis has been extended to cover two other countries, Japan and Sweden, with opposite results to those of Italy.

2 - Decline in Agriculture's Share in Product among Countries

2.1 - *Agriculture's Share in Product and Per Capita Income*

A sample of 47 countries has been used to analyse the differences in agriculture's share in product. The size of the sample is much smaller

than it could be: very small countries and those with rather unreliable national accounts' estimates have been excluded (as have centrally planned economies).[2]

The estimates confirm the existence of a very close relationship between the level of per capita income and agriculture's share in product. It is also confirmed that the pattern of agriculture is more uniform than those regarding industry and services (see equations 1.1, 1.2 and 1.3).

The results of the estimates are shown in Table 1. Attention must be drawn to the following considerations.

a) The differences among countries in agriculture's share in product are closely correlated to the differences in per capita income, especially if the latter are expressed in relative terms (ln GDP). Moreover these differences tend to become gradually smaller as one passes to higher income levels, as is proved by the satisfactory result obtained by adding the income-squared variable.

b) The fact that 91% of the variance of A/Y is explained by only one factor, *i.e.* per capita income, has a precise and significant economic meaning. Differences between countries are numerous and often very important; they concern dimensions and resource endowment, international position (in a political, economic and geographic sense), climate, history and customs. In each country these factors have determined the time and rhythm of per capita incomes systematic tendency to grow. Nevertheless these factors have not been able to appreciably influence the distribution of the GDP between agricultural and non-agricultural activities. The conclusion is inavoidable that both this distribution and the growth of per capita income are the result of one and the same process which works according to a rigid law.

c) The considerations expressed in the previous point are obviously not meant to be interpreted literally. It must be borne in mind that about 10% of the A/Y variance is not explained by the regression;

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[2] Following a standard practice, I have excluded very small countries (those that, in 1970, had a population of less than one million inhabitants) and city-states such as Singapore and Hong Kong. At this point, 90 countries are left in the UN *Yearbook of National Account Statistics*. But many of these, on account of numerous factors, have very dubious estimates. In my selection of countries with reliable estimates, I have used a general criterion, which is probably, however, restrictive in this context. I have considered only those countries for which the UN *Yearbook* gives disaggregated estimates of the demand, or, to be more precise, food consumption estimates. In this way, the number was reduced to 47. When analysing the problem of prices, I had recourse to a sub-group of 30 countries.

that some countries show significant deviations from the pattern (Figure 1) and, finally, that the GDP is not very useful in explaining differences in agriculture's share for countries whose per capita incomes are close (in relative terms). We must therefore try and find the reasons why some countries diverge from the pattern of the curve in Fig. 1.

2.2 - *Divergences from the General Pattern*

2.2.1 - *Demand for Agricultural Products: Descriptive Analysis*

In the analysis of the deviations from the pattern of single countries, I have worked on two levels. The first is of a descriptive-accounting type, designed to single out any component, or components, of the economic system which make it possible to balance the deviation of the agricultural sector; the second, or causal level, consists in trying to identify the causes which determine the divergences.[3]

On the accounting level, with all the necessary data at hand, it would not be difficult to "explain" the value added of agriculture or its share in GDP. If we designate the value added of agriculture A, the following identity can be written:

$$(I) \quad A = (X-M)_a + FD_a + ID_a - I_A$$

The first three elements on the right represent the demand for agricultural products; $(X - M)_a$ the net foreign demand; FD_a the final domestic demand; ID_a the intermediate demand; I_a represents the input of the agricultural sector.

All the elements of (I) could be expressed as a percentage of domestic product:

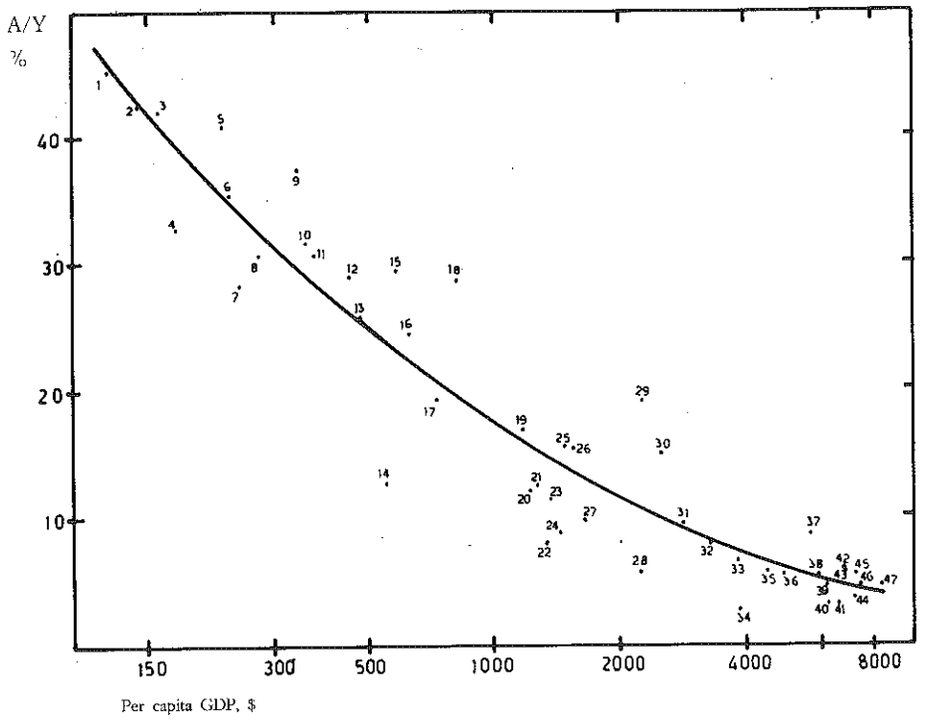
$$(II) \quad A/Y = (X-M)_a/Y + FD_a/Y + ID_a/Y - I_A/Y$$

On the basis of the input-output matrix, one could analyse each of the elements of the expression (II). Unfortunately, few countries possess the information necessary to construct the matrix, and because of the different criteria of estimation used, there are still fewer cases in which the matrixes can be directly compared.

[3] The two levels of analysis frequently intersect, both because descriptive-accounting analysis helps to formulate explicatory hypotheses and because, in a quantitative analysis, the explanatory variables often represent both aspect.

FIGURE. 1

AGRICULTURE'S SHARE IN PRODUCT AND PER CAPITA INCOME.
47 COUNTRIES, 1975 (equation. 1.1) (*)



(*) 1: Malawi; 2: India; 3: Tanzania; 4: Pakistan; 5: Madagascar; 6: Kenya; 7: Togo; 8: Sri Lanka; 9: Sudan; 10: Thailand; 11: Honduras; 12: Philippines; 13: El Salvador; 14: Zambia; 15: Colombia; 16: Korea (South); 17: Syria; 18: Malaysia; 19: Panama; 20: Brazil; 21: Uruguay; 22: Jamaica; 23: Mexico; 24: South Africa; 25: Yugoslavia; 26: Portugal; 27: Iran; 28: Venezuela; 29: Greece; 30: Eire; 31: Spain; 32: Italy; 33: Israel; 34: United Kingdom; 35: Japan; 36: Austria; 37: Finland; 38: France; 39: Netherlands; 40: Belgium; 41: Germany (Fed. Rep.); 42: Norway; 43: Australia; 44: United States of America; 45: Denmark; 46: Canada; 47: Sweden.

If one wants to carry out large-scale international comparisons, it is therefore necessary to turn to other types of documentation. In the econometric estimates I have used the trade balance of agricultural product (NX_a/GDP) which can be considered a good estimate of $(X - M)_a/Y$,[4] food consumption, $d.C_f$ as an indicator of the final

[4] Compared with the desired variable, it does not take into account indirect exports of agricultural products. Moreover, the estimate criteria of imports and exports are not homogeneous (CIF and FOB).

demand for agricultural products, the consumption of fertilisers, d. Fert., as a proxy of the inputs used by the agricultural sector.[5]

The countries in which A/Y is relatively high are, on average, net exporters of agricultural products. In fact, the addition of the variable NX_a/GDP determines an appreciable improvement in the estimates (1.4). For every 2.5 points of net agricultural exports, A/Y increases by about one point. The introduction of the variable $d.C_f$ is also effective, whereas the variable d.Fert does not produce satisfactory results.

In conclusion (equation 1.5) in the countries which are net agricultural product exporters, and/or characterized by relatively high food expenditure, A/Y is also relatively high.

TABLE 1

AGRICULTURE'S SHARE AND PER CAPITA INCOME. 47 COUNTRIES, 1975. RESULTS OF THE ECONOMETRIC ESTIMATES

V. Dip.	Const.	ln GDP	$(\ln GDP)^2$	NX_a/GDP	$d.C_f/Y$	R^2	SEE
1.1 A/Y	166.9	−33.48	1.71			0.91	4.08
		(5.6)	(4.0)				
1.2 I/Y	−112.2	37.70	−2.36			0.50	6.78
		(3.8)	(3.4)				
1.3 S/Y	13.8	4.96				0.55	6.50
		(7.4)					
1.4 A/Y	149.9	−29.72	1.50	0.38		0.93	3.57
		(5.6)	(4.0)	(3.7)			
1.5 A/Y	149,4	−29.70	1.50	0.42	0.20	0.94	3.41
		(5.8)	(4.2)	(4.3)	(2.3)		

Here, and in the following tables, 1975 stands for the average 1974–76. A/Y, I/Y, S/Y: share % of the value added of Agriculture (including forestry, hunting and fishing), Industry and Services to GDP at factor cost; ln GDP: logarithm (base e) of per capita GDP (market prices) expressed in U.S. dollars; NX_a/GDP: net exports of agricultural products, in % of GDP; $d.C_f/Y$: deviations between real and predicted values of food consumption (C_f) as % of GDP obtained fom: $C_f/GDP = 87.2 - 8.25$ ln GDP; R^2: coefficient of determination; SEE: standard error of estimate; "t" ratios of the coefficients in brackets. The sources are: UN (1982) for GDP and its components; WORLD BANK (1983) for the population and exchange rates; UN (1979 and 1983) for NX_a.

The data used in this study and the detailed information about the sources and method of calculation are shown in an appendix which is not published here owing to lack of space. The author would be happy to send the appendix to any interested readers.

[5] $d.C_f$ and d. Fert represent the absolute deviation between real and predicted values which result, respectively, from the correlation between the food share in total expenditure and per capita income, and quantity of fertilisers and income.

2.2.2 - *Resource Endowment*

When one thinks of the causes which determine the divergences of individual countries from the pattern, the first to come to mind is the resource endowment. Unfortunately, it is extremely difficult to find a variable which directly represents this aspect. In fact, most of the possible indicators concern phenomena which also influence the level of income and not only agricultural production.[6] Secondly many of the available measures reflect not solely physical but also economic factors.[7]

It is necessary, therefore, to resort to indirect indicators. I have had recourse to long-period data on exports (1965-75). More precisely, I have used the indicator $(X_a - X_{rm})/GDP$[8] to differentiate the countries according to their natural resources, both agricultural and non-agricultural. The equation 2.2 (Table 2) is appreciately better than the regression in which only the income variable appears (2.1). The standard errors of estimate is considerably reduced; the parameter of $(X_a - X_{rm})/GDP$ reflects the great differences in agriculture's share in product between countries where the export of agricultural products predominates and those in which the main export is non-agricultural raw materials.

The influence of the variable $(X_a - X_{rm})/GDP$ is important, not only for lower-income countries, but also for more developed countries (equations 2.4 - 2.6).

The existence of considerable differences in the share of A is demonstrated more explicitly by the regressions shown in Table 3 and in Figure 2. In order to identify groups of homogeneous countries as regards resource endowment, I have divided the 47 countries into three groups, arranged on the basis of the level of variable $(X_a - X_{rm})/GDP$. I have termed the three groups of countries as follows (the figures in brackets give the average value and minimum/maximum values of this variable):

a) ARE - countries endowed with agricultural resources (12.2; 6.5/17.8);

[6] In a very fertile country, the availability of this resource favours economic development, and both agricultural production and income will be high. Yet, since the income effect prevails, A/Y's share is inferior to that of a country, with poor agricultural resources (and, for that reason, less developed). Evidently the difficulties derive from the fact that the world does not normally offer a number of cases sufficient to isolate the effects of this factor.

[7] The quantity and quality of the available land are widely influenced by the amount of investments in it and by the choice of crops.

[8] X_a: agricultural exports; X_{rm}: exports of non agricultural raw materials.

TABLE 2

AGRICULTURE'S SHARE, PER CAPITA INCOME AND RESOURCE ENDOWMENT, 1975. RESULTS OF ECONOMETRIC ESTIMATES

Dep. V.	Const.	ln GDP	$(\ln GDP)^2$	$(X_a - X_{rm})/GDP$ 1965-75	R^2	SEE	SEE%
			All countries, 47				
2.1 A/Y	166.9	–33.48	1.71		0.91	4.08	23.1
		(5.6)	(4.0)				
2.2 A/Y	147.0	–28.42	1.39	0.32	0.94	3.28	19.2
		(5.6)	(3.9)	(4.6)			
			Poor countries (per capita GDP < $ 2400), 29 countries				
2.3 A/Y	101.4	–12.1			0.83	4.94	20.5
		(11)					
2.4 A/Y	92.5	–10.8		0.20	0.88	4.25	17.7
		(10)		(3.2)			
			Rich countries (per capita GDP > $ 2400), 18 countries				
2.5 A/Y	32.7	–3.18			0.25	1.82	34.5
		(2.2)					
2.6 A/Y	33.7	–3.32		0.24	0.42	1.67	31.6
		(2.5)		(2.0)			

When the variable $(\ln GDP)^2$ does not appear it means that it does not bring about any improvement in the results.
The group of poor countries includes the first 29 countries listed in Figure 1 (note).

b) BRE - countries with balanced resources (2.6; 1.0/4.3);

c) NRE - countries endowed with non-agricultural natural resources (−8.1; −44.6/0.9).

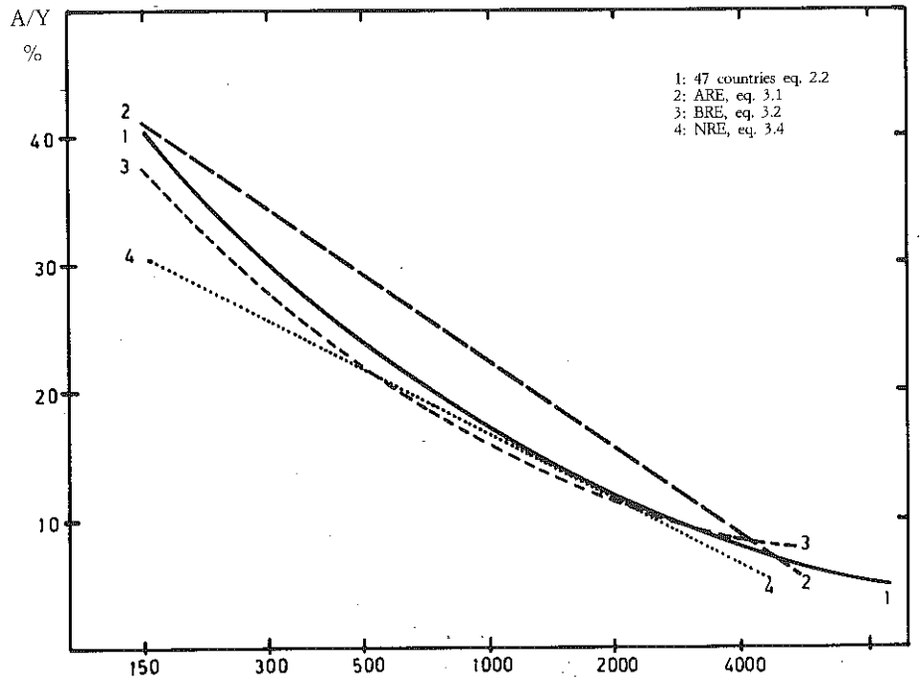
Agriculture's share is markedly different in the three groups of countries, especially at low and average per capita income levels, whereas the elasticity of the share to income is very similar. The countries included in groups a and b (Table 3) are homogeneous in their resource endowment. There is, however, much less homogeneity among the countries belonging to group c. In fact, in this last case, contrary to the other two, the variable "resources" is significant, and substantially improves the regression (equations 3.3 and 3.4).

A final remark concerning the whole group of 47 countries.

If the predicted values of the function 2.2 are compared with the actual ones, it will be realized that several of the countries that show

FIGURE 2

AGRICULTURE'S SHARE IN PRODUCT AND PER CAPITA INCOME IN THREE GROUPS OF COUNTRIES WITH DIFFERENT RESOURCE ENDOWMENTS



negative deviations[9] — for example, almost all the Latin America countries — are characterized by relatively high rates of urbanization and also by a relatively high share of services. The greater distance between the points of production and consumption of agricultural products (typical of countries with a high rate of urbanization) might be expected to depress agriculture's share in favour of that of services. The econometric test, carried out introducing the share of the services' value added (in terms of deviations) resulting from the function 1.3: d.S/Y) produces good results.

[9] *i.e.* relatively low A/Y values.

TABLE 3

AGRICULTURE' SHARE AND PER CAPITA INCOME IN THREE GROUPS OF COUNTRIES WITH DIFFERENT RESOURCE ENDOWMENTS, 1975. RESULT OF ECONOMETRIC ESTIMATES

	DEP. V.	Const.	ln GDP	$(\ln GDP)^2$	$(X_a - X_{rm})/GDP$ 1965-75	R^2	SEE	SEE%
			ARE (countries with agricultural resources), 15 countries					
3.1	A/Y	90.8	−9.9			0.90	3.59	12.2
			(11)					
			BRE (countries with balanced resources), 16 countries					
3.2	A/Y	165.5	−35.4	1.98		0.88	3.88	25.1
			(3.8)	(2.9)				
			NRE (countries with non-agricultural natural resources), 16 countries					
3.3	A/Y	52.9	−5.6			0.72	3.17	43.3
			(6.0)					
3.4	A/Y	70.4	−7.6		0.22	0.90	2.00	27.5
			(10)		(4.7)			

The composition of the three groups in the following (the numbers correspond to the countries shown in Fig. 1 (note): ARE: 1, 3, 5, 6, 8, 9, 10, 11, 12, 13, 15, 18, 21, 30, 45; BRE: 2, 4, 7, 17, 19, 20, 22, 23, 24, 26, 29, 31, 33, 37, 39, 43; NRE: 14, 16, 25, 27, 28, 32, 34, 35, 36, 38, 40, 41, 42, 44, 46, 47.

$$\text{(III)} \qquad A/Y = 150.4 - 29.6 \ln GDP + 1.47 (\ln GDP) + \\ + 0.26 (X_a - X_{rm})/GDP - 0.24 \ d.S/Y \qquad R^2 = 0.95; \quad SEE = 3.11$$

If instead of the services share, (d.S/Y), the industrial share is introduced (d.I/Y), the results are worse, and the t ratio is relatively low. Therefore, although the previous explanation requires further tests, the fact remains that the deviations of A/Y correspond more frequently with opposite deviations in the services' share rather than with that of industry.

2.2.3 - *Relative Prices*

The cross-section analysis shown in the preceding section was based on a group of 47 countries, whereas here, I am using a sub-group of 30 countries. The results of the estimates are shown in Table 4. The variables are analogous to those used for the sample of 47 countries, they differ only in the price system used.[10]

The principal results are as follows:

a) The estimates based on 30 countries are almost identical with those of the larger group. The only difference of any importance occurs when other variables are introduced in addition to income. In such cases the regressions carried out on 30 countries produce better results than those based on 47 countries (compare equations 4.a1, 4.a2 and 4.a3 with the analogous equations 2.1, 2.2 and III).

b) When GDP at current prices is substituted by GDP at uniform prices (GDP_U), the introduction of the squared income variable does not bring any improvement. Since this last variable expressed the tendency to attenuate the differences in A/Y (the same relative differences in GDP), one can draw the conclusion that this tendency disappears when the countries are compared on the basis of GDP_U, whereas the usefulness of the other explicative variables remains confirmed.

c) The improvements obtained by introducing the "relative prices" variable (equations 4.c3 and 4.c4) are interesting. Relative prices can be considered as a further indicator of resource endowment. As expected, the regressions show an inverse relationship between the level of relative prices of agriculture and A/Y. This is true both for P_a/P_y and for P_a/P_i (relative prices of agriculture compared with those of industry). Of particular interest is the fact that the good results are not limited to the variable P_a/P_y but also concern P_a/P_i. In fact, the latter result is more significant, in economic terms, than that obtained with the variable P_a/P_y, (which is also implicitly included on the right side of the equation, given that $A_U/Y_U = A/Y/P_a/P_y$).

[10] There is a further difference as regards the variable $(X_a - X_{rm})/GDP$, which now refers to 1974-1976 instead of to 1965-75. The reference to the longer period would also have required the GDP_U estimate which I have considered unnecessary, as the variable $(X_a - X_{rm}/GDP$ is very stable over time, so that the reference to a different time period does not really matter.

TABLE 4

AGRICULTURE' SHARE AND PER CAPITA INCOME, CURRENT AND UNIFORM PRICES, 30 COUNTRIES, 1975. RESULTS OF THE ECONOMETRIC ESTIMATES

DEP. V.	Const.	ln GDP	$(\ln GDP)^2$	$(X_a-X_{rm})/GDP$ 1974-76	d.S/Y	R^2	SEE
4.a1 A/Y	158.0	–31.1	1.54			0.91	4.04
		(4.3)	(3.0)				
4.a2 A/Y	136.6	–25.3	1.15	0.20		0.94	3.20
		(4.2)	(2.7)	(4.1)			
4.a3 A/Y	139.4	–26.2	1.22	0.26	–0.30	0.96	2.50
		(5.3)	(3.5)	(5.9)	(3.5)		

DEP. V.	Const.	$(\ln GDP)_U$	$(X_a-X_{rm})^*$ 1974-76	$d.S/Y_U$	P_a/P_y	P_a/P_i	R^2	ES
4.b1 A/Y	117.2	–13.2					0.84	5.25
		(12)						
4.b2 A/Y	115.8	– 13.0	0.40				0.90	4.22
		(14)	(4.0)					
4.b3 A/Y	115.4	– 12.9	0.51	– 0.39			0.93	3.52
		(17)	(5.7)	(3.5)				
4.c1 A_U/Y_U	107.2	– 11.9					0.78	5.73
		(10)						
4.c2 A_U/Y_U	105.9	– 11.8	0.36				0.84	5.06
		(11)	(3.0)					
4.c3 A_U/Y_U	135.0	– 13.2	0.42		– 17.8		0.90	4.03
		(14)	(4.4)		(4.1)			
4.c4 A_U/Y_U	116.2	– 10.6	0.40			– 24.5	0.88	4.49
		(11)	(3.7)			(2.9)		

* $(X_a-X_{rm})/PIL_U$.

Y_U indicates GDP at uniform prices among countries; P_a, P_i and P_y represent, respectively, the intercountry relative prices of the agriculture's value added, industries' value added, GDP. All the above valuations are based on the study by KRAVIS *et al.* (1982) and are the same as I used in a previous work of mine (ERCOLANI, 1983), to which readers can be referred for further information.

d) As was to be expected, the coefficients for the income variable and the values of elasticity in group "a" equations are lower than those of the other two groups of equations.[11]

[11] A quick comparison of the average elasticity is made possible by the regressions in logarithmic terms shown below. In this case, of course, the parameter of the independent variable represents the elasticity.

$\ln A/Y = 7.15 - 0.65 \ln GDP$ R^2 0.87
$\ln A/Y = 9.29 - 0.89 \ln GDP_U$ » 0.80
$\ln A_U/Y_U = 8.78 - 0.82 \ln GDP_U$ » 0.77

e) Table 5 shows, in correspondence with 7 levels of GDP, the predicted values for agriculture's share and the values of elasticity corresponding to some of the equations shown in Tables 2-4. One can see that there are only slight differences between the various regressions when the same system of prices is used; this is a confirmation that the variables added to the income variable, serve to explain the position of individual countries without influencing the pattern.

TABLE 5

PREDICTED VALUES OF A/Y AND ELASTICITY

PIL o PIL_U $	EQUATIONS 4.a1	4.a2	(III)	4.b1	4.b2	4.c1	4.c2	4.c4
	INDEPENDENT VARIABLES A/Y	A/Y	A/Y	A/Y	A/Y	A_U/Y_U	A_U/Y_U	A_U/Y_U
		47 countries		30 countries				
	predicted values							
150	42.1	40.0	40.4					
300	31.6	30.7	31.0	42.2	41.7	39.3	38.7	36.7
600	22.7	22.6	23.1	33.1	32.7	30.9	30.5	29.3
1200	15.5	15.9	16.6	24.0	23.7	22.7	22.3	22.0
2400	9.9	10.5	11.5	14.9	14.7	14.6	14.1	14.6
4800	6.0	6.5	7.9	5.7	5.7	6.2	5.9	7.3
6400	4.8	5.2	6.8	2.0	1.9	2.8	2.5	1.7
	elasticity							
150	– 0.39	– 0.36	– 0.36					
300	– 0.44	– 0.41	– 0.40	– 0.31	– 0.31	– 0.30	– 0.34	– 0.29
600	– 0.51	– 0.47	– 0.45	– 0.40	– 0.40	– 0.38	– 0.43	– 0.36
1200	– 0.60	– 0.55	– 0.50	– 0.55	– 0.55	– 0.52	– 0.58	– 0.48
2400	– 0.69	– 0.64	– 0.54	– 0.89	– 0.88	– 0.82	– 0.92	– 0.72
4800	– 0.75	– 0.75	– 0.53	– 2.29	– 2.30	– 1.88	– 2.19	– 1.45
6400	– 0.73	– 0.78	– 0.48	– 6.73	– 6.77	– 4.09	– 5.13	– 2.50

To find out the predicted values, the independent variables differing from GDP have been treated as constant (attributing a value equal to the average value). To calculate elasticity non-round figures have been used.

3 - Comparisons between Time Series and Cross-section Patterns

The identity of the factors which determine the differences among countries in the sectoral distribution of GDP, particularly the relationship between distribution and the level of per capita income, is an interesting analysis in itself. Of course, the value of cross-section analysis increases if the results can be considered indicative of the historical evolution. That is to say, if the differences found between countries with different per capita income levels can be used as reliable forecasts of the changes which historically accompany the growth of per capita income.

It does not seem necessary here to remind the reader of the methodological limitations or the particular circumstances essential for the achievement of a perfect correspondence between cross-section and time-series results. Kuznets (1971) has made an exhaustive examination of these problems (see, in particular, pp. 174-82).

Several authors have compared the decline of the agricultural product, as revealed historically, with the results of cross-section analysis. For the purposes of this essay, the most interesting analyses are those by Chenery and Taylor (1968) and by Kuznets (1971). Chenery and Taylor found that their projections based on a cross-section analysis of 54 countries (covering the period 1950-63), underestimated the actual decline of agriculture's share (and that of mining) in 9 present day developed countries. The proportion "explained" by the cross-section ranged from a minimum of 66% to a maximum of 85%. Kuznets (pp. 182-198) obtained analogous results by comparing cross-section patterns (based on 50 countries and referring to 1958) with the time series of 9 countries. In both these cases, the cross-section analysis was based on data at current prices and current exchange rates. In the time series, Kuznets used constant prices for A/Y, whereas Chenery and Taylor used current price data.

The results shown below also confirm that cross-section analysis underestimates the decline in A/Y's share over time. Nevertheless the differences appear to be less than those found in previous studies mainly on account of the different methodology used here and, above all, because of the price system employed in the cross-section analysis.

On the problem of prices the following points should be stressed:

a) the historical evolution of P_a/P_y and P_a/P_i for most of the present-day developed countries and for the whole period covered by the

available time series does not show any definite pattern. It is not therefore very important to distinguish between estimates at current prices and those at constant prices when measuring the changes in the sectoral distribution of product in the long run (Ercolani, 1983).

b) Whereas in cross-section comparisons, since P_a/P_y is on average higher in poorer countries, the use of current[12] or constant price data (among countries) is not unimportant. For, the first criterion of assessment, as compared with the second, overestimates agriculture's share in poor countries (Ercolani, 1983).

c) The rates of exchange exaggerate differences in international income. For this reason, if the estimate based on the exchange rates is replaced by estimates based on purchasing-power parities (PPP), the curves, which represent the relationship between agriculture's share and income, are more sloping. The increased inclination remains, even when the estimate at PPP is applied to agriculture's share (instead of applying it only to the GDP variable), since the differences between countries on a general price level (*i.e.* the aspect referred to above) are decidedly greater than the differences in agriculture's relative prices (P_a/P_y shown in point b).

Table 6 shows the results of the econometric estimates on time series compared with the cross-section (equations 6.5 and 6.6) discussed in the preceding section.

Equation 6.1 represents the average tendency revealed historically in 9 developed countries. I have adopted this solution since I agree with Kuznets (1971 pp. 174-75) that the results of the cross-sections should not be compared with the historical evolution of individual countries, but with that of a group of countries.

In the time series, the GDP is estimated at 1975 uniform prices (as in the cross-section analysis) while agriculture's share is at current prices.[13] I have also carried out the historical analysis on the basis of

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[12] Values at domestic prices converted into a single currency on an exchange rates basis.

[13] Generally speaking, the time series data represent five yearly averages. When the post-war series and those of preceding periods had years in common (and corresponded to the same definitions), I corrected the latter so as to make the A/Y value tally.

The A/Y time series for 8 countries (excluding Canada) are the same as those used in a previous study of mine (ERCOLANI, 1983). I obtained the time series for GDP_U by extrapolating backwards the 1975 value (1974-76), using growth rates based on data published by MADDISON (1979). I consider the estimates acceptable when restricted to the purposes for which they have been used here: *i.e.* to find, for each country, A/Y's trends as per capita GDP grows. However, in general terms, I do not consider the series to be wholly comparable between countries, since A/Y's components are not always homogeneous as far as definitions and methods of estimation are concerned. Furthemore, the level of GDP_U cannot be considered a very trustworthy indicator when it is extrapolated for a considerable number of years.

agriculture's share at constant prices. As was to be expected (see point a), the regressions do not show important differences when compared with those in which the share is at current prices.

In order to represent the historical evolution, several equations are given in Table 6.

Equation 6.1 has been estimated allowing each country to assume its own intercept (introducing a dummy variable for each country). Yet only in a few cases do the differences among countries appear significant (see the values of t ratio in the notes to Table 6). Moroever, equation 6.1 does not differ greatly from equation 6.3 estimated without recourse to the dummy variable.

TABLE 6

AGRICULTURE'S SHARE AND PER CAPITA INCOME.
CROSS-SECTION AND TIME-SERIES ANALYSIS.
RESULTS OF ECONOMETRIC ESTIMATES

	DEP. V.	Const.	ln PIL_U	dummy country	dummy t1 -1880	dummy t2 1881-1915	R^2	SEE
				time-series (9 countries, 119 observations)				
6.1	A/Y	135.6**	– 15.5	*			0.93	3.50
			(27)					
6.2	A/Y	107.9**	– 12.2	*	7.6	3.2	0.95	3.07
			(14)		(5.7)	(3.2)		
6.3	A/Y	130.1	– 14.8				0.75	6.28
			(19)					
6.4	A/Y	102.5	– 11.5		7.4	4.9	0.77	6.01
			(10)		(3.5)	(2.8)		
				cross-section (30 countries, 1975)				
6.5	A/Y	117.2	– 13.2					
6.6	A_U/Y_U	107.2	–11.9					

* Equations 6.1 and 6.2 have been estimated by adding as many dummy variables as there are countries (or sub-periods) less one: Canada 1919-76; the latter determines the value of the intercept of the equation which results from the regression.

** The intercept in equations 6.1 and 6.2 represents the average intercept, equal to that which results from the regression (136.9 in eq. 6.1) plus the weighted average of the dummies' coefficients; these (relating to 6.1) are shown here as follows (in brackets t ratios): Australia 1861-1976: 3.98 (2.11); Canada 1870-1920: 8.99 (4.02); Denmark 1871-1976: – 1.76 (0.94); Germany 1849-1934; – 0.24 (0.11); Germany (Fed. Rep.) 1953-76: – 2.99 (1.35); Japan 1887-1976: – 7.20 (3.48); United Kingdom 1801-1976: – 10.75 (5.75); Italy 1861-1976: 0.36 (0.18); Sweden 1861-1976: 1.88 (0.99); U.S.A. 1839-99: 2.20 (1.00); U.S.A. 1929-76: 0.36 (0.17).

TABLE 7

PREDICTED VALUES FROM SOME OF THE EQUATIONS CONTAINED IN TABLE 6.

	EQUATIONS		
	6.1	6.5	6.6
GDP_U $, 1975	DEPENDENT VARIABLES A/Y	A/Y	A_U/Y_U
300	47.1	41.7	39.2
600	36.3	32.7	31.0
1200	25.6	23.7	22.7
2400	14.8	14.7	14.5
4800	4.1	5.7	6.2

The results of the comparison between time-series and cross-section analysis make it possible to affirm that the historical decline of A/Y is only partially "explained" by the growth of GDP. The same concept can be expressed in other terms. Over time, there have been reductions in A/Y's share which are not associated with the increase in per capita GDP.

On a general level it is not difficult to imagine the factors which may have caused this reduction (changes in technology and in international environment, etc.). Obstacles arise, however, when one tries to represent these phenomena with specific variables. For this reason I have tried to quantify the effect of these factors by introducing some dummy time variables into the equations.

Of the test carried out, the one which produces the best results (equations 6.2 and 6.4) contains a dummy variable (equal to 1) for the observations relating to the first 3/4 of the 18th century and another for the following period up to the first World War.[14] If it is considered that the value of the parameters of the time dummies represents a correct estimate of the intensity with which the socio-economic changes took place, it follows that their influence was considerable. If today, at the

[14] However, a further dummy for the interwar period does not yield good results.

same level of income, conditions were similar to those at the turn of the century, the share of agriculture would be more than 3 points greater (equation 6.2), and compared with 1800, the difference would be more than 7 points.

4 - Causes of the Decline in the Share of the Agricultural Product

4.1 - *Historical Analysis*

The changes in the distribution of the product that accompany the growth of per capita income are caused by the changes in the composition of demand and by technological and organizational transformations.

In order to measure the long-term role played by factors belonging to each of these categories, one would need information which is not normally available (input-output tables). Yet, given the characteristics of the agricultural sector,[15] it is possible to obtain some useful approximate measurements from statistical information available in several countries.

G. Fuà (1974) has studied the decline in agriculture's share in Italy and has measured the influence exercised by the changes in the composition of demand and by technological and organizational transformations. His main conclusions were as follows:

a) in the whole period examined (1897-1967), the two groups of factors had a similar quantitative influence;

b) the changes in the composition of demand exercised a crucial role in the earlier stages of economic development, whereas technological and organizational transformations have predominated in the more recent phases.

Along the lines of G. Fuà's analysis,[16] I have extended the study to two countries with very different characteristics, namely Japan and

[15] I refer to the fact that it is a primary sector (the purchases from other sectors are limited), whose products, particularly in temperate countries, are for the most part used for local consumption.

[16] Fuà's work, previously quoted, has been republished, with some modifications, in FUÀ (1981), pp. 141-155. I have taken the data which appear in the following tables from this latest version.

Sweden, with the aim of checking whether the Italian results could be generalized. The quantitative estimates concerning the three countries are shown in Tables 8-10 and in Figure 3.

Algebraically the contents of the three tables are as follows (the meaning of the symbols is shown at the foot of Table 8).

In Table 8, agriculture's share is split as follows:

$$A/Y = \frac{A}{C_f} \frac{C_f}{Y}$$

Table 9 contains the breakdown of the ratio between agricultural value added (A) and food consumption (C_f):

$$A/C_f = \frac{A}{GMP} \frac{GMP}{GMP_f} \frac{GMP_f}{C_{f.A}} \frac{C_{f.A}}{C_f}$$

Table 10 contains the breakdown of the ratio between foodstuff consumption and income:

$$C_f/Y = \frac{C_f}{C} \frac{C}{Y}$$

All the data are to be considered as approximate indications, those in brackets are based on insufficient information.

The principal aspects shown on the right hand side of Table 8 and in Figure 3 can be synthesized as follows:

1. In the three countries, the decline in A/Y is greater, the greater the increase in per capita GDP, for the second period as regards Italy and Japan, and for the first as regards Sweden;

2. both groups of factors in all three countries have contributed substantially to the decline in A/Y, but, while in Italy, and above all in Sweden, the technological and organizational factors predominate (line b) in Japan the contrary is true, and the relative reduction of food consumption was predominant (line c);

3. in Italy, the reduction in the share of food consumption is predominant in the first period, while the effect of technological transformations prevails in the second. In the other two countries, however, the reverse is true.

The aspects shown in points 2 and 3 are also evident in Figure 3.[17] The greater slope in the curve relative to Japan denotes the heavy

[17] The area defined by the co-ordinates of each point of the curve represents A/Y. Thus, the nearer the points are to the origin of the axis, the smaller is the A'S share.

TABLE 8

RATIOS BETWEEN AGRICULTURAL PRODUCT, FOOD CONSUMPTION AND TOTAL PRODUCT

	ratios (%)						indices of variation in the ratios		
	ITALY								
	1897	1913	1921	1938	1949	1967	1967/1897	1938/1897	1967/1949
a. A/Y	48	42	43	27	27	12	25	56	45
b. A/C_f	79	78	76	68	62	37	47	86	60
c. C_f/Y	61	54	56	39	43	33	54	64	76
GDP p.c., $	792	1157	1100	1461	1384	3355	424	184	242
	JAPAN								
	1885	1910	1925	1935	1955	1975	1975/1885	1935/1885	1975/1955
a. A/Y	41	35	24	17	18	6	13	41	31
b. A/C_f	80	71	54	50	51	34	43	61	66
c. C_f/Y	52	48	45	34	34	16	31	67	47
GDP p.c., $	412	599	836	987	1098	4770	1158	240	434
	SWEDEN								
	1868	1893	1913	1923	1938	1943	1953	1953/1968	1923/1868	1953/1923
a. A/Y	39	53	24	19	13	11	10	25	48	52
b. A/C_f	85	74	59	47	46	39	37	44	55	79
c. C_f/Y	46	45	40	40	29	29	26	58	87	66
GDP p.c., $	379	602	973	1094	1697	1751	2398	633	289	219

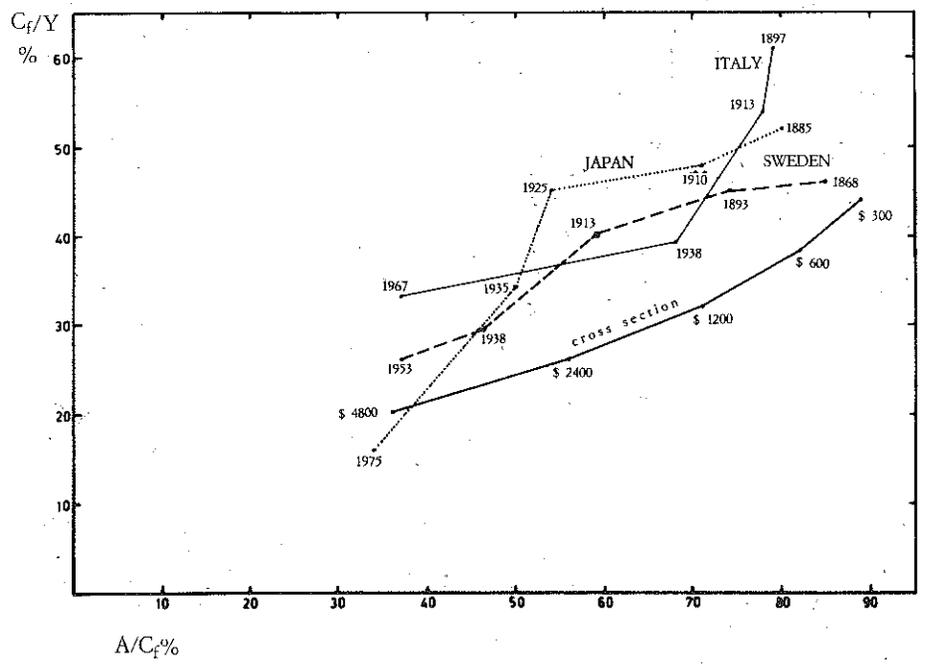
Any discrepancies are due to rounding off the figures.

The data shown in tables 8-10 represent three-year averages for Italy and (in principle) five-year averages for Japan and Sweden. All are at current prices. Y: GDP at factor costs, except for Japan (market prices); A: value added of agriculture, forest and fishing (aff); C_f: food (including beverages and tobacco) consumption; FA: final output of aff; FA_f: final output of foddstuffs (domestic supply of agricultural foodstuffs); $C_{f,A}$: food consumption of agricultural products (domestic demand for agricultural foodstuffs). The per capita GDP is in U.S. dollars at 1975 uniform prices, estimated by the process shown in note 13.

The first three lines of data for Italy are taken from FUÀ (1981); most of the estimates for Japan are based on information taken from OHKAWA and ROSOVSKY (1964 and 1973) and HAYAMI (1975); the Swedish data are elaborations based on data published by JOHANSSON (1967).

FIGURE 3

DECLINE IN AGRICULTURE, ENGEL'S LAW AND TECHNOLOGICAL AND ORGANIZATIONAL CHANGES



decline in food consumption. It is also evident that the Italian curve has a greater slope in the first period than in more recent years. The contrary is true for Sweden, and even more so for Japan. The figure also shows the results of the cross-section analysis which are described in the following section.

Table 9 shows the effects of technological transformations. It will be observed that the increase in A's purchases from other sectors (line b1) has clearly had a smaller effect in all countries than the decline of that part of C_f spending that goes to the agricultural sector. In other words, with the growth of income, the agricultural sector becomes a little less primary, and above all the process of food production becomes longer because of growing intervention from non-agricultural sectors (food industry, trade, transport).

TABLE 9

RATIOS BETWEEN AGRICULTURAL PRODUCT AND FOOD CONSUMPTION

	ratios (%)						indices of variation in the ratios		
	ITALY								
	1897	1913	1921	1938	1949	1967	1967/1897	1938/1897	1967/1949
b. A/C_f	79	78	76	68	62	37	47	86	60
b1. A/FA	94	93	95	89	90	80	85	84	89
b2. FA/FA_f	(80)	(80)	(80)	(70)	(60)	107			
b3. $FA_f/C_{f.A}$	(100)	(100)	(90)	(100)	(100)	95	55	88	67
b4. $C_{f.A}/C_f$	(110)	(110)	(110)	(110)	(110)	43			
	JAPAN								
	1885	1910	1925	1935	1955	1975	1975/1885	1935/1885	1975/1955
b. A/C_f	80	71	54	50	51	34	43	61	66
b1. A/FA	86	87	85	84	81	70	81	97	87
b2. FA/FA_f	110	111	120	113	103	102	93	103	99
b3. $FA_f/C_{f.A}$	(101)	(94)	(88)	(87)	(90)	(90)	57	62	78
b.4 $C_{f.A}/C_f$	(83)	(79)	(61)	(60)	(68)	(53)			
	SWEDEN								
	1868	1893	1913	1923	1938	1943	1953	1953/1868	1923/1868	1953/1923
b. A/C_f	85	74	59	47	46	39	37	44	55	79
b1. A/FA	95	91	85	84	80	77	73	77	88	87
b2. FAV/FA_f	136	139	132	131	130	130	151	111	97	115
b3. $FA_f/C_{f.A}$	(96)	(92)	(89)	(85)	(88)	(92)	(82)	51	61	79
b4. $C_{f.A}/C_f$	(69)	(64)	(59)	(50)	(50)	(42)	(41)			

Any dicrepancies are due to rounding off.

TABLE 10

RATIOS BETWEEN FOOD CONSUMPTION, TOTAL CONSUMPTION AND INCOME

	ratios (%)						indices of variation of the ratios		
	ITALY								
	1897	1913	1921	1938	1949	1967	1967/1897	1938/1897	1967/1949
c. C_f/Y	61	54	56	39	43	33	54	64	76
c1. C_f/C	68	66	68	54	55	44	65	79	80
c2. C/Y	90	83	84	72	80	74	82	80	93
	JAPAN								
	1885	1910	1925	1935	1955	1975	1975/1885	1935/1885	1975/1955
c. C_f/Y	52	48	45	34	34	16	31	67	47
c1. C_f/C	64	63	58	50	54	28	44	78	52
c2. C/Y	80	76	78	69	63	57	70	86	90
	SWEDEN								
	1868	1893	1913	1923	1938	1943	1953	1953/1868	1923/1868	1953/1923
c. C_f/Y	46	45	40	40	29	29	26	58	87	66
c1. C_f/C	53	51	50	49	38	40	38	72	92	78
c2. C/Y	87	88	80	82	76	73	69	79	94	84

Any discrepancies are due to rounding off.

Table 10 shows that both the reduction of C/Y and that of C_f/C, or Engel's law, have contributed to the decline in A/Y but the effect of the second variable is greater than that of the first. Nevertheless in Sweden the difference between the two effects is not very important in the first period, or in fact in the whole span of time considered, whereas in Japan Engel's law clearly prevails. Italy is in an intermediate position as far as the relative weight of the two effects is concerned, and in the first period shows a course similar to that of Sweden.

Lastly, it should be recalled that in a study concerning 13 developed countries[18] over the period 1952-70, the decline in A/Y is due mainly to the reduction in A/C_f, yet this regularity seems less clear when the sub-periods 1950-61 and 1961-70 are examined.

[18] LOVASCIO and TAMBERI (1977).

4.2 - *Cross-section Analysis*

In Table 11, lines a and c are the predicted values from the two equations shown in note,[19] estimated on the data at uniform prices of 30 countries. Line b is calculated on the basis of the other two.

This simple exercise gives some interesting indications.

Table 11 and the curve shown in Figure 6 show that the smaller share of the agricultural product (which is found when considering countries with a growing income level) is associated with larger reductions in A/C_f than in C_f/Y.

It is also noted that the influence of technological and organizational transformations is predominant in the higher income bracket, whereas the effect attributable to the reduction in the share of food expenditure prevails, even if only slightly, at lower income levels. These results are therefore closer to the Italian case than to the evolution which took place in Japan and Sweden.

TABLE 11

RATIOS BETWEEN AGRICULTURAL PRODUCT, FOOD CONSUMPTION AND TOTAL PRODUCT. CROSS-SECTION ANALYSIS, 30 COUNTRIES, 1975

	per capita income (GDP_U), $							
	300	600	1200	2400	4800	4800/300	1200/300	4800/1200
	ratios (%)					indices of variation of the ratios		
a. A/Y	39	31	23	15	6	16	58	27
b. A/C_f	89	82	71	56	31	35	80	44
c. C_f/Y	44	38	32	26	20	45	73	62

All the data are at uniform prices.
Any discrepancies are due to rounding off.

5 - Conclusions

The principal results can be summed up with reference to the three main issues examined.

[19] $A/Y = 107.2 - 11.9 \ln GDP$; $Cf/Y = 93.7 - 8.7 \ln GDP$.

1. The endowment of resources and the dissimilarities among countries in the agricultural share in GDP.

2. The relationship between agriculture's share and per capita income, both among countries and over time.

3. The decline in agriculture's share and the role played by two groups of factors: those connected with the demand for food and those associated with technological and organizational transformations.

As regards the first point, three categories of country have been identified. Those endowed with agricultural resources, those rich in non-agricultural natural resources and those with balanced resources. The differences between the first two groups of countries are appreciable. A/Y in countries endowed with agricultural resources exceeds by almost 1/3 (at the same level of income) the share of the other group of countries. It has also been shown that there is an inverse relationship between the level of relative prices in the agricultural sector and the share of the same sector.

The results of the comparison between time series and cross-section confirm that the decline in A/Y over time is greater than that implied by cross-section comparisons. For it has been shown that over time there have been reductions in A/Y which are not connected with changes in income level. Such discrepancies do not seem to be negligible. The econometric estimates would appear to indicate that in less developed countries the level of A/Y is today considerably lower (20-25%) than that of developed countries in the first phases of their development or similarly that today, in the rich countries, agriculture's share is about half of what one would expect according to the variations in their income.

As regards the causes of the decline in the agricultural share, G. Fuà's analysis for Italy has been extended to include two other countries, Japan and Sweden. The analysis has brought out some transformations which accompany the relative decline of the agricultural product. These transformations are synthesized by the following two indicators, A/C_f and C_f/Y. Both tend to diminish in the course of development. The decline in the first ratio reflects in particular the modifications in the distribution of expenditure as income grows. The decline in the second ratio, on the other hand, reflects the technological and organizational transformations which tend to reduce the contribution of the agricultural sector to the final value of food products. It has been found that in Japan and Sweden the relative share of the two groups of factors has shown a course opposite to that of Italy. In fact, in

these countries, the reduction in A/C_f is predominant in the first decades of development while in the following period that of C_f/Y has prevailed.

Ancona,

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