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Factor Price and Capitalization

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INTRODUCTION

The interest in quantifying available capital and how it changes with the requirements for economic growth. The modernization process in agriculture has entailed the substitution of labor-intensive techniques, animal power and high reemployement levels by capital-intensive methods, mechanical power and an increasing use of industrial inputs. The problems connected with the capitalization of agriculture have therefore become very important.

The controversy over the theory of capital is widespread. The echoes fron the debate between the English neo-Keynesians from Cambridge and the neo-necclassicists from Cambrige, Massachusetts, started in 1953 by Joan Robinson, have still not died away. Nor have the problems connected with economic growth and income distribution over time been solved.

"But when studying economic growth, whether stemming from agriculture or from any other economic sector, investments are necessarily the center and nucleus of the analysis" (Schultz, 1967, p. 61).

The search for a unit to calculate share capital on an aggregated basis has become a chimera for both sides. "The unit sought after had to be independent of distribution and relative prices, so it could be used <<without use of circular logic>> in the explanation of production, participations and the prices in general, within the framework of the theoretical neoclassical fiction of the static state" (Harcourt, 1977, p. 9). Thus we lost any hope of achieving a measure of capital which is independent of distribution and structure of relative prices.

The changes in the direction of relative price trends vis-a-vis constant methods of production cannot be reconciled with any notion of capital as a mesurable quantity independently of distribution and prices (Sraffa, 1960, p. 38). Capital appears in statistics as an amount of money, but "the value of capital depends on the profits rate" (Robinson, 1976, p. 229).

Notwithstanding theoretical difficulties, the attempts to calculate productivity, to analyze technical progress and to obtain profitability have not ceased. In applied economics studies, it is frequently necessary to use only approximate measures, due "only to econometric convenience" as stated by Solow, or to statistical shortcomings. It is also true that the theoretical debate is still being developed even further (see Harcourt and Laing, 1977). But our first purpose here is much more modest: to describe the evolution of agricultural capital in Spain. Thus it will be necessary to assume that its resulting estimates are also determined by the initial statistical errors.

In the first place, an aggregate indicator of the evolution of agricultural capital will be obtained, followed by the results obtained using this annual series of capital to analyze the comparative evolution of global productivity. Finally factor price and factor use are related using a partial productivity model.

THE ANNUAL SERIES OF AGRICULTURAL CAPITAL

In order to obtain an annual index of the evolution of

the agricultural capital stock, it is necessary to have an initial estimate for the starting period, statistics on utilization of fixed capital (amortizations), investments --both in fixed capital formation as well as in stock variations-- and an adequate deflator to revalue the accumulated capital stock.

In our case, we have a census of capital for the economy as a whole, which was conducted by Prof. Velarde in the Universidad Comercial de Deusto, and published as "La Riqueza Nacional de España" (Velarde et at., 1968). Among its main advantages, it has a high level of sectorial disaggregation, although it used broad-ranging criteria (purchase, market and replacement prices) due to the scope of the work, that covers all the economic sectors. This study gives the value of agricultural capital for two consecutive years, 1963 and 1964. Land crops, buildings, cattle census and machinery are included in this valuation.

The task of assessing capital stock for all economic sectors has never again been undertaken, and only some estimates for specific sectors can be found. Thus, the II Plan de Desarrollo Economico y Social provides information about the

chemical and iron and steel sectors, among others, but with a total lack of reference to the methodology used.

On the other hand, different approaches to the assessment of the capital stock/output ratio by means of incremental coefficients can also be found; the study carried out by the INI Foundation (Fanjul et al., 1974) stands out among them, with a disaggregation level of 34 sectors for the periods 1962/66 and 1966/70. The problems encountered when drawing conclusions on capital intensification by sector can be observed in this study, and they stem from the lack of quality of avaible investment statistics.

Other existing estimates on the marginal capital-output ratio are those prepared by the Ministries of Industry (M. of Industry, 1960)(M. of Industry, 1980) and of Labor (Cavero et al., 1976). In those dealing with the secondary sector, the information was obtained from a sample of industrial companies with 1958 data for the first, and 1971 to 1975 data for the second. Capital-employment coefficients in this sector were calculated with regional disaggregation based on the Agricultural Wealth series prepared by the Ministry of Agriculture (MAPA,

1972).

This study is not based, like the ones above, on sample data, but on an updating of data from 1963 and 1964 censuses of agricultural capital. To this end, the Secretaria General Tecnica (SGT) employed physical variation indices suitable to each subsector (HP/Hectare of Plowed Land, Kg. of live weight/Hectare, etc.) so as to obtain an annual series in real terms. These data were then coverted to current values by means of the General Price Index of the Economic System. Nevertheless, this series has serious problems when evaluating net investment, mainly in the Land and Permanents Crops and Buildings components.

No capital censuses for the rest of the economic sectors have been prepared since the above mentioned 'Riqueza Nacional de España', though there are two more recent estimates for the agricultural sector for the years 1972 and 1976 (MAPA, 1975 and MAPA 1980).

Also, the SGT published an annual series of agricultural capital 1970-74 based on the 1972 inventory and using the series of Gross Fixed Capital Formation, amortization

and stocks variations (MAPA, 1975). This series also shows a marked incoherence with the series published previously for the period 1963-72.

A detailed study of the problems caused by available statistical data, the inconsistencies they lead to, as well as the possibilities of drawing up a new annual series of capital (San Juan, 1984) allow us to obtain the results summaraized below:

The more important statistical gaps are noticed when assessing net investment in Land and Permanents Crops and Buildings. In the first case , the problems stem mainly from deficient information ataible on private improvements and also from the lack of data on land prices . This leads to a poor assessment of investments, asset revaluation and amortizations. With regard to buildings, the problem lies mainly in the fact of having assigned them an average life of 12 years; the consequence of this unrealistic decision is that buildings are amortized surprisingly fast.

Data on gross investment prepared by the SGT are

probably conservative (see Tarrafeta, 1979). Also, it is necessary to add capital losses (via forest fires and loss of fertile land) to the amortization of "machinery and equipment" and "buildings and improvements" in order to obtain the net investments for each years.

Therefore, inventory data were chosen for the review of the annual series of agricultural capital, assuming that they were more reliable than the avaible data on investmelts in amortizations, even after the adequate selection process was made.

The procedure followed (see San Juan, 1984) consists of obtaining the annual series based on the 1963, 1965, 1972, and 1976 capital censuses with the selected data from Gross Fixed Capital Formation, amortizations and stock variations, then introducing the necessary corrections. To this end, we have used the allocation method --proportional to the annual rates of variation of the theoretical values obtained-- of the annual accumulated rates of discrepancies between the theoretical value and the corresponding inventory value.

Thus, the series obtained is coherent with the inventory data and does not show the "jumps" present in the existing official series. This procedure allows us also to take into account all statistical data series available.

The annual series of the agricultural capital stock obtained is shown in table 1. The capital deflator used is the same as in the above mentioned estimates, up to 1975; from this year on, a specific price index was elaborated in view of the accuracy rendered by the improvement of statistical information. This deflator was calculated from the series of "Investiment Prices Paid" and "Prices Percived, Livestock". The first one shows the evolution of the price of investments in machinery, crops, buildings and permanent improvements, weighted with a 93,3% in the deflator. The remaining 6,7% corresponds to livestock, in accordance with the agricultural capital structure indicated in the last census. The index obtained is shown in table 2.

It is necessary to poilt out that the recent publication of a survey on land prices (MAPA, 1984), allows a better knowledge of the evolution of the value of the main

component of the agricultural capital stock. Even though, this series was originated in 1979, and thus does not allow for improvements on the estimated annual serie of agricultural capital stock, providing nevertheless very useful information for its extension.

The annual series of the agricultural capital stock allows not only for quantification over time of this magnitude, but also the generation of other indicators whose calculation requires it.

Table 3 shows the results obtained using the annual series of agricultural capital stock at constant prices for the calculation of the total productivity in the agricultural sector. Variation in global productivity has been obtained as the ratio between the output really acquired in a moment "n" and the theoretical output really acquired in a moment "n", assuming that production variation were only due to variation in the quantities of labor and capital employed.

The formula used for the calculation of global

productivity is the following:

$$PGn = \frac{GVAn/GVAn\text{-}1}{\alpha_{n-1}\,(Ln/Ln\text{-}i) + \beta_{n-1}\,(Kn\text{-}1/Kn\text{-}2)}$$

where:

n =time indicative subindex, years in this case

GVA = Gross Value Added at factor costs and constant prices

α = labor participation in GVA at current prices

β = capital input participation in GVA at current prices

K = agricultural capital stock, at constant prices, valued at December 31 of each n year.

Results obtained permit an appraisal of the effects of the modernization process of the Spanish agricultural sector on the global productivity. This allows us to differentiate between two main periods:

In the first one, the alteration of negative and positive rates determines little long-term productivity improvement.

In the second, starting from 1972, a strong growth of global agricultural productivity can be noticed until the end of the period under study.

Incremental coefficients capital/output and capital/labor can also be obtained from the capital stock series. These coefficients show the change introduced in the degree of utilization of the primary factors: capital and labor. From the data shown in table 4, the continous decrease from 1973 of the capital/output ratio must be pointed out.

FACTOR PRICE AND CAPITALALIZATION

In most theoretical models, the process of capitalization in agriculture appears as one of the essential factors in the explanation of productivity impovements within the sector. However, an explanation of the economic mechanisms impelling the capitalization process is not often found.

"The bibliografy of economic growth has been dominated

for some time by macro-models that are oblivious both to the changes over time in relative factor price as well as to the changes in investiment profitability related to these factor prices (...). This omission is justified by several reasons, one of them being that the profitability of the new factors of production is hidden under the label of technical change" (Schultz, 1967, p.63).

We do not intend to present an overall explanation of this complex process in the Spanish case, which would require a research wich, to a large extent, is yet to be carried out. However, it is possible to describe the main vectors that have launched this process. In any event, these hypotheses would require a more systematic comparison before being definitively accepted.

As to the evolution of the relative prices of primary factors in the Spanish agricultural system, some quite clearly defined long-term tendencies can be observed. Table 5 shows results obtained by calculating two compound indixes that relate the evolution in the global agricultural productivity with the evolution of primary factors prices. The first index, relating

productivity to agricultural wages, shows that wage growth has been faster than growth in global productivity. This seems to have stopped in 1980. Furthermore, global productivity has been growing faster than capital remuneration per unit, as shown by the tendency to increase of the second of the above mentioned indices. In fact, this tendency to increase only ceases in 1964-65, probably due to the poor harvests of these years, and in 1972-73.

Therefore, the change in the structure of relative prices of primary factors of production appears as one of the main elements instigating the process of labor subtitution by capital and means of production originating outside the sector.

In fact, the compound index relating prices percibed by farmers (output prices) to agricultural wages decreases systematically over the perios under study. On the other hand, the index of prices percibed/paid presents an opposite trend, increasing until 1973. But the repercussions in Spain of the first oil crisis marked a first break in this tendency in 1974. After four years of recovery, the second oil crisis seems to have marked the start of period a of increase in prices paid by

farmers (inputs prices) at a higher rate than that of prices percived (output price) between 1979 and 1983.

MECHANIZATION

The most typical source of increase of partial productivity of work in agriculture is intensified use of mechanical means of traction.

If the mechanization process is mesured by the indicator relating HP per 100 hectares of plowed land, the tendency to increase present over the last three decades does not seem to have stopped either. Data in table 6 show that mechanization levels stop increasing at certain points, althoug the tendency to increase is maintained in the long term. However, data on licensed machinery (table 7) show a certain stagnation in the number of new machines registered, which seems to be compensated by the increase in average power and longer utilization periods.

The growth in available power of machines combined with the uninterrupted decrease of the population engaged in farming produces a sharp ride, over the long term, in the HP/L ratio. As can be seen in the table 9, the rising trend in power per worker remains steady even in the most recent years.

In general, the introduction of mechanized technology shows a negative relation with both the relative price machinery/work and the relative price land/work (Yamada and Ruttan, 1980). This means that the introduction of mechanichanized technology permits shifts savers of land and work.

Before the second energy crisis, machinery becomes cheaper in terms of both the price of work and the price of land.

By contrast, beginning in 1980 machinery becomes more expensive with respect to work as is shown by the growth in the Pch/Wa index in table 10.

As for land, it does not experience an increase in price relative to work until 1983-84, and furthermore, the growth

in the Pa/Wa index is very slight (Table 13).

In order to obtain a global relation between new investments and the cost of work, we use an index of relative prices Pi/Wa, where Pi is an index derived from prices paid in investing in machinery, in the sowing of crops and the preparation of land. This indicator allows us to appreciate how the relative price Pi/Wa has experienced only small changes. After the second energy crisis, there is a slight price increase in investiments relative to work, but in 1984 the level reached is similar to that of 1976 (Table 10).

Still, for a correct interpretation of the data it is necessary to point out that the growth in the indicator HP/L is being slowed at present by the decrease in the fall in the active farm population during 1983-84.

Likewise, it is important to note that the indicator HP/L ougth to be interpreted with caution because of the statistical difficulties involved in evaluating the number of workers engaged in Spanish agriculture.

Furthermor, the population engaged in agriculture, L, has experienced tow important changes in its composition during the period 1976-83:

a) An increase in the number of active males (from 72,8% to 74,3%).

b) A decrease in the number of those still active once they reach 65 years of age (from 9,9 to 5%).

In addition, the population engaged in agriculture also depends on the number of unemployed workers. The region of Andalusia, in the south, contains more than half of the country's agricultural unemployed, with a rate of 17,2% wich is far superior to the national average (5,7 in 1983). Consecuentely The results of the harvest in the Andalusian region significantly affect variations registered in the population engaged in agriculture.

To these considerations one must add the difficulty in evaluating adequately the extension of agriculture as a part-time activity. We should also remember that the variation in the power of machines, HP, does not allow us to register increases in

productivity owed to the adoption of mechanical improvements in macines and tools.

These difficulties lead us to view this indicator as a proxy variable for our study.

It is important to point out that the mechanization rate has been different according to the financing posibilities of each farm, and also to the type of crops. Thus, for instance, while some crops have been able to assimilate technologies available in other countries quite easily and achieve high mechanization levels --as in the case of grain crops--, other type of crops have not had technology available to cope satisfactorily with certain tasks, as in the case of olive trees for oil production. Thus, wage costs have continued to be an ever-increasing burden for these crops. Whenever cost increases could not be reflected in prices (as in the case of olive trees, due to demand shifting to other vegetables oils), a crop profitability crises has occurred.

CHEMICAL TECHNOLOGY

The use of chemical technology, fertilizers and others agro-chemicals products, permits the substitution of land and work. The growing use of fertilizers per unit of cultivated surface is negatively related to relative prices fertilizers/land and fertilizers/work. In general, the quantity of this factor that is utilized sows extreme elasticity to its relative price.

Table 11 shows how, in the case of Spain, the use of fertilizers, wich had been growig since the 1940's, undergoes a change as a consequence of the second energy crisis. In fact, the index F/A, killgrams of fertilizing units per hectare of fertilizables surface, experiences a noticiable slump in the period 1980-83.

This process may be explained by the rise in price of fertilizers relative to land and work, since both the index Pf/Pa and the index Pf/Wa in table 11 exibit rising values beginning in 1980.

Further, the fall in Spanish comsumption of fertilizers has been intensified by the drought of 1981. This combination of phenomena has been of such magnitude that it has brought about a

crisis in the fertilizer industry, provoking its complete restructuring, a process that is currently under way.

The response of farmers to the rise in price of fertilizers has been first to decrease comsumption by using formulas better suited to each type of terrain, and then later to reduce comsumption as a way to save on production costs.

As for &FITOSANITARIOS& products, they too have become more expensive relative to land and work, a development that inverts previous trend (Table 11).

In sumary, it is clear that the change registered in relative prices because of the second energy crisis has brought about an evident slump in the use of chemical technology in Sp'nish agriculture.

BIOTECHNOLOGY

The introduction of biotechnology has been encouraged historically by the fall in the relative price of compound feedstuff measured against that of fodder. Feedstuff thus acts as

a substitute for the land factor especially when, as is the case with Spain it is largely imported.

In the cattle-raising sub-sector a wide range of different situations can also be observed, both from the point of view of production types as well as that of land space. Without intending to deal with them exaustively, the important role played by productivity modernization in the change of the meat production structure can be mentioned as an example. Briefly, this process has consisted in introducing modern techniques of selection and handling of stabled cattle, that have led to the outbreak of an intensive cattle-raising activity, clearly differenciate from traditional cattle-raising that depends on extensive land use. Production intensification has allowed significant productivity improvements to take place and, consecuently, an evolution in the structure of costs has come avbout, that has allowed prices competition with extensive-production meat.

This has been progressively lossing its market share, especially during periods when the conditions of the feestuff world market have alllowed an import trade at relatively low

prices.

The intensification process of livestock farming is one of the clearest examples of the negative consequences that may result from the adoption of new technologies without carrying out a parallel adaption process. Intensive cattel-raising has provided significant productivity improvements, althoug by means of introducing technologies developed for countries with different natural resources. This has resulted in important deficits in the agricultural economic balance due to a great extent to need to import increasing quantities of feedstuff for cattle.

Wishing to study the evolution of relative prices for feedstuff/fodder in table 12, we have established three different ratios. The reason behind the construction of these ratios is the difficulty involved in finding a representative price for fodder. By contrast, we have at hand a index of prices prices paid by cattle ranchers for compound feeds, calculation that represents the weitght average derived from the prices paid for different types of feed.

The next estep is to compare the price paid for feedstuff, Ppc, with a numbers of factors. First, with the price of land utilized for pasturages, Pfd. The second relative price hs calculated using as a basis for comparison in the denominator the price of vetch, Pv, a fodder regularly utilized in Spain. Similarly, in the thirtd index the price of alfalfa, Pal, is used in the denominator since it is a fodder whose commercialization is widespread.

Consequently, the relative price feedstuff/land employed for pastures, Ppc/Pfd, exibits a trend that is more stable over the long term than the relative prices feedstuff/vetch, Ppc/Pv, and feedstuff/alfalfa, Ppc/Pal, for the latter are more influenced by climatic variables and their effects on the harvests.

In the ligt of all the indices used, it becomes evident that the relative price of feedstuff compared to fodder rose after the second energy crisis.

Feedstuff became cheaper only relative to vectch and alfalfa during 1981-82, but once again rose in price in 1983. It

is therefore imposible to speak of a return to the historic trend of falling prices during the period 1972-79.

In sumary the indices utilized also point to a movement in relative prices after 1979 that reverses the historic trend wich had contributed to the greater use of biological technology in cattle-raising.

In this regard it is curious to note that the deficits in Spain's comercial balance for agriculture have been reduced in the period 1979-84 and that the balance has even shown a surplus. Given the importance of feedstuff imports, the movement detected in relative prices ougth to be a significant factor when the time comes to explain this changes. Likewise, the indicators could be reflecting the effects of policies instituted to improve the dedree of self-sufficiency in the feeding of cattle.

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LAND USE AND FARM SIZE *

Finally it is important to note that the improvements in productivity detected in Spanish agriculture must be positively related to the growth in the sixe of small farms and to the decrease in the number of parcels into which farms are divided.

To show the contrast most effectively, we have used data from the agricultural censuses of 1972 and 1982, conveniently refined to allow as homogeneous a comparison as possible.

We thus confirm that the total number of parcels has declined drastically (-24,4%) and that simultaneosly the size of the existing parcels has increased.

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* My acknolage to Maria Jesus Romo by her statistical support in this part.

Specifically, parcels greater than 5 hectares in size become more numerous (+1.484,9%) whereas fewer are registered for lots measuring Ø,5 and 1 ha (-77,1%) and for those under Ø,5 ha in size (-96,59%).

Consequently, a decrease is registered for the average number of parcels per farm, wich falls from 1Ø to 8,7 (12 parcels/farm in 1962). This reduction holdes for farms of all sizes (except for farms between Ø,5 and 1 ha) and most pronunced in farms that extend beyond 2ØØ ha.

Simultaneously, the data reveal a reduction in the total number of farms that comprise between Ø,5 and 5Ø ha, while an increase is detected in large farms (between 5Ø and 1ØØØ ha) except for those between 2ØØ and 3ØØ ha.

As exceptions to this general rule we have an increase in the number of smallest farms (+8,45%) and a decrease in the sumber of farms greater than 1ØØØ ha. At the same time, the number of farms registered without land fell by 29,44% during the period 1972-82.

In sumary, one may point to a trend toward mediun to large farms with fewer parcels and larger average size for each parcel.

The significance of farm size varies according to wheter one is dealing with unirregated or irregated land. Hence, we will now analize the principals changes in the exploitation of cultivated fields.

Irrigated surfaces have increased by +3,31% while unirrigated lands have decreased by -8,37%.

Within the irrigated category, the crops showing an increase in cultivation are grapes +63.32%, fruits trees either alone or occring whith herbaceous crops +4,Ø2%, herbaceous crops +1,69% and fruits trees, olive trees and grapes planted together. The area devoted to olive trees alone or in company of herbaceouscrops has fallen by -Ø,36%, and the land on wich herbaceous crops and forest species occur togeder has decreased by -Ø,28%.

In the unirregated category, the crops showing the

largest decreases are, in this order, herbaceous crops occuring with forest species -75,85%, fruits trees, olive trees and grapes occuring together -27,97%, olive trees alone or associated with herbaceous crops -11,55%, herbaceous crops alone or mixed -6,17% and grapes -4,55%.

We may therefore conclude tentatively that the following represent variations likely to have a positive influence on productivity: the distribution of land ~~of land~~ within a farm, the tendency to increase the number of "intermediate" farms, and the sift toward irrigated crops and fruits trees. By contrast, productivity will be disminished by the proliferation of small farms (smaller than Ø,5 ha) (we can neither affirm nor deny that this increase is caused by the increase in extensiveness of the last census) and the shift from grapes to irrigated crops.

CONCLUSIONS

The growth in agricultural productivity in the coming years will be related to, among other factors the type of

technological innovations adopted by Spain. Nevertheless, these innovations will in turn depend not only on technical progress made available to the sector but also in the relative prices of the factors that go into production.

Viwed from this perspective, the changes registered in relative prices of the principal factors in agricultural production --changes owed in large part to the second energy crisis-- represent a significant change in the frame of reference that sugests the type of technology to be introduced. In adition, the fall in real prices of petroleum and the uncertainty regarding how long this condition will last pose numerous problems for those who must desing a viable agararian technology for the future.

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Tables

TABLE 1

ANNUAL SERIES OF THE AGRICULTURAL CAPITAL STOCK
(Thousands of Million Pesetas)

Year	Current Prices	1970 Prices
1963	1.416,8	2.130,5
1964	1.471,8	2.081,8
1965	1.502,2	1.935,8
1966	1.855,2	2.251,5
1967	2.034,3	2.338,3
1968	2.226,3	2.438,4
1969	2.398,4	2.538,0
1970	2.635,2	2.635,2
1971	2.971,0	2.745,8
1972	3.340,3	2.845,2
1972	3.575,7	2.750,5
1973	3.881,1	2.601,3
1974	4.319,0	2.459,1
1975	4.807,8	2.345,3
1976	5.729,8	2.198,7
1977	6.345,5	2.070,5
1979	7.160,4	2.011,4

Source: Own.

TABLE 2

AGRICULTURAL WEALTH PRICE INDEX
(Indexes of prices 1876 = 100)

Year	Investment	Livestock	Wealth
1976	100,0	100,0	100,0
1977	128,1	112,5	127,1
1978	151,2	132,7	150,0
1979	175,3	149,8	173,6
1980	197,6	147,7	194,3

Source: Own.

TABLE 3

GLOBAL AGRICULTURAL PRODUCTIVITY

Year	Annual Rate	1964 index = 100
1965	—5,27	94,73
1966	9,11	103,36
1967	1,43	104,84
1968	—1,37	103,44
1969	3,02	106,57
1970	—18,33	87,03
1971	14,34	99,50
1972	1,79	101,28
1973	6,45	107,81
1974	—0,01	107,80
1975	7,43	116,14
1976	13,81	132,18
1977	2,41	135,37
1978	11,57	151,03
1979	3,01	155,58
1980	17,59	182,94

Source: Own.

TABLE 4

EVOLUTION OF THE CAPITAL/OUTPUT RATIO AND CAPITAL/LABOR RATIO IN AGRICULTURE
(variation annual rates)

Year	Capital/Output	Capital/Labor
1965	—0,50	—6,32
1966	9,28	15,62
1967	—1,45	7,54
1968	5,55	6,16
1969	1,87	7,48
1970	5,81	9,16
1971	—6,40	8,98
1972	3,00	7,15
1973	—7,72	0,50
1974	—10,30	—2,17
1975	—5,92	1,79
1976	—9,75	3,49
1977	—2,31	0,64
1978	—12,10	—2,83
1979	0,49	3,81

Source: Own.

TABLE 5

COMPOUND INDEXES GLOBAL PRODUCTIVITY/WAGES AND GLOBAL PRODUCTIVITY/CAPITAL
remuneration per unit

	P_G/W_a	P_G/r_u
	(1964 = 100)	(1964 = 100)
1964	100	100
1965	85,42	80,75
1966	81,26	87,00
1967	74,25	116,27
1968	67,92	127,74
1969	63,62	133,71
1970	45,02	166,84
1971	46,80	146,43
1972	42,41	140,24
1973	37,89	132,77
1974	28,65	170,43
1975	26,45	139,31
1976	24,01	174,75
1977	19,16	145,31
1978	16,88	165,91
1979	14,82	208,64
1980	15,40	222,39

P_G/W_a = Relative index-agricultural global productivity/average agricultural wage
r_G/r_u = Relative index-agricultural global productivity/capital remuneration per unit
r_u = (Net agricultural surplus)/(Agricultural capital)$_{n-1}$; in current Pesetas

Source: Own.

TABLE 6

MECHANIZATION INDEXES: Historical series of HP per 100 plowed hectares

Years	All motor machines	Tractors and cultivators only
1950	1,9	—
1955	4,2	7,7
1960	9,9	14,9
1961	12,5	17,9
1962	16,9	22,7
1963	21,5	27,9
1964	25,4	33,0
1965	30,0	38,7
1966	35,7	45,7
1967	42,1	53,6
1968	48,7	62,2
1969	56,0	71,3
1970	59,8	75,9
1971	63,9	80,6
1972	71,2	89,1
1973	79,9	99,1
1974	89,2	109,9
1975	98,2	120,5
1976	107,8	131,4
1977	116,8	132,1
1978	125,5	150,7
1979	136,2	162,4
1980	149,1	176,6
1981	156,7	184,7
1982	155,3	187,5
1983	168,8	195,6

Source: Dirección General de la Producción Agraria (MAPA, 1983 p. 597) and (MAPA, 1984b p. 71)

TABLE 7a

TRACTORS, CEREAL COMBINE HARVESTERS AND IRRIGATION ENGINES: Historial series of stock at December 31 of each year registered in the Delegaciones Provinciales de Agricultura

Years	Tractors		Motor cultivators		Cereal combine harvesters		
					Self-propelled		Drawn
	Number	HP	Number	HP	Number	HP	Number
1945	59	—	—	—	—	—	
1950	12.798	75.000	—	—	—	—	—
1955	27.671	858.311	503	3.633	210	10.219	732
1956	32.402	1.037.387	552	4.179	266	13.172	983
1957	35.752	1.165.474	706	5.417	360	17.513	1.261
1958	40.680	1.348.825	1.122	8.257	793	33.243	1.916
1959	47.083	1.601.619	1.583	11.247	1.243	52.361	2.667
1960	56.845	2.004.849	2.273	16.823	1.937	88.857	3.028
1961	71.077	2.562.858	3.330	22.495	2.600	118.245	3.181
1962	92.755	3.488.887	5.926	37.490	3.409	155.584	3.296
1963	114.410	4.415.112	10.171	66.073	5.364	253.008	3.530
1964	130.132	5.117.158	15.283	96.967	8.823	404.791	3.746
1965	147.884	5.943.892	21.951	143.109	11.509	583.676	3.539
1966	169.187	6.993.260	30.617	212.203	14.593	768.058	3.837
1967	191.385	8.109.339	41.069	304.823	18.371	1.022.262	3.923
1968	213.299	9.264.763	52.379	417.306	22.518	1.351.980	4.012
1969	239.544	10.585.111	63.187	524.619	25.769	1.629.848	3.951
1970	259.819	11.641.916	72.267	619.153	27.966	1.833.486	3.630
1971	282.371	12.795.542	82.467	728.183	30.096	2.039.265	3.835
1972	306.189	14.148.069	96.531	928.742	31.798	2.202.007	3.767
1973	330.459	15.595.979	112.675	1.175.070	33.122	2.351.391	3.850
1974	355.554	17.183.668	129.603	1.448.105	34.611	2.510.118	3.724

TABLE 7a (Continued)

Years	Tractos		Motor cultivators		Cereal combine harvesters		
					Self-propelled		Drawn
	Number	HP	Number	HP	Number	HP	Number
1975	379.070	18.718.534	148.201	1.736.064	36.140	2.749.544	3.534
1976	400.928	20.259.968	163.925	2.018.996	37.705	2.965.521	3.513
1977	421.393	21.738.488	181.057	2.323.802	39.087	3.149.378	2.950
1978	455.675	23.653.626	193.669	2.497.120	40.176	3.291.582	3.192
1979	491.595	25.710.886	206.434	2.663.928	41.488	3.439.919	3.181
1980	523.907	27.730.943	220.532	2.834.983	41.568	3.587.974	—
1981	548.080	29.116.527	230.841	2.989.280	42.361	3.694.839	—
1982 (avance) (1)	562.626	30.017.810	230.964	2.942.085	42.691	3.715.811	—
1983 (avance) (2)	593.000	31.785.000	247.000	3.207.000	44.000	—	—

(1) Does not include data on the Basque Country from February, 1982.
(2) Figures made up to thousands.

Years	Irrigation engines			
	Internal combustion		Electric	
	Number	HP	Number	HP
1955	63.210	368.619	16.752	144.178
1956	65.427	384.818	17.143	149.811
1957	72.636	449.925	17.913	157.425
1958	77.233	474.240	18.540	161.164
1959	82.683	504.999	19.439	166.705
1960	87.248	528.019	19.855	168.735
1961	93.798	564.986	20.238	170.791
1962	100.242	602.107	20.340	170.278
1963	106.739	638.330	20.650	173.025
1964	111.728	671.640	21.078	180.708
1965	118.427	711.818	21.460	194.217
1966	125.518	752.041	21.654	196.191
1967	132.228	797.431	22.097	199.574
1968	138.302	845.157	22.364	203.125
1969	143.402	907.332	22.534	206.055
1970	148.921	970.916	22.097	208.488
1971	153.538	1.025.145	22.604	211.228
1972	158.992	1.098.276	22.829	212.200
1973	163.205	1.184.453	22.684	212.920
1974	169.403	1.293.432	22.648	213.531
1975	173.584	1.424.474	22.731	215.933
1976	173.972	1.437.236	22.797	218.159
1977	174.613	1.490.309	22.736	218.393
1978	174.394	1.513.946	22.622	221.253
1979	171.546	1.583.071	22.674	222.301

SOURCE: Dirección General de la Producción Agraria (MAPA, 1983 p. 595) y (MAPA, 1984a p. 71).

TABLE 7b

TRACTORS AND COMBINE HARVESTERS:
Registrations in the Provincial Offices of Agriculture over the last years

Years	Tractors				Motor cultivators	Cereal combine harvesters
	Wheeled		Tracked	Total		
	Domestic	Imported				
1967	17.735	3.815	981	22.531	—	3.906
1968	20.191	3.648	1.080	24.919	—	4.438
1969	25.960	4.379	1.858	32.197	10.580	3.581
1970	20.456	2.853	1.616	24.925	9.289	2.611
1971	20.751	2.855	1.685	25.291	10.532	2.620
1972	22.852	3.085	1.857	27.794	15.042	2.127
1973	25.147	3.292	1.633	30.072	17.362	1.862
1974	25.024	4.437	1.867	31.328	18.958	1.870
1975	34.369	4.595	1.689	30.633	19.640	2.408
1976	23.935	4.512	1.687	30.134	18.889	2.293
1977	25.277	4.019	1.481	30.777	19.814	1.870
1978	31.639	4.408	1.358	37.405	14.987	1.615
1979	26.726	7.819	1.377	35.922	13.748	1.311
1980	22.579	9.600	1.281	33.640	14.269	1.492
1981	16.349	5.508	829	22.686	11.789	1.013
1982 (1)	16.063	4.717	874	21.654	10.653	794
1983	15.821	3.955	881	20.657	9.651	709

Source: Dirección General de Producción Agraria (MAPA, 1983, p. 597) and (MAPA, 1984a, p. 71).
(1) Does not include data on the Basque Country from February, 1982.

TABLE 8

AGRICULTURAL MACHINERY: Census at September 1 over the last years

Type of machinery	1977	1978	1979	1980	1981	1982
PLOWING EQUIPMENT FOR TRACTOS						
Subfloorers	33.567	34.402	38.857	44.589	46.998	46.228
Mouldboard or disc plows	341.536	344.579	363.296	378.331	386.619	393.242
Millers	48.582	55.577	59.654	67.991	71.953	73.493
Harrows	167.813	168.986	180.427	192.646	193.314	196.642
Cultivators	263.389	270.178	292.073	308.345	315.019	325.291
SOWING, FERTILIZING AND PROTECTION EQUIPMENT (for tractors or self-propelled machines)						
Cereal and pasture plants sowers ...	124.686	117.678	133.672	138.641	139.026	140.622
Corn, cotton, beet, etc, sowers	24.880	24.886	25.035	25.943	30.317	29.364
Manure spreader	25.448	6.479	30.495	32.517	31.933	34.490
Fertilizer spreading machines	112.194	111.173	130.023	131.025	136.211	138.645
Pulverizers and sprayers (excluding backpack manual sprayers)	106.145	110.766	129.541	127.257	135.347	139.997
HARVESTING EQUIPMENT (for tractors or self-propelled machines)						
Mowers (forage reaping)	40.019	44.746	45.219	53.124	51.616	52.431
Harvester-Bailing Machines	26.401	28.122	32.689	36.675	38.048	40.603
Forage combine harvesters	5.027	5.175	5.644	5.864	6.704	6.860
Binder-reaping machines	27.902	24.349	23.535	22.123	19.437	19.493
Cob harvesters	794	815	856	892	873	891
Beet lifters	5.303	5.828	6.625	8.162	8.678	9.439
Beet harvesters	1.523	1.606	2.165	2.160	2.033	2.147
Potato lifters	9.075	17.079	12.242	13.671	13.884	14.573
Potato harvesters (bagging machine)	438	581	1.594	758	675	788
AUXILIARY EQUIPMENT						
Farming engines excluding irrigation engines						
Internal combustion	29.116	28.511	49.181	31.723	37.453	30.786
Electric	35.938	34.548	36.929	38.630	37.308	37.827
Mechanical tractor loaders	16.704	16.998	25.021	24.365	26.974	28.680
Farming vehicles	341.931	321.532	296.007	288.595	278.352	264.791
Tractor wagons	331.176	347.212	379.574	407.872	414.518	424.787
Mechanical grain elevators	52.618	52.186	62.734	65.444	67.116	69.215
Mechanical ensilagers	2.711	3.092	3.341	4.000	5.018	5.146
Treshers	14.276	15.476	11.176	10.481	10.737	10.130
Fodder mills	43.911	48.086	52.993	59.306	64.726	69.423
Mechanical milkers	54.841	62.306	71.161	78.929	88.895	96.063
Mechanical sheepshearers	4.109	4.138	11.720	6.921	6.016	7.384
Mechanical saws	62.442	69.583	82.867	95.927	113.885	123.763
SURFACE IRRIGATED BY SPRAYING (hectares)	423.286	406.839	503.110	502.655	570.751	600.366

Source: CM 1982 Questionnaires (MAPA, 1983, p. 596)

TABLE 9

MECHANICAL TECHNOLOGY

YEARS	1972	1976	1980	1982	1983	1984
INDEX	-----	------	------	------	------	------
HP	60,5	100,0	135,3	147,6	152,2	--
L	117,8	100,0	79,2	72,1	72,0	68,8
HP/L	51,4	100,0	170,8	204,7	211,4	--

HP: Power in tractors, motor cultivators and cereal combine harverster.

L : Number od workers ocuped in agricultural sector.

Source: Own

TABLE 10

MACHINERY, INVESTMENTS PRICES AND WAGES

YEARS	1972	1976	1980	1982	1983	1984
INDEX	-----	------	------	------	------	------
Php	--	100,0	209,4	272,7	307,3	347,2
Pi	--	100,0	197,6	250,5	282,4	312,5
Php/Wa	--	100,0	97,1	103,4	106,8	111,0
Pi/Wa	--	100,0	91,6	95,0	98,2	99,9

Php: Machinery prices paid by farmers (MAPA, B.M.E.A)

Pi : Investments prices (machinery, permanents crops and territorials improvements) paid by farmers (MAPA, B.M.E.A)

Wa : Agricultural wages (MAPA, B.M.E.A.)

Source: Own

TABLE 11

CHEMICAL TECNOLOGY

YEARS	1972	1976	1980	1982	1983	1984
INDEX	-----	------	------	------	------	------
F/A	92,4	100,0	116,7	101,8	84,4	102,4
Pf	92,4	100,0	182,8	269,4	293,2	328,2
Pf/Pa	--	100,0	89,3	115,6	114,6	117,4
Pf/Wa	132,7	100,0	84,7	102,1	101,9	104,9

F/A : Fertilizer input in terms of total physical weights of N, P205 and K20 per hectare of agricultural land fertilized (MAPA, 1984a).

Pf : Fertilizer prices (MAPA, B.M.E.A.)

Pa : Agricultural Land prices (MAPA, 1984b)

Wa : Agricultural wages

Source: Own

TABLE 12

BIOLOGICAL TECHNOLOGY

YEARS	1972	1976	1979	1980	1981	1982	1983	1984
	-----	-----	-----	-----	-----	-----	-----	-----
Pal	.75	1,40	1,93	2,10	2,50	2,53	2,70	--
Ppc	62,3	100,0	132,8	146,2	169,7	183,7	227,3	261,5
Pfd	--	--	82,5	86,0	89,3	94,1	100,0	113,8
Pv	.80	1,32	1,66	1,68	1,98	2,17	2,32	--
Ppc/Pfd	--	--	70,8	74,8	83,6	85,9	100,0	101,1
Ppc/Pv	102,8	100,0	105,6	114,9	113,1	111,7	129,3	--
Ppc/Pal	116,3	100,0	96,3	97,5	95,0	101,7	117,9	--

Pal : ₧/Kg alfalfa

Ppc : Feedstuff for cattle. Index 1976=100

Pfd : Fodder land price.Index 1983=100

Pv : ₧/Kg vetch

Ppc/Pfd : Index 1983=100

Ppc/Pv : Index 1976=100

Ppc/Pal : Index 1976=100

Source: Own

TABLE 11

RELATIVE PRICE LAND/LABOUR

YEARS	1972	1976	1980	1982	1983	1984
INDEX	-----	------	------	------	------	------
Pa	--	100,0	204,6	233,0	255,8	279,5
Wa	43,4	100,0	215,7	263,8	287,6	312,9
Pa/Wa	--	100,0	94,9	88,3	88,9	89,3

Pa Agricultural land prices (MAPA, B.M.E.A.)

Wa Agricultural wages (MAPA, B.M.E.A.)

Pa/Wa Relative price agricultural land/labour

Source: Own

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REFERENCES

CAVERO, J. et al. (1976): Estudio sobre el coeficiente capital/empleo en la agricultura española. Madrid. Ministerio de Trabajo.

FANJUL, O. (1977):Cambios en la estructura interindustrial de la economia espñola 1962-1970: una primera aproximacion. Madrid. Fundacion del INI.

HARCOURT, G.C. (1977):"Introduccion general medicion de los inconmensurble" in G.C. Harcurt and N.F. Laing (eds.) Capital y crecimiento. Mexico. FCE.

HARCOURT, G.C. and N.F. LAING (eds.)(1977):Capital y crecimiento. Mexico. FCE.

MAPA (1975): Las cuentas del sector agrario, n@. 1.

MAPA (1980): Cuentas del sector agrario, n@. 5

MAPA (1983): Anuario de estadistica agraia 1982.

MAPA (1985): Anuario de estadistica agraria 1983.

MAPA (1984a): Manual de estadistica agraria 1984.

MAPA (1984b): Encuesta de precios de la tierra. Sintesis metodologica y resultados 1983. Madrid. MAPA.

MAPA (1980-86): B.M.E.A.

MAPA (1986): Manual de estadistica agraria 1985.

MINISTERIO DE INDUSTRIA (1960): Coeficientes de capital en los principales sectores de la industria española. Madrid. Ministerio de Industria.

MINISTERIO DE INDUSTRIA (1980): Los coeficientes de capital-producto y de capital empleo en los pricipales sectores de la industria española. Madrid. Ministerio dd Industria.

ROBINSON, J. (1976):'La medida del capital: fin de la controversia', in J. Robinson. Relevancia de la teoria economica. Madrid. Martinez Roca.

SAN JUAN, C. (1984):La agricultura en la economia española: Capacidad de financiacion, productividad y rentabilidad. Madrid. Editorial de la Universidad Complutense.

SCHULTZ, Th. (1967):Modernizacion de la agricultura. Madrid. Aguilar.

SRAFFA, P. (1960):Production of commodities by Means of Commodities. Prelude.to a Critique of Economic Theory. Cambrige University Press.

VELARDE, J. et al. (1978):La Riqueza Nacional de España. Bilbao. Universidad Comercial de Deusto.

YAMADA, S. and RUTTAN, V.W. (1980):"International Comparisons of Productivity in Agriculture", in J.W. Kendrick and B.N. Vaccara (eds.).New Developments in Productivity Mesurement and Analysis.

Chicago. National Bureau of Economic Reserch.

ABREVIATIONS USED

INI: National Institute of Industry

MAPA: Ministry of Agriculture, Fisheries and Food.

B.M.E.A.: Boletin Mensual de Estadistica Agraria (Monthly Bulletin of Agricultural Statistics)

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