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Prices and productivity in inland Spain during the nineteenth century: a 'sleepwalking' agriculture?

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Summary:

The aim of this paper is to measure the advance of agricultural productivity in the Ebro Basin (South Navarra) between 1780 and 1900. The construction of several indices of agricultural commodities and factor prices allows us to apply the methodology of Total Factor Productivity (TFP). As distinguished from the thesis of stagnation, our estimate of the annual rate of TFP growth between 1786 and 1900 is close to 0.3%. This rate was particularly high between 1815 and 1830, when it rose to 3 percent. The results strengthen the case for an optimistic interpretation of the performance of Spanish agriculture during the nineteenth century.

Keywords: Total Factor Productivity, Agriculture, Prices, Spain, Nineteenth Century

JEL Codes: N53, N13, N93, Q11, R11, R32

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I. Introduction

A ‘sleepwalking’ agriculture? What is the reason for such a strange sub-heading? Those familiar with the literature on the history of the Spanish economy will have immediately understood the purport of the question. The title that James Simpson chose for his 1995 book, *Spanish Agriculture: The long Siesta, 1765-1965*, expressively summarizes his thesis. In this book, Simpson breaks away, albeit in part, from traditional interpretations of the backwardness of Spanish agriculture and its role in blocking modern economic growth. Against the pessimistic theses of Nadal (1973) and Tortella (1984), it echoes the more optimistic arguments of Grupo de Estudios de Historia Rural (1983), Garrabou y Sanz (1985), and Prados de la Escosura (1988), confirming the striking production and specialization growth of Spanish agriculture. This break with the historical paradigm is, however, only partial since, in Simpson’s opinion, the productivity growth of this sector, especially the productivity of labor, was very poor up to the 1950s. In this prolongation of the pessimistic theory, Simpson states that, in contrast with northern Europe, the growth of Spanish farming activity, especially during the nineteenth Century was basically of the extensive type.

This study examines this thesis from a regional viewpoint, using for the purpose an approximation to total factor productivity (TFP) through price-related factors tested by Hoffmann (1991) (1996) or Sutherland (2002) for the case of France, and by McCloskey (1975), Crafts (1985) or Allen (1992) for that of Britain. This is not the first time this method has applied to the Spanish case (Coll & Bringas, 2000) (Bringas, 2000: 151-159), but it is the first time it has been done using annual series with a high degree of homogeneity and reliability.

The method underlying this approximation to TFP using prices and the assumptions behind are explained below. Further on, the construction method for price and cost indexes will be shown, ending in the presentation of the TFP curve. Lastly, results will be contrasted with those from other more direct calculation methods to check their credibility.

II. The approximation to total factor productivity by prices

Total Factor Productivity (TFP) is an idea deriving from hypotheses formulated by Solow in the 1950s. Widely used among economists, it was used later and in a more limited way by economic historians, and many question its usefulness, proposing other alternative indicators (Federico, 2005: 74-75). In part, it is criticized for its own residual methodology nature in a production function of the Cobb-Douglas type. Thus it has been shown that despite the habitual association of this residual feature with technological change and production efficiency, there are many other factors, some as random as climate, that can influence its development. It has also been argued from a Schumpeterian point of view, that this type of measure does not adequately reflect product innovation and, generally speaking, the qualitative changes that influence growth. From a Marxist viewpoint, this methodology has been shown to make sense only within a certain historical context, that of free-market capitalism, under which land, labor and capital are presented as socially differentiated factors. Ecological economics, for its part, has pointed out the limitations of this methodology when calculating the environmental costs of growth, whose negative impact on living standards should not be minimized (Burkett, 2006).

There is no purpose in explaining in detail the mathematical logic underlying our reasoning, since this has already been done thoroughly by other authors.[1] We will only point out that all our detailed calculations overlie a relatively simple insight: greater productivity –producing more with less – also implies producing at lower cost. In farming terms, lower production costs can be initially translated into higher profits for the most productive farmers, but will eventually lead to either higher profits for landowners, higher wages for farm workers, higher returns on farming capital, or lower prices for consumers. Granting the foregoing, it would be possible to deduce total productivity levels from the factors of the relationships between rents, wages and prices.

However, there are some implicit assumptions that should be examined. One of these consists of considering the market to be the main resource allocation

[1] The equation has the following formula:

$$TFP= w_1^{v1}... w_n^{vn} / p_1^{u1}\ldots p_m^{um}$$

Where p_i represents the prices of each of the products, and u_i the share of each in the total added farming value; w_j represents the price of each factor; and v_j the share of each factor in total cost. (Hoffman, 1996: 84-86)

mechanism, as well as the fact that it is a competitive market in which marginal income and marginal costs are equal. Another consists of thinking that both the proportional composition of the product and its total cost do not change over the period considered.

In fact, there is no doubt regarding the market's role in allocating resources in the case of the mid-valley of the Ebro. If our valuation is done from the point of view of the destination of the product, it is true that part of the harvest is destined for own consumption (as human food, seed or livestock feed), but production for marketing was a fact, even among smallholders, who showed an inclination to plant vineyard as a strategy to optimize their capital and labor force. Much the same can be said from the viewpoint of production factors. It is true that part of the labor requirements were satisfied through the use of family members, but the hiring of piece-workers was regularly and generally resorted to, and labor reserves were abundant as may be seen from the analysis of land-ownership distribution. Moreover, the real estate market showed great activity, more in land rentals than in purchase and sale. In global terms, a little over one third of the available farmland was placed under short-term rental contracts.

The basic question is whether the operation of these markets was sufficiently flexible and transparent to allow prices to reflect the marginal utility of the produce. Historical literature has pointed out the distortions that Ancient Regime institutions ('mortmains' and entailments, fixed maximum prices,…) introduced in the operation of markets. From the viewpoint of product sales, Navarre also shows some exceptional features, such as the geographical restriction of the market arising from the double customs protection separating this kingdom from those of Castile and Aragon until 1841. Likewise, we have the rigid trading policy adopted by the *Cortes*, limiting exports of grains and imports of wine and oil. Additionally there were restrictions on free domestic circulation of wheat and a rigid control of local markets, maintained up to the *Cortes* of 1817-18. These same *Cortes* in 1818 decreed the suppression of workers' fixed wages, thus freeing labor markets, something that had already happened in Castile in 1767. In any case, the liberalization of product markets and factors is an irreversible fact as from 1840.

Lastly, this methodology assumes the stability of the composition of both products and production costs. It is an arbitrary assumption for calculation purposes, since

we cannot know how the amounts produced and consumed vary. Despite the fact of certain relatively important changes in product composition as from the end of the eighteenth Century, such as the popularization of new crops (mainly potatoes but also beet and fodder crops) or the increase of traditional ones (such as vines, olives and maize), I believe that adopting this criterion is not unrealistic. As for production costs, no significant changes appear to have occurred in view of the level of technology we found at the beginning of the twentieth Century.

In summary, in order to calculate the TFP we should have the annual price series for different products and production factors, as well as the corresponding matrixes for product composition and total production cost coefficients. For the first task we have mainly used accounting sources: family assets accounts that have enabled us to reconstruct merchandise price series, wages and rents, ecclesiastical corporation accounts to complete the former during the period prior to *desamortización* or freeing from mortmain, municipal accounts to reconstruct organic fertilizer series, and civil entity accounts such as those of the *Hospital de Tudela*, the *Casa de Misericordia de Pamplona* or the *Ramo de Carnicerías* (Public Butchery) for different towns, which have also been used to complete some of the series.[2]

[2] For this exercise we have combined a wide number of sources, which are detailed in an annex to this paper. Together with the accounts of the marquises of San Adrián (1795-1900) and the count of Zaldívar (1862-1873; 1884-87; 1891-93; 1900-06; 1911-19; 1924-26), we have also taken some of the annual accounts of the marquisate of Sartaguda (1831-48; 1851-59), and of the Arteta family in Corella (1822-50), the Jiménez de Cascante lineage in Tudela and Cascante (1820-47), as well as the accounts of the Fitero (1783-1807; 1814-19; 1823-34), La Oliva (1814-19; 1823-34) and Tulebras (1829-36) monasteries, of corporations such as that of the *Hospital de Gracia de Tudela* (1780-1843) and the *Casa de Misericordia de Pamplona* (1781-1905), and from the public butchers' markets of Pamplona, Villafranca, Arguedas and Tudela.

III. Manufacturing the numerator: a farming price index for Navarre

Using the above-mentioned accounts we have constructed a set of farm produce price series, but the type of source we have used involves a certain bias that should be explained. Firstly, we have largely taken wholesale prices, producer sales prices, which do not include distribution or tax costs. This is not a problem for the purpose of this study, since these are the prices that specifically interest us. Secondly, the level of aggregation that we use takes the year as a reference, since it is hardly feasible to reconstruct other kinds of levels (daily, monthly, seasonal) using these kinds of sources. Thirdly, we use a time unit that does not coincide with the calendar year or the farming year, but rather with the accounting year, whose exact limits may vary from one balance sheet to another. Lastly, facing the option of collecting all the prices mentioned in one year for a certain article in the accounts ledger so as to estimate a median annual price, we have preferred to calculate a weighted average price by dividing the amount obtained by the quantity of the product sold. In summary, the series we present here should be understood as annual series per financial year of weighted wholesale prices.

Our question is: what are the goods that should form part of the farming price index, and in what proportion? Luckily we can consult three major surveys of farming production dating from the beginning, the middle and the end of the century.[3] Results are summarized in Table 1. This details the information for the south of Navarre (the area around the city of Tudela), the origin of most of the series that we present, since the relative weight of olive oil and wool is markedly higher there than in the area as a whole. Additionally we find that product structure is very similar here at the beginning and midway through the century, although there are some interesting features, such as the drop of the relative weight of wheat, or the introduction in the first half of the century of root crops

[3] Between 1803 and 1807, the *Diputación* (delegated council) of the Kingdom collected copies of the *tazmías* or Tithe Records from all the villages and settlements, in order to calculate the total production figures for the Kingdom. In 1811, the French government used the results of this survey, organized by the official Jean-Baptiste de Rancy, to share out the territorial tax burden. At mid-century the Ministry of *Fomento*, through its *juntas provinciales de agricultura, industria y comercio*, and the General Statistics Department attempted to draw up a census of farming production in the country, distributing a lengthy survey in 1857, whose results would later be discredited as unrealistic. In Navarre, the Secretary of the Provincial Committee, Florencio Sanz Baeza, completed and validated the figures on his own initiative, publishing his findings in book form (Sanz Baeza, 1858). In the last decade of the century, the work of the engineers of the *Junta Consultiva Agronómica* finally consolidated a statistical series of areas and production volumes that Domingo Gallego took on himself to validate and edit (Gallego, 1986: 1026).

and fodder crops. The 1910 figures increase the weight of livestock and forestry production, and reflect the crisis of the Phylloxera epidemic in vineyards.

Table 1: Gross farming production in Navarre in 1803-07, 1857 and 1910, valued at each year's prices (data in pesetas = pts)

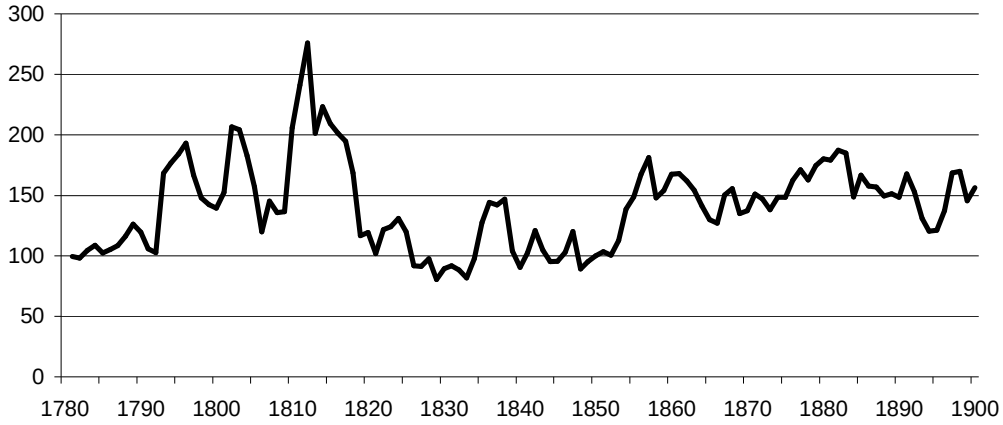
	South Navarre 1803-07		Navarre 1803-07		Navarre 1857		Navarre 1910	
	Pts (10^6)	%	Pts (10^6)	%	Pts (10^6)	%	Pts (10^6)	%
Wheat	0.95	36.2	8.54	39.8	16.89	32.4	36.98	32.0
Other cereals	0.30	11.5	3.23	15.1	7.41	14.2	11.09	9.6
Legumes	0.11	4.2	0.91	4.2	2.39	4.6	4.91	4.2
Plants for textiles	0.17	6.5	0.64	3.0	1.09	2.1	1.65	1.4
Roots and tubers	0	0	0	0	0.86	1.7	8.79	7.6
Fruit and vegetables	0	0	0.36	1.7	1.14	2.2	9.64	8.3
Wine and by-products	0.42	16.3	4.31	20.1	10.39	20.0	4.08	3.5
Olive oil	0.37	14.2	0.92	4.3	2.08	4.0	1.22	1.0
Fodders	0	0	0.00	0	2.78	5.3	3.37	2.9
Crops	2.32	88.9	18.91	88.2	45.04	86.5	82.35	71.4
Meat	0.13	5.0	1.08	5.0	5.02	9.6	13.18	11.4
Wool	0.16	6.1	1.02	4.8	1.20	2.3	1.84	1.6
Dairy and eggs	0	0	0.03	0.1	0.32	0.6	10.01	8.7
Livestock products	0.29	11.1	2.13	9.9	6.54	12.5	25.17	21.8
Forestry products	0	0	0.39	1.8	0.52	1.0	7.86	6.8
Total	2.61	100	21.43	100	52.08	100	115.38	100

The production from the area around Tudela and the total area of Navarre in 1803-07 is valued at the regular prices estimated in 1811 by French officials. The production in Navarre in 1857 and 1910 is valued at prices in the respective years.

Sources: AGN, Reino, Estadística, dossier 49; Sanz Baeza (1858: 83-95); Gallego Martínez (1986: 1026-1027).

Given this production structure, having the price series for eight farming products –wheat, barley, kidney beans, wine, olive oil, beef, mutton and rough wool – enables us to cover 90 percent of the production. Bearing in mind that our interest is centered on multiple Mediterranean-type crop growing in Navarre, which is where most of our series are taken from, the weighting used is inspired by the production structure of South Navarre at the beginning of the nineteenth Century. If we ignore some irrelevant production items, index composition will be established as follows: wheat (0.37), barley (0.13), kidney beans (0.05), wine (0.17), olive oil (0.15), beef (0.02), mutton (0.04) and wool (0.07).

Figure 1. Farming price index in the south of Navarre, 1781-1900 (1850=100)



When we combine these prices in the respective proportions in a Laspeyres index, we obtain a curve similar to that of Figure 1. This is a familiar scenario: first an inflationary spiral from the last third of the eighteenth Century, worsened by the wars against the French Convention (1793-96) and the Napoleonic occupation (1818-14) and by the poor harvests (1788, 1803-04, 1811); second, a deep deflation in the post-Napoleonic War era, touching bottom (1829, 1833) on the eve of the first Carlist War (1833-39), followed by a short inflationary cycle caused by that conflict after which the 1780s price level was recovered, with some price rises in 1842 and 1847; and lastly strong price increases as from 1854, coinciding with the gold rush and the expansion of international trade, as from which moment the curve reaches a permanent plateau, despite the deflationary trends of 1860 and 1880-90.

IV. Manufacturing the denominator: a farming production cost index for Navarre

We should proceed likewise with the denominator: What share should be allotted to each of the factors within production costs? The most reliable and complete sources to answer this question are the valuation sheets prepared by the engineers of the *Diputación Foral* (regional government) cadastre service in the first years of the twentieth Century.[4]

Table 2 summarizes the results obtained from a sample of these sheets, restricted to the south of the Province. The source has enabled us to differentiate composition from production cost in 21 different types of crops, both dry cultivation and irrigation-based. From these proportions, and bearing in mind the cultivated area of the south of Navarre around 1905, we have calculated a weighted average that we can take as the basis for building the factor price index. In short, median production costs include 19 percent for land rental, 35 percent for labor, another 19 percent for animal work power, 8 percent for seeds, 8 percent for fertilizers, 2 percent for irrigation water, and the remaining 9 percent for miscellaneous expenses such as storage, guarding, product transformation, wear and tear of equipment and risks.

According to these results, we can propose the following composition of expenditure: land rental (0.22), wages (0.39), animal work power (0.21), seeds (0.09) and fertilizers (0.09). To reconstruct any one of these series is not a complicated matter, such as in the case of seeds, for which we use wheat's own price series, included in the numerator. The wages series requires greater specification. Here we choose the day laborer series, for unspecialized farm workers with an eventual contract, and forego the inclusion of women's, children's and servant's wages. We have tried to maintain the homogeneity of the series by rejecting the summer wages related to the reaping cycle that used to represent the annual maximum wages, partly due to the extended 'sunrise to sunset' workday, and partly due to the higher skill level required.[5]

[4] The problem is that these sheets reflect the concrete production models that were in force at the beginning of the twentieth Century. Nevertheless, they can be extrapolated to the nineteenth Century, in view of the overwhelming preponderance of manual labor procedures and poor level of technology inferred from the tools and equipment described. In regard to this source, private accounting figures are biased in different ways, reducing their usefulness: the assets management model with direct administration of vineyards and olive groves and renting out of grain cropland provides good data for the former, but poor data in the latter case.

[5] The non-monetary component of wages, reduced to a jug of wine per farm worker, has been expressed in monetary terms using the price series for cheap wine. For further details, see Lana (2007a).

Table 2: Participation of the factors in cultivation costs in the south of Navarre, 1905

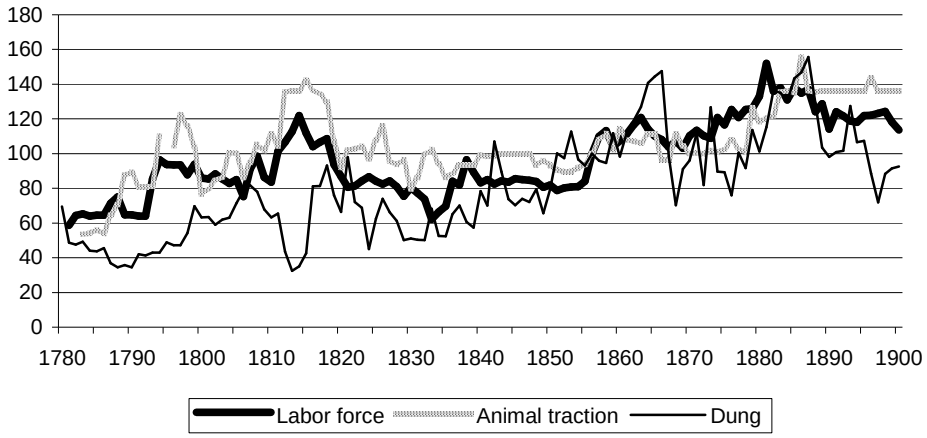
	1 Rental %	2 Wages %	3 Wages %	4 Traction %	5 Seeds %	6 Fertilizers %	7 Water %	8 Others %	9 Total Cost Pesetas/Ha
Market Garden	22.7	34.2	1.7	4.1	11.4	21.3	2.2	2.4	1141
Peppers	9.7	35.0	0.8	5.7	24.4	20.4	1.6	2.5	1435
Hemp	21.4	35.8	0.0	10.7	8.0	21.4	0.2	2.4	1040
Potatoes	20.4	30.5	1.5	8.3	17.6	16.0	1.7	4.1	765
Artichoke	19.4	38.7	5.2	4.6	7.0	19.4	3.2	2.5	716
Sugar beet	15.5	33.1	5.9	25.1	0	14.3	3.5	2.6	534
Alfalfa	29.6	28.1	0.0	10.6	2.1	14.8	2.6	12.2	530*
Kidney bean	20.3	33.0	4.1	8.1	23.8	3.9	3.6	3.2	467
Maize	21.7	25.4	1.4	27.6	1.7	11.9	5.8	4.4	449
Broad bean	31.9	27.1	1.8	7.6	8.2	15.9	3.8	3.6	439
Irrigated Wheat	24.4	23.6	1.2	24.2	10.4	5.3	4.0	6.9	416
Irrigated Barley	28.1	23.4	1.2	23.6	6.8	6.4	3.6	6.9	386
Irrigated Oats	24.2	25.7	1.4	29.5	5.2	0	5.7	8.2	322
Dry wheat	2.6	32.7	0.3	37.3	21.3	0	0	5.8	148
Dry Barley	3.4	34.3	0.4	41.5	13.4	0	0	7.1	132
Dry Oats	2.6	34.6	0.4	44.8	10.4	0	0	7.1	129
Irrigated Olive groves	25.7	37.7	0.1	11.5	0	7.5	1.4	16.1	328
Dry Olive groves	22.4	32.9	0.3	15.8	0	11.4	0	17.2	190
Irrigated Vineyards	26.6	37.9	0.0	6.5	4.5	9.0	2.1	13.5	317
Dry Vineyards	21.3	47.4	0.0	5.0	6.5	6.6	0	13.1	200
Root stock plantations	1.9	34.1	1.0	19.5	14.7	25.9	0	2.8	429*
Weighted average	19.0	34.0	0.9	18.8	8.4	8.2	1.8	8.9	189

(1) Land rental; (2) Male wages; (3) Female wages; (4) Dray animals; (5) Seeds and seedlings; (6) Fertilizers and agrochemicals; (7) Irrigation water; (8) Others (storage, guarding, processing, equipment wear and tear, risks); (9) Total cost in pesetas per hectare.
For the weighted average calculation surfaces for each of the crops in 1905 were used.
*.- Six-year average for alfalfa; Three-year average for vineyard plantations.
Source: Evaluation sheets prepared and signed by agricultural engineer Florencio Roldán for Tudela (10-24-1905) and Cascante (8-31-1906), AGN, DFN, *Cadastre*, cjs.16133-16151
In the case of vineyards, we have taken the 1890 evaluation sheets of Fustiñana, Tulebras, Ribaforada, Murillo el Cuende, Murillo el Fruto and Milagro. AGN, DFN, *Cadastre*, cj. 16.131

These same accounting sources enable the detailed reconstruction of expenditure on animal dray labor, since it was common practice to hire mule teams or yokes of oxen on the market in exchange for a daily payment. This is a good indicator of agricultural equipment costs, since the amount charged remunerated the total expense of the yoke, the animals, the feed, the veterinary charges, shoeing and shearing, harness, gear, dray items and the wages of the worker in charge of the yoke. In order to obtain the purest possible series we have selected the data on the simple daily wages for mule teams, rejecting asses and oxen, as well as yokes composed of three or more animals and data on individual dray horses. We have also taken the precaution of discounting the wages of the worker associated with the dray team from the dray capital remuneration.

Constructing the fertilizer cost series was more difficult. Although we observed the use of chemical fertilizer and guano on the southern Navarre farms as from the 1880s, up to well into the twentieth Century, basic fertilization techniques used organic fertilizers. Accounting documents are full of references to purchases of dung. Nevertheless, this type of information is hard to use systematically due to discontinuity of data and ambiguity of the units of measurement involved. An alternative method, and safer from the viewpoint of series continuity, is taking the dung purchase records on municipal accounts for the public corrals and vacant pasture lots. As these purchases were mainly made in annual auctions, except in the case of the Pamplona butcher, who sold dung on a quarterly basis, the series shows pronounced annual fluctuation. However, for the same reason it is a series that is plainly subject to market rules and sensitive to agricultural factors. [6]

Figure 2. Evolution indexes for labor, animal traction and fertilizer prices (1856=100)



We have left the land rental series to the last. From private accounts, we have prepared eight rental series in specie per unit of surface for the districts of Corella (1795-1874), Monteagudo (1800-1900), San Adrián (1823-1900), Tulebras (1841-1900), Cortes y Buñuel (1858-1888), Sartaguda (1831-43; 1847-48; 1851-59), Hospital de Gracia de Tudela (1780-1843) and Monasterio de La Oliva (1815-

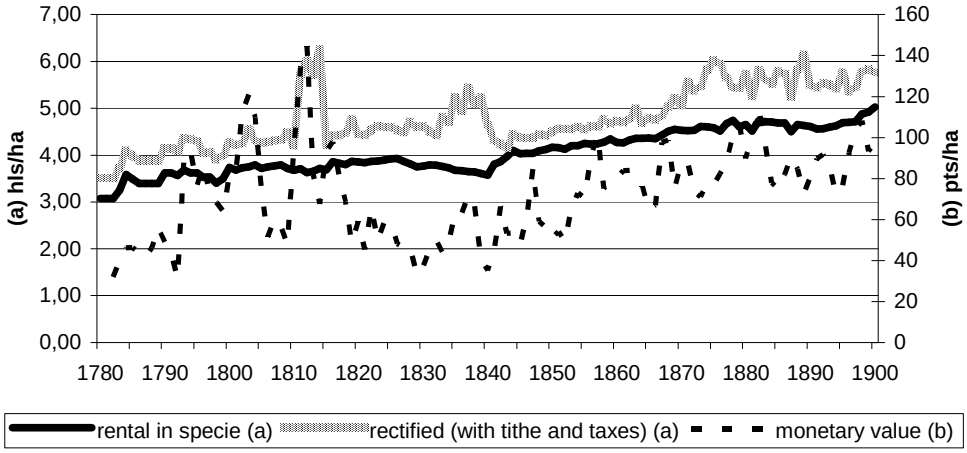
[6] Rental figures have been collected for corral contracts in the municipalities of Villafranca, Carcastillo, Arguedas, Cortes, Mélida and San Adrián as from 1836, and the period prior to 1836 has been covered by using the figures from rental of the corrals of the Public Butchery of Pamplona (up to 14 in number and divided among different periods) and by the account books of Villafranca town council. So as to obtain a homogeneous series from such heterogeneous information (many rentals are limited to only a few years or show a diversity of areas and values that make them unsuitable as sources for calculating realistic averages) the 69 series have been converted into annual shares of increase refered to medium value of each serie. Then the average of these increases has been calculated in order to construct an index of evolution. A problem with this series is that the lessee of the dung might not be the actual user of it, so the prices quoted would not be final user prices, but rather prices to retailers.

1834). These eight series of varying importance, due to soil quality differences, have been transformed to common-based index numbers and later reconverted to wheat values, taking as a reference the average value in 1870.

Figure 3 reflects the development of this series and of its expression in monetary terms, the wheat price series having been used for conversion purposes. The rental series in specie shows the exhaustion of rental increases over the last decade of the eighteenth Century, although the movement of wheat prices prolonged rental increases in monetary terms up to the fall of the Napoleonic Empire. A futile attempt was made to mitigate the post-war price drops with some rental increases in specie, although over the 1820s rentals tended to fall, eventually collapsing during the years of the first Carlist War. Subsequently, in order to compensate for the final suppression of the tithe system and the establishment of a new fiscal order, land rentals began to rise steadily, both in terms of grain and monetary value. The plateau observed between 1841 and 1843 corresponds precisely to the suppression of the tithe system, which had been used up to that time by the farmers. As from that moment, the value of the tithes was incorporated to the rentals collected by the landowner, who in this area, generally undertook to make fiscal payments to the government. These increases stopped around 1880, and rentals began to drop in both wheat and cash terms. The farming crisis thus began to become visible, although the movement of the curve over the last few years of the century indicates a relegation of the phenomenon known as the '*grande déroute des rentiers du sol*'.[7]

Figure 3. Average land rentals in the south of Navarre, 1780-1900

[7] Désert (1976: 374-378); Robledo Hernández (1984); Turner, Beckett & Afton (1997: 248-252). See the generalized viewpoint of Garrabou (1988).



The rental series would be incomplete had we not incorporated to the soil rental series the tax burdens that competed with soil rental as profit absorption mechanism. We refer to the tithes and to the government taxes. In the case in point, the latter adopt the form of: a contribution to the Crown (*donativo*) approved by the Kingdom's *Cortes* at their meetings in 1801-02, 1817-18 and 1828-29, the *contribución foral* or quota paid to the government by Navarre according to the Law of August 18, 1841, the *Culto y Clero* (clergy and worship) contribution in place of the tithe, and lastly, the extraordinary 'war taxes' of 1808-14, 1833-39 and 1873-76.

In the case of the tithe, a burden in proportion to the size of the harvest, proper reconstruction would imply the knowledge of the annual development of farming production. Failing this, we can adopt the same criterion as was used for decanting owners when the suppressed tax was incorporated to the rental value of the land. Thus, the property administrator of the Goñi family warned in 1842: '*El aumento que se observa en este año y se observará en los siguientes en las rentas de 2 almudes en cada robo de trigo proviene de la supresión del Diezmo, que antes pagaban íntegro los inquilinos y ahora pagan en su mayor parte los propietarios en la contribución de culto y clero sustituida al diezmo*'('This year's increase, which may be observed in subsequent years in the rental of 2 *almudes* for each *robo* of wheat is due to the suppression of the Tithe, which was formerly paid in full by the tenants and is now mostly paid by the landowners within the contribution for *Culto y Clero* that has taken the place of the tithe')[8]. The two

[8] A.G.N., Arteta, folder 16, file 49, year 1842.

almudes per *robo* of wheat are the equivalent of 12.5 percent, or the amount commonly used for the tithe (10 percent) plus the 2.5 percent of the *primicia* (first fruits paid to the Church). Consequently, we increased the rentals paid in specie by this percentage in the years prior to 1841.

For government taxation purposes, we will take as a guide the fiscal contributions paid by the marquises of San Adrián in their administrations in the Valley of Queiles during the nineteenth Century (Lana, 2007b: 33). Striking points are the fact that direct government taxation is discontinuous in Navarre during the Ancient Regime, the fiscal severity of taxation during the war-torn periods of 1808-14 and 1833-39, and the regularizing of taxation after 1840, with a strong stepping up of fiscal pressure as from 1868. We have used the indicator of taxes paid in proportion to gross income for these assets to rectify the land rental series, increasing it by the respective proportion (by around 10 percent between 1840 and 1870 and by around 20 percent from that date to 1900).

The corrected land rental series, including tithes and government taxes, is reflected in Figure 3. Together with a greater visibility of the war cycles, especially that linked to the Napoleonic occupation, the rental curve in specie neutralizes the 1840 decade jump and stresses the rising trend during the last third of the century.

V. The total factor productivity curve

Having assembled all the necessary materials, we are finally able to apply the total factor productivity equation. The results may be observed in Figure 4, which also shows the evolution of the farming product price index and that of production costs. All of these series are expressed in mobile five-year averages, calculated as from the index numbers whose 100 percent value was set at the year 1856.[9]

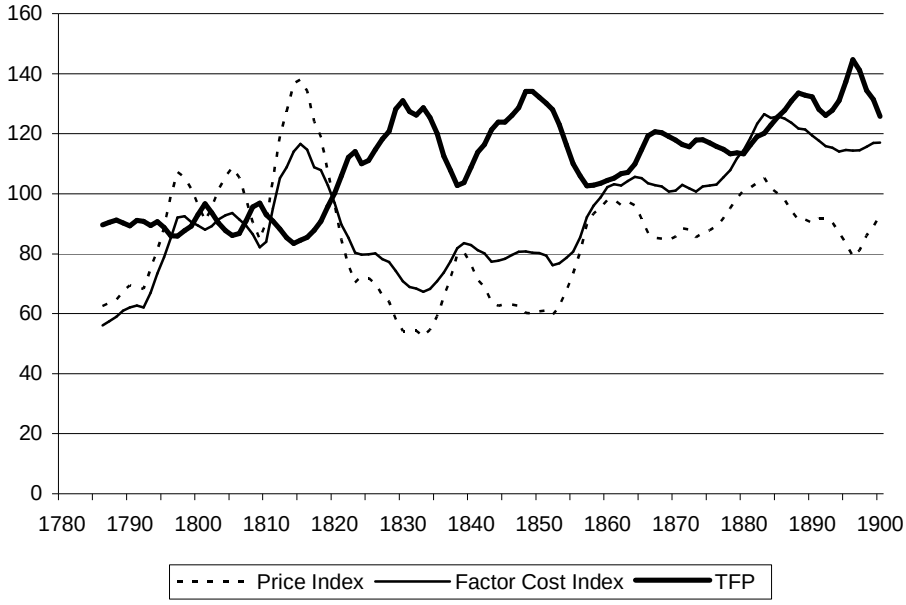
In comparative terms, the price series for farming products shows more robust growth during the difficult situation at the beginning of the nineteenth Century, while showing a deeper depression during the second quarter of that century. Contrarily, the price factor series shows lesser sensitivity to the second wartime situation than to the first, growing less during the decades of century change and also dropping less between 1815 and 1855. During the second half of the century, factor price behavior shows a greater trend toward increases than that of product prices, if we except the second half of the 1850s and the last years of the century.

The total productivity curve of the factors reflects the gap between the product and factor curves. We can distinguish three major stages. The first practically suggests a stagnation, showing a clear downward trend between the 1780s and the decade of 1810/20. It coincides with the end of the eighteenth Century expansion cycle and the long and difficult wartime cycle during the French Revolution and the Napoleonic Empire. The second cycle would begin in the immediate postwar years, extending up to the decade of the 1850s, with a pause during the first Civil War (1833-1839). The most notable feature is the strong increase of the TFP, whose index would jump in a few years from 84 to 134, supported by a deflation affecting the products more than the factors. The exceptional nature of the first Carlist War, leads one to consider the drop in this variable over that period to be an exogenous and passing phenomenon. The third stage opens with a strong drop of the indicator as a result of the inflationary process of the 1850s, but soon shows a sustained recovery that, after a period of stagnation during the seventies, returns to growth during the eighties, passing the threshold value of 140 around 1895. The total productivity of all the factors would thus have grown at an annual rate of

[9] The land rental series that has been used is that which expresses the monetary value of rental in specie (corrected to incorporate tithes and taxes) according to yearly wheat prices. This method has been chosen for reasons of coherency, since the rest of the inputs and products are also expressed in terms of currency.

0.3 percent between 1786 and 1900, an appreciable value, if we bear in mind the time period involved.

Figure 4. Evolution of price and cost index and of TFP in the south of Navarre, 1782-1900 (five years mobile average, 1856=100)



What is mainly surprising is the significant advance of total factor productivity we find during the second stage, reflected in a figure of 3.0 percent annually between 1815 and 1830. As this period coincides with the crisis in the Ancient Regime, with a government clearly unable to recover the statistical progress of the eighteenth Century, we lack other indicators to confirm this advance. The murky nature of this period, taken together with qualitative testimonies to the social and political problems of the time, did not allow the forecasting of such a result. This leads to the temptation of questioning the methodology used. Is it a simple statistical illusion, or does it reflect structural farming transformations during the period? This latter idea is supported by the fact that the curve, despite its fluctuations, never returns to the levels it had at the beginning of the 1780s. The fact of its not returning to its starting point at the end of the war cycles forces one to consider the presence of some structural force operating during the deflation period to make the increase registered in the 1820s irreversible.

Were the above data true, the image of a 'sleeping' agriculture, as proposed by James Simpson, is hardly defensible. What is more, the likelihood of intensive

growth over this period would outdo the expectations of many Spanish agricultural historians that have aligned themselves with the more optimistic interpretation. Our results would therefore confirm, albeit with important differences in regard to timing and amounts, the estimates of Prados (1988) and Bringas (2000) using less reliable sources.

VI. However, do prices reflect productivity?

It is time to admit that the methodology we have used can take us no further along the road. We have detected some important changes in the structure of relative prices and factors, but we do not know for certain if these prices correctly reflect marginal utility in a context where markets play an important role, albeit a complementary one to that of other economic allocation and social reproduction mechanisms. To advance further, we will find ourselves obliged to resort to other indicators.

For the validation of data obtained, we can assay a test, albeit a rough one, using figures obtainable from other sources. Table 3 summarizes the most credible information we possess to estimate the farming production of southern Navarre. The first column corresponds to estimations for the year 1800 for fiscal use by the Napoleonic administration using the tithes as a starting point, although the source does not clarify whether figures are for that specific year or a more general-type estimation. The second is also tithe in origin, but refers to annual data for the 1802 to 1806 period, from which we have calculated the five-yearly average. Thus, as the first column probably indicates the upper threshold, the second, affected by the poor harvests early in the century, marks the lower boundary of estimation. At the later stage of the century, the third column reproduces estimations carried out by engineers reporting to the *Junta Consultiva Agronómica* in their report covering the first years of the 1890s. To the figures resulting, we have added an estimation of the potato harvest taken from figures for 1818 and 1903-06. The last column reproduces the calculations made by the engineers of the *Diputación de Navarra* as from a detailed study of costs and products by district, again for fiscal use. The problem is that as it happens to coincide with an epidemic of Phylloxera, during which fiscal exemptions were granted to affected vineyards, we are not given information on grape harvests, small though they may have been. This

production having been valued at 1910 prices, following the steps of Domingo Gallego, we were able to obtain a direct and reasonable estimate of the increase of farming production during the nineteenth Century, which varies between 0.74 and 1.06 percent annually depending on the reference data taken.

Table 3. Gross farming production in the Tudela de Navarre District, 1800-1906

Harvest	Unit	1800	1802-06	1882-90	1903-06
Wheat	Hl	107,363	75,792	115,202	205,159
Rye and Spelt Wheat	Hl	4,786	2,897	1,358	1,924
Maize	Hl	45	1,438	15,378	35,688
Barley	Hl	4,488	35,245	40,058	128,111
Oats	Hl	5,591	4,156	5,460	26,994
Olive Oil	Hl	6,878	3,665	12,868	19,086
Wine	Hl	34,938	40,007	207,495	-
Legumes	Hl	4,734	4,782	5,728	8,301
Potatoes	Mt	0	0	3,014*	5,193
Sugar Beet	Mt	0	0	-	34,158
Alfalfa	Mt	0	0	-	1,495
Flax	Mt	18	21	-	0
Hemp	Mt	240	167	-	22
Value at 1910 prices	Pesetas (10^3)	4,812	3,714	10,115	10,717

*.- Potato production in 1882-90 was estimated from 1818 data (430 Mt) and 1905 data (5193 Mt), assuming a constant annual growth rate.

Sources: Lana (1999)

Bearing in mind that the total annual increase of factor productivity between 1800 and 1900 has been calculated by us at 0.31 percent , the increase of factor endowment–basically the total amount of land, work and capital- should have moved between 0.43 and 0.75 percent per year. This exercise is feasible, although we will be obliged to make some assumptions and work on some perhaps dubious estimates. The results, again circumscribed to the surroundings of Tudela, are summarized in Table 4. Using survey data, the sown area around 1800 was estimated at 22.8 thousand hectares, and in 1900 at 54.2. This shows an annual growth rate of 0.87 percent, confirming the extensive process of interior colonization that had taken place.[10] In the case of the labor force, we have taken as an indicator the size of the total population in 1797 and 1900, since determining the number of the individual farming labor assets –both male and

[10] The figure of 22.8 thousand hectares under cultivation that has been assumed for 1800 actually pertains to 1817-18 and is that of the land survey ordered by the *Cortes del Reino*, answered by most of the rural municipalities on a printed form. The lack of data has been compensated for by extrapolating the share of the municipalities sampled over the total number of municipalities at the end of the century. The 1817-18 survey was discredited due to concealment of assets, so the distribution of taxation continued to be based on population figures, but I believe we can vouch for this figure, bearing in mind that the area under cultivation could have grown between 1800 and 1817, and because in this case we have taken the higher estimation (the lower one would be of around 19.52 thousand hectares). The 1900 figure is that given in the provincial cadastre taken by crop mass (Jaén, 1904).

female- offers insoluble problems. Moreover, considering that the region over this period retained its non-industrialized characteristics leads one to think that the growth rate of farming human labor assets could not have differed much from that of the general population. Thus we can estimate the increase of this variable at around 0.55 percent.

In regard to the capital factor, three variables have been considered: firstly, the number of head of dray animals (horses, mules, oxen and asses), obtained from the cadastres, transforming these to units of live weight according to the GEHR (1985) coefficients. An important problem with this data is that the only information available for the beginning of the nineteenth Century is dated 1817, and is slanted with postwar reconstruction bias. If there are signs of important recovery in smallholding livestock, especially sheep flocks, the same thing does not seem to have happened in the case of dray animals, whose population was seriously depleted *manu militari,* i.e., by the military confiscation of these animals for transport use. Although we may be overstating the expansion of this variable, we can temporarily accept the resulting 0.89 percent annual rate. [11] Secondly, the total quantity of wheat seed grain has been estimated, bearing in mind the average yields per unit sown on both dates. A standard yield of 1:5 was considered for 1800, taking one wheat seed from each five harvested for sowing use. Taken on the 1800 harvest, this represents 21.5 thousand hectoliters (15.2 on the mean harvest of the 1802-06 period, assuming a yield of 1:5, improbable in this case). For the end of the century we have taken the average yields obtained from the valuation sheets for 1890 (1:7.7 for irrigated wheat and 1:5.35 for dry-grown wheat) and for 1905 (1:10.9 for irrigated and 1:5.9 for dry-grown) to calculate an amount of wheat seed of 16.9 thousand hectoliters for 1882-90 and of 25.9 thousand hectoliters in 1903-06. We can allocate the average of these two figures (21.4 thousand hl) to the year 1900, thus finding in this chapter, in contrast to the others, a savings of this factor.[12] Lastly, we have carried out an estimation of the available dung as from the allocation of fixed coefficients to the structure of

[11] The *censos de frutos y manufacturas* (produce and manufacture manifests) prepared at the request of the Crown by the Corella municipality confirm the delay in the reconstituting of the mule herd volume, which in the 1814 to 1819 period was at 40 percent of that existing between 1799 and 1807, while sheep flocks had already been reconstituted by 1816 (Lana, 1999:69). The conversion to live weight has been done by giving oxen a coefficient of 3.71 Qm, one of 3.26 Qm for horses and mules, and one of 1.72 Qm for asses.

[12] Estimates by Statistical Progression give a value of 81,424 hl for the irrigated wheat harvest in the district of Tudela and of 33,778 for that of dry wheat. Statistics prepared by *Diputación* engineers in the 1903-06 period set the value of the former at 114,516 hl and of the latter at 90,642 hl.

livestock herds at both extremes of the century. The result in this case is a modest annual increase of 0.13 percent that might even have been lower, due to the already mentioned depletion of dray stock in 1817.[13]

Table 4. Estimation of the growth rates of factor endowment and the expected rate of production increase for the district of Tudela, 1800-1900

Quantity of Factors	c.1800	c.1900	Rate (%)	weighting
Surface area under cultivation (thousands of Ha)	22.8	54.2	0.87	0.22
Population (thousands)	28.5	49.4	0.55	0.39
Dray animals (live weight, thousands of Qm)	6.9	16.8	0.89	0.21
Wheat seed (thousands of Hl)	21.5	21.4	-0.00	0.09
Dung (thousands of Mt)	90.6	103.3	0.13	0.09
Weighted growth rate of the amount of factors:			0.62	
Total factor productivity growth rate:			0.30	
Expected growth rate of farming production:			0.92	
Production growth rate 1800-1900 (data from 1800 and 1882-90):			0.74	
Production growth rate 1800-1900 (1802-06 and 1882-90):			1.00	
Production growth rate 1800-1900 (1800 and 1903-06):			0.80	
Production growth rate 1800-1900 (1802-06 and 1903-06):			1.06	
Production growth rate 1800-1900 (block averages):			0.89	

Sources: Lana (1999)

If we assume the same weighting order for factors as we used before, the average rate of increase of the quantity of production factors amounts to 0.62 percent annually. If we add to this figure the 0.30 percent growth of the TFP between 1800 and 1900, we will find that the increased production that should have been recorded is of around 0.92 percent. The production growth rates (always calculated over intervals of one hundred years despite the passage of less or more time between periods of data availability, to attribute them to 1800 and 1900 respectively) vary as we have seen between 0.74 percent and 1.06 percent, with the most probable average magnitude around 0.89 percent (if we operate with the averages for both blocks of data). Bearing in mind the probable overstatement of the figure given for dray animal labor, due to the underestimation of our starting figure, our result seems very satisfactory. [14] The test validates the accuracy of the results obtained from the price and cost analysis. This exercise thus confirms the existence of an important farming growth which was not exclusively due to the

[13] The dung production coefficients per head of livestock have been taken from the *Memorias provinciales sobre producción y consumo de abonos en el año 1933. Producción y consumo de abonos en la provincia de Navarra calculado por la Sección Agronómica* (General Archives of the Administration, Agriculture section, folder Nº 247). They are as follows: 10 metric tones yearly per horse or mule head, 10.5 metric tones per head of cattle, 6 per ass, 0.55 per sheep or goat and 1.5 metric tones per hog.

[14] If we arbitrarily assume that the dray animal herds in 1817 represented 60 percent of those in pre-war times (we have seen that Corella gives the figure of 40 percent), the factor quantity annual rate increase would be 0.51 percent, and the expected increase of production would be around 0.82 percent.

increase of production factors, but rather also involved a significant increase of productivity.

Our results therefore support the ancient optimism of Moreau de Jonnes, or that of more recent date expressed by Llopis, García Sanz, Garrabou and Sanz, and the authors of the book *El pozo de todos los males*[15], in regard to the period between 1815 and 1840, with the sole reservation that what for these authors continued to be a phenomenon of a fundamentally extensive nature, related to the collapsing of institutional barriers to interior colonization, now becomes a movement of a strongly intensive nature, reflected in a pronounced rise of the joint productivity of the factors involved. It is likely that the extensive component of this growth became visible in the 1850s, in the drop we have seen in both the TFP curves. However, the irreversible nature of that improvement of productive efficiency obtained during the years of the liberal revolution is noticeable in the fact that the new growth wave of the 1860s (and again that of the 1880s) starts from a much higher point than the previous one, reaching previously unattained levels.

[15] According to Alexandre Moreau de Jonnes, who termed Spanish farming growth as "unique within Europe" (Bernal, 1999: 94), the explanation for this would lie in the increased yield of the soil, around 47 percent in the 1803 to 1834 period (Bernal, 1999: 159). Llopis (1983), as well as García Sanz (1985: 78-84) and Garrabou & Sanz (1985: 97-138) stressed the simultaneously extensive and intensive nature of farming growth in the *Ochocientos* (nineteenth Century), although they all showed great caution – due to lack of data– in estimating the size of this intensive growth, initially limiting it to regional specialization. The reference for the book *El pozo*… is Pujol et al. (2001)

VII. Conclusions

This paper has employed a methodology heretofore little-used in Spanish agricultural history that is not exempt from criticism originating from different points of view. All said and done, we have gambled here on using the solidity of price series constructed from local and regional accounting sources to attempt an approximation to the development of the farming sector in the nineteenth Century. Our interest lay in subjecting the methodology proposed by Allen and Hoffman to examination and, once its credibility had been clarified, observing through it the development of productive efficiency in regional agriculture, by means of the concept of total factor productivity.

At the end of the road it seems we have achieved a satisfactory balance. The resulting TFP curve seems to be consistent with other information and indicators that are not based on prices. The methodology we have chosen, therefore seems to be the right one, despite any objections in regard to its basic assumptions (Grantham, 2000) or its deficiencies (Burkett, 2006).

The results additionally reinforce the idea that the farming sector grew during the nineteenth Century, and that a very major part of this growth took place during the dark period following the end of the Napoleonic Wars and Latin American emancipation. The novelty resides in that this growth, as well as being driven by an extensive increase of production factors, notably of farmland, showed a high degree of intensiveness and spurred a remarkable growth of total factor productivity. This is why throughout this century we find not only increased farming production, but also a significant improvement of production efficiency.

This growth albeit did not take place in a sustained and homogeneous way, but rather was marked by repeated slowdowns that were followed by periods of recovery and more or less intensive growth acceleration: From 1780 up until 1815 we may observe a gradual but evident drop in factor productivity, followed by a marked rise in this indicator, with a 3 percent annual growth rate between 1815 and 1830. Once the inertia caused by the first Carlist War had been overcome, this movement continued, culminating in 1848-49. Here we can not explain in detail how this growth could be possible, but at least we could point out some hypothesis: the increase in plantations of vineyards and olive groves oriented to

market, the introduction of new plants (potatoes, maize, forages) in the herbaceous rotations, and some unnoticeable improvements in practices, such as the diminution of the seeding frame and the treatment of seed against fungus.

During the third quarter of the nineteenth century, the behavior of total factor productivity became more mediocre, although most of its benefits were by then consolidated. The strong drop of the indicator during the 1850s was partially recovered in the 1860s, but it was only in 1888 that the indicator topped the ceiling value achieved in the previous growth wave, reaching a new maximum value by 1896, which was precisely the year of the Phylloxera epidemic in the Province of Navarre.

The interpretation of the behavior of this indicator opens up a very suggestive line of work. However, this will have to be the object of a new research study. Suffice it to say for the present that, as we had suspected, an apparently dormant farming sector had actually moved unobtrusively a considerable way along the road.

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