Double concentration explaining the outstanding increase in the Spanish agricultural production

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Abstract

The agricultural production in Spain increased strongly during the 2nd half of the twentieth century and the beginning of the twentieth-first, with growth rates higher than that of the main European countries. This period involved deep agricultural transformations in the context of the second globalization, generating product and regional changes in crop production. We use index decomposition analysis to evaluate the changes in the value and volume of crop production, as well as the role of product composition and the regional distribution of production.

In this paper we find a double concentration: on the one hand, the Spanish agriculture trended to produce high value-added products, such as vegetables, fruits and olive oil. On the other hand, crop production concentrated on the southern and eastern provinces in Spain. The expansion of irrigation, new technical innovations, the growing external demand (favoured by the incorporation of Spain in international markets), and changes in the internal demand with a more diversified diet, allowed this double concentration.

Keywords: agricultural history, index decomposition, Spain, regional analysis.

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1. Introduction

The agricultural production and productivity in Europe have been one of the main themes of the economic history literature (Alston and Pardey, 2014; Federico, 2005; Gollin et al., 2014; Lains and Pinilla, 2009; O'Brien and Prados de la Escosura, 1992). These variables augmented strongly during the second globalization, owing to the deep transformations in this sector that included technical innovations increasing the dependence on the non-agricultural sectors of the economy, the growing market integration among agricultural products, and the reduction in the share of the labour and land factors (while capital increased its share).

The case of Spain is striking, among other reasons, given the continuous increase in agricultural production and productivity, especially during the second half of the twentieth century (Clar et al., 2016). This continuous growth did not happen in other European countries because since 1980s the agricultural production was stagnated (Martín-Retortillo and Pinilla, 2015a). Furthermore, this growth was not homogeneous among the Spanish regions, and also diverged by groups of products.

During this period the technical change was fundamental in Spain, similarly than in other European countries (Grigg, 1992). Besides, the dictatorship regime invested in the construction of hydraulic infrastructures that expanded irrigation. Agricultural production was also pushed up in the transition from a dictatorship to a democratic political system, with the progressive integration in international markets, especially since 1986. Spain incorporated into the European Economic Community (EEC hereafter), and it was benefited, notably with respect to other European countries, by the implementation of the Common Agricultural Policy (CAP henceforth).

In this context, the objective of this paper is to analyse the changes in the Spanish crop production during the second half of the twentieth century; evaluating how, where and why it experienced such a sustained and significant growth. To that aim, we use information on the volumes of production and of prices perceived by farmers for 132 products and 48 Spanish provinces from the Spain's Agrarian Statistics Yearbooks (MAPAMA, 2010, 2005, 1980, 1955) during the second globalization. The high regional and product disaggregation detail is an important

value added of this paper, as it allows studying the long term changes experienced in the Spanish agricultural sector in depth. Methodologically, after completing the database and obtaining the main descriptive trajectories in agricultural production, we use index decomposition analysis (IDA). This technique separates the trend of an aggregate into the variations of its determinants, being useful to provide insights on the factors behind structural changes as the experienced by the Spanish agricultural sector. Specifically, we first try to explain changes in monetary production on the basis of variations of its volume and value. Then, in a second analysis we move the focus to examine variations of its localization and specializations ("reallocation decomposition"), i.e. where agricultural production was historically located and in which products it was based on.

Our article adds empirical evidence on the factors which have allowed a conspicuous growth in a European agriculture like the Spanish. We observe that the heterogeneous growth for the Spanish crop production was based on a double concentration: agriculture was focused on high value-added products, such as vegetables, fruits and olive oil, and, on the other hand, in spatial terms, in the south and east of Spain. The expansion of irrigation, the evolution of the internal demand and the progressive international market integration explain this double concentration.

The remainder of the article is organized as follows. The second section deals with the review of the historical context and the general growth of crop production in Spain since the second part of the twentieth century. The third section explains the methods used in this article for the decomposition of monetary production. In section 4 results on the decompositions are discussed. The final section 5 concludes and extends the discussion of policy relevance for the Spanish agriculture and even possibly for that of other countries.

2. Historical context: Spain in the European agriculture

We explain in the following paragraphs the context in which the development of the Spanish agriculture took place from the second half of the twentieth century. This should serve to better understand the main results of the paper that fill a gap in literature, i.e., the systematic and detailed computation and analysis of the

variations in regional and crop specific production volumes and values, which we rigorously perform in Section 3.

According to FAOSTAT agricultural production grew annually at 1.9% from 1955 to 2005-2010. This growth was lower than the experienced by developing regions, but higher than that of developed countries[1]. In that way, we can place Spain in an intermediate situation in terms of production growth worldwide, but in the top position considering Western European countries. At the global level, the Spanish case is striking for the innovative and institutional factors that were mostly adopted in this relative short-time period (Pinilla, 2008) and that had no precedent in history. Spain massively introduced technical innovations from the non-agricultural sectors of the economy, such as agricultural machinery, chemical fertilisers and hybridisation and selection of seeds. Besides, the development of irrigation boosted agricultural production thanks to the large advances on water infrastructure.

First, in terms of agricultural machinery, the adoption of tractors, reapers, and threshing machines decreased the dependence on draught cattle. These inputs augmented strongly the labour productivity, but also, rose the importance of non-agricultural inputs (Grigg, 1992). The Spanish agricultural mechanization was faster compared to European countries, despite the administrative obstacles to incorporate tractors during 1950s (Clar, 2009). In this regard, Spain converged to the European level of mechanization (Martín-Retortillo and Pinilla, 2015a).

Second, chemical products as fertilizers and pesticides were another important non-agricultural input. While its introduction was significant in Europe during the twentieth century, especially after the Second World War, it was huge in Spain, again converging to European levels. Despite the establishment of the Nitrate Directive of 1991, given the serious environmental problems derived from use (Brouwer and Silvis, 2010; Gardner, 1996), Spain continued increasing its

[1] For example, the annual growth of developing regions between 1961 and 2005 was 2.67%, 2.98%, 3.05%, and 3.08% for Sub-Saharan Africa, Latin America, Southern Asia and Middle East and North Africa, respectively. Meanwhile, the growth in Eastern and Western Europe, Japan, Australia and New Zealand and North America (USA and Canada) was 0.52%, 0.98%, 0.61%, 1.66% and 1.71%, respectively. Spain grew at 2.01% between these years (FAO, 2012, 2004).

consumption of chemical fertilizers during the 1990s and the beginning of the twentieth-first century (Clar et al., 2018).

Third, as commented above, biological innovations were also remarkable to explain the improvement in the agricultural production and productivity. These advances, adopted since the final decades of the nineteenth century (Olmstead and Rhode, 2008), intensified in the 1940s and 1950s, focusing on the hybridisation and genetic selection of seeds. As a result, the yields of several crops increased. This is the case of wheat, with 50% of its yield improvement during the second half of the twentieth century attributed to biological innovations. The most developed countries benefitted from these innovations, but this increase was lower in Mediterranean countries, compared to Western Europe, given their particular climatic conditions (Harwood, 2018; Pujol-Andreu, 2011). Bio-technology became one of the most important innovations in agriculture, particularly given the appearance of high-protein triticale varieties for animal-feeding in Europe, double-zero rapeseed growing in northern climates, nitrogen-fixing genes in non-leguminous crops and high-protein/high lysine content in winter wheat (Gardner, 1996).

Finally, the expansion of irrigation was also relevant in a European Mediterranean country like Spain. On the one hand, the technical innovations related to irrigation infrastructure allowed supplying water in arid regions. Whereas irrigated area more than doubled along the European continent, the Spanish case is more outstanding, as it almost tripled during the second half of the twentieth century. This expansion was especially intense during 1950s, 1960s and 1970s, when the Franco's dictatorship promoted the construction of dams as a pillar of its agrarian policy. At the same time, the share of irrigated production on the total agricultural production increased from 42.3% to 65.5% between 1955 and 2006 (Cazcarro et al., 2015a; Martín-Retortillo and Pinilla, 2015a; Pinilla, 2008). On the other hand, the use of plastic greenhouses, sprinkler and drip irrigation and sandy soils were some of the most important technical innovations that allowed improving the water productivity (López-Gálvez and Losada, 1999).

Apart from these technical developments, the new institutional framework was also key to explain the expansion of the Spanish agricultural production. Since the

last decades of the nineteenth century the Spanish agriculture exported Mediterranean horticultural products, with a predominance of European countries as its main commercial partners (Hernández-Armenteros et al., 2016; Pinilla and Ayuda, 2010). The Spanish Civil war and the autarky period entailed the collapse of agricultural trade. The integration of the Spanish agriculture recovered from the Stabilization and Liberalization Plan in 1959, but chiefly after the entrance in the EEC in 1986. In this period, the Spanish agri-food exports grew annually at 6.1%, while the imports augmented at 6.2%. This peak growth matches with a light and volatile increase in the openness ratio during 1970s, and with a strong increase from 1985 to the first years of the twentieth-first century (Clar et al., 2015).

The incorporation of Spain into the EEC not only eased commercial exchanges, but also modified the level of agricultural protectionism. The intervention on the agricultural sector was relatively low until Spain became a member of the EEC. In fact, the Nominal Rate of Assistance[2] (NRA henceforth) was very low during the 1950s, 1960s and the beginning of the 1970s, compared with the rest of Western European countries. Only Denmark, USA, Canada and Australia had less support for farmers between 1950 and 1975 (Fernández, 2016). During these years the EEC farmers benefitted from a strong agricultural protection derived from the CAP, meanwhile the Spanish agriculture was out of this system (Andreosso-O'Callaghan, 2003; Neal, 2007; Tracy, 1989). Basically, the CAP guaranteed high prices, generally higher than the international ones, incentivising to increase agricultural protection from the beginning of the EEC until the MacSharry reform in 1992. The low agricultural protection reversed from 1986, when Spain incorporated into the EEC. In this regard, the NRA grew from approximately 10%, as a percentage of the undistorted price, in the first half of the 1980s, to 70% in the second half of the twentieth century (Anderson and Valenzuela, 2008).

Until 1975, the lack of agricultural support was combined with the inflexible practices of a dictatorship. As a result, the agricultural development was carried out without considering the farmers voice or with little effective resistance in

[2] The nominal rate of assistance (NRA) is defined as the percentage by which government policies have raised gross returns to farmers above what they would have been without the governments intervention (or lowered them, if NRA < 0). The NRA is expressed as a percentage of the undistorted price (Anderson and Valenzuela, 2008).

several issues, such as land consolidation policy, hydraulic policy and agricultural extension. In terms of the hydraulic policy, the technical criteria was dominant, prioritising the construction of water infrastructure for irrigation or energy generation, thus provoking the displacement of rural populations (Herranz, 1995).

In sum, the lack of agricultural support together with the dictatorial context until the last years of the 1970s, generated an agricultural system based on a productivist model. It focused on the increases in agricultural production, expanding irrigation and adopting massively non-agricultural technical innovations, modifying also the regional and crop patterns of agricultural production. With this basis, the combination with a high number of hours of sunshine and the availability of water resources increased the potentialities of the sector in the following decades. Since the 1980s, the incorporation into the EEC and the implementation of the CAP linked the increase in production to international markets, especially the most demanded products to export (Clar et al., 2018), such as vegetables, olive oil and wine.

3. Data and methodology

In this section, we go into the main data sources to analyse the Spanish agricultural production since 1950s. Then, we explain the approach used to obtain the determinants of the long term changes in agricultural production.

3.1. Data

First, we collect the physical agricultural production (Q_{ijt} expressed in tons) from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, 2005 and 2010 (MAPAMA, 2010, 2005, 1980, 1955). These data are at the provincial and crop levels, providing the study with an appropriate disaggregation detail to analyse the structural changes happened in the Spanish agriculture from the second half of the twentieth century. Thus, we work with 48 Spanish provinces and 132 agricultural products. Then, we obtain information on the current prices (P^c_{it} expressed in *pesetas/ton)* perceived by farmers for each crop (MAPAMA, 2010, 2005, 1980, 1955). Note that in order to separate the inflation impact and to account for the change in real production and in the value of crops; data have been deflated using 1980 as a base year. The calculated agricultural price indexes are around 7.4 and

2.8 for 1955-1980 and 1980-2005-2010, respectively[3]. These indexes are used to obtain 1955 and 2005-2010[4] deflated prices (P_{it} expressed in constant 1980 pesetas), below introduced in equation (1) to estimate monetary agricultural production.

Hence, the paper focuses on three key moments for the Spanish agricultural sector. First, we look at the mid twentieth century (1955), just before the cited 1959 Stabilization and Liberalization Plan that set the end of the Spanish autarky and entailed the openness to international markets. This period was also previous to the intense development of hydraulic infrastructures during the middle years of Franco's Dictatorship. As a mid-point we focus on 1980, when a large number of water infrastructures had already been developed. This moment in time also represents the beginning of the democracy in Spain, and the previous status to the incorporation to the EEC that triggered a large commercial expansion and important changes for agriculture. Finally, we look at the beginning of the twentieth-first century by averaging a dry (2005) and humid year (2010) following Cazcarro et al. (2015a). This final period gives the picture of a democratic, globally integrated and more environmentally-aware country.

3.2. Methodology

Once we have described the data sources and characteristics, we explain the methods used for the empirical analysis. To start, we estimate monetary agricultural production ($Prod_{ijt}$ expressed in pesetas) for each crop *i*, province *j* and year *t*. We use information on the physical production (Q_{ijt}) and prices (P_{it}) introduced in the previous section, which yields:

$$Prod_{ijt} = Q_{ijt}P_{it} \qquad (1)$$

From equation (1) we can also obtain, for each period, the total production by region ($Prod_{jt} = \sum_i Q_{ijt}P_{it}$), the total production by crop ($Prod_{it} = \sum_j Q_{ijt}P_{it}$) and the total national production ($Prod_t = \sum_i \sum_j Q_{ijt}P_{it}$).

[3] By chaining the previous information, we obtain a prince change of 20.5 for the whole period (1955-2005-2010).

[4] We take these years to examine changes up to the present, since there was relatively high variation of precipitations in these years, being 2005 a relatively dry year, and 2010 a relatively humid year (something which does not happen for 1955 and 1980, which were average years).

After calculating the evolution of monetary crop production of the Spanish regions, we proceed with the quantification of the main forces behind the historical changes in this variable. This will allow identifying the most significant structural patterns driving trends in the value of agricultural production. With this objective, we use decomposition analysis that links the change on an aggregate variable, i.e. the monetary production in our case, with a set of determinants. Note that the effects derived from decomposition analysis display the changes that would have happened '*ceteris paribus*' (regarding the other factors), that is, if the other factors had remained constant. A previous study on agricultural patterns using decomposition analysis for different explicative factors and different regional and sectoral detail can be found in Cazcarro et al. (2015b). Among the existing decomposition techniques, we utilize IDA (Ang and Zhang, 2000), and more concretely, we concentrate on the Logarithmic Mean Divisa Index (LMDI). As indicated by Ang (2015), the LMDI-I additive decomposition, presented in Ang et al. (1998), is preferred when working with a quantity indicator as the monetary production[5].

Nota that the whole set of effects presented in Sections 3.2.1 and 3.2.2 are calculated for the two sub-periods of analysis, 1995-1980 and 1980-2005-2010. In order to obtain these impacts for the entire period (1955-2005-2010), literature indicates two alternative procedures: non-chaining, and chaining analysis. The first one only looks at the initial (1955) and final years (2005-2010) for the decomposition, whereas the latter is obtained using the data of the intervening years (1980, in our case). We follow Ang et al. (2010) who state that the chaining procedure is preferred when more than two years of data are available, since it accounts better for the ups and downs along the period[6]. Thus, we get two sets of decompositions (1950-1980 and 1980-2005-2010) that are chained obtaining the result of the whole period (1950-2005-2010) (Ang, 1994; B. Ang and Liu, 2007; Ang et al., 2010).

[5] For observations with zero-values, we apply the analytical limit strategy (Ang and Liu, 2007) when doing the decomposition analysis.

[6] They literally acknowledge that "chaining analysis is preferred because it gives results which are more representative of the true situation, it makes full use of the data available, and it is more flexible in terms of application".

Before going into the formulation of the decomposition effects, we need to define the logarithmic mean of monetary production. Being 1 and 0 the final and initial periods, respectively, we get:

$$L(Prod_{ij1}, Prod_{ij0}) = \frac{Prod_{ij1} - Prod_{ij0}}{\ln(Prod_{ij1}) - \ln(Prod_{ij0})} \qquad (2)$$

After that, following Ang et al. (1998) we proceed with the decomposition of the agricultural monetary production. We first develop the "value decomposition" and then the "reallocation decomposition". In both of them, their multi-dimensional (crop and province dimensions) and multi-level (different levels of aggregation) character allows an in-depth examination of the long term agricultural changes and patterns, highlighting their main structural heterogeneities[7].

3.2.1 The value decomposition: prices and quantity effects

Equation (3) represents the change in monetary agricultural production between periods 0 and 1.

$$\Delta Prod = Prod_1 - Prod_0 = \sum_i \sum_j Q_{ij1} P_{i1} - \sum_i \sum_j Q_{ij0} P_{i0} = QE + PE \qquad (3)$$

This change can also be expressed as the sum of the quantity and price effects obtained using the LMDI-I additive decomposition introduced by Ang et al. (1998). This yields equations (4) and (5) for the quantity (QE) and price (PE) effects, respectively:

$$QE = \sum_i \sum_j L(Prod_{ij1}, Prod_{ij0}) \ln\left(\frac{Q_{ij1}}{Q_{ij0}}\right) \qquad (4)$$

$$PE = \sum_i \sum_j L(Prod_{ij1}, Prod_{ij0}) \ln\left(\frac{P_{i1}}{P_{i0}}\right) \qquad (5)$$

This first decomposition, the "value decomposition", tries to capture to what extent long term changes in monetary agricultural production are driven by changes in the volume of production (quantity effect, QE) and by changes in the value (price) of the different crops (price effect, PE). Note that despite the monetary agricultural production has been deflated for the whole crop production; the price effect exists as a result of the price differences among different products and might be specially

[7] For a review on the importance of the multi-level and multi-dimensional character of IDA see Ma (2014) and Ang and Wang (2015)

informative when working with a regional and crop detail. This perspective deepens into the role of agricultural expansion but also into the specific crops and regions responsible for the increase in the value of the Spanish production as a result of the growing production of high valued products.

3.2.2 The reallocation decomposition: composition, regional (share) and scale effects

Similarly, the change in monetary agricultural production between years 1 and 0 can be expressed as the sum of the change in the product shares within provinces (composition effect, CE), the change in provincial composition of production (regional effect, RE) and the change in total monetary production (Scale effect, SE).

$$\Delta Prod = Prod_1 - Prod_0 = \sum_i \sum_j \left(\frac{Prod_{ij1}}{Prod_{j1}} * \frac{Prod_{j1}}{Prod_1} * Prod_1\right) - \sum_i \sum_j \left(\frac{Prod_{ij0}}{Prod_{j0}} * \frac{Prod_{j0}}{Prod_0} * Prod_0\right) = \sum_i \sum_j c_{ij1} * r_{j1} * s_1 - \sum_i \sum_j c_{ij0} * r_{j0} * s_0 = CE + RE + SE \quad (6)$$

Again, following Ang et al. (1998) we estimate the CE, RE and SE in the following equations:

$$CE = \sum_i \sum_j L(Prod_{ij1}, Prod_{ij0}) \ln\left(\frac{c_{ij1}}{c_{ij0}}\right) \quad (7)$$

$$RE = \sum_i \sum_j L(Prod_{ij1}, Prod_{ij0}) \ln\left(\frac{r_{j1}}{r_{j0}}\right) \quad (8)$$

$$SE = \sum_i \sum_j L(Prod_{ij1}, Prod_{ij0}) \ln\left(\frac{s_1}{s_0}\right) \quad (9)$$

Accordingly we can explain the changes in monetary production as a result of variations in: 1) the crop composition of production (CE) that allows to evaluate the productive change towards more/less valued products within regions, 2) the regional redistribution of production (RE) that informs on the geographical displacements of monetary production between regions and 3) the scale of monetary production (SE). Hence, the "reallocation decomposition" sheds light into the contribution of structural changes, i.e., into the changes in crop and regional specialization patterns.

4. The Spanish agricultural production: a view based on regions and products

After going into the data and methods of this study, we move to the results section in which we analyse the evolution of the Spanish agricultural production from the second half of the twentieth century.

Table 1: Monetary production value (prices deflated with the base year 1980) by region (in million pesetas) and annual growth rates.

	Region	Level (million pesetas)			Annual growth rates (%)		
		1955	1980	2005-2010	1955 to 1980	1980 to 2005-2010	1955 to 2005-2010
AN	Andalusia	84,854	224,431	363,687	4.0%	1.8%	2.8%
AR	Aragon	22,814	64,116	93,543	4.2%	1.4%	2.8%
AS	Asturias	8,307	9,472	6,541	0.5%	-1.4%	-0.5%
CB	Cantabria	2,141	2,887	1,880	1.2%	-1.6%	-0.2%
CL	Castile and Leon	79,737	132,993	114,888	2.1%	-0.5%	0.7%
CM	Castile-La Mancha	44,508	119,454	107,900	4.0%	-0.4%	1.7%
CT	Catalonia	31,577	87,691	77,362	4.2%	-0.5%	1.7%
EX	Extremadura	22,137	53,936	93,546	3.6%	2.1%	2.8%
GA	Galicia	34,348	56,970	54,056	2.0%	-0.2%	0.9%
IB	Balearic Islands	5,929	13,097	10,791	3.2%	-0.7%	1.2%
MC	Murcia	7,836	32,340	72,200	5.8%	3.0%	4.4%
MD	Madrid	6,592	9,640	5,783	1.5%	-1.9%	-0.3%
NC	Navarra	10,855	22,694	26,713	3.0%	0.6%	1.7%
PV	Basque Country	6,917	8,722	7,163	0.9%	-0.7%	0.1%
RI	La Rioja	6,821	16,143	15,035	3.5%	-0.3%	1.5%
VC	Valencian Community	44,785	101,584	89,958	3.3%	-0.4%	1.4%
TOT	**Total**	**420,158**	**956,170**	**1,141,047**	**3.3%**	**0.7%**	**1.9%**

Sources: Own elaboration from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, and 2005 to 2010 (MAPAMA, 2010, 2005, 1980, 1955).

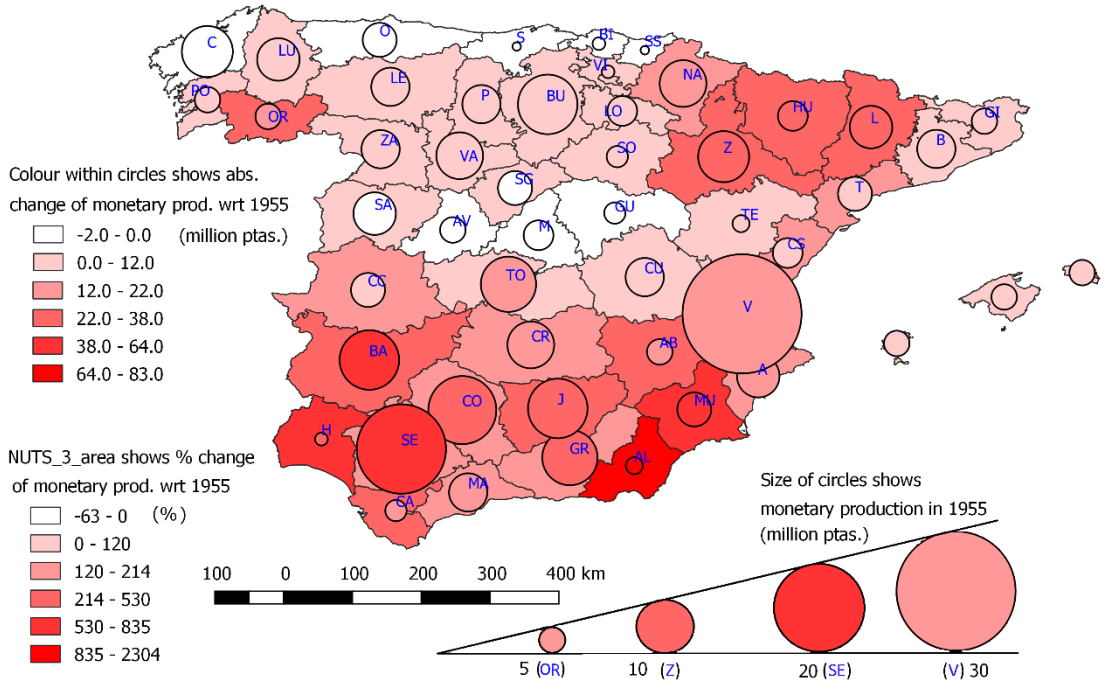
Table 1 shows the level of production in monetary units and its annual growth rates. We may see that national monetary production was 420 billion pesetas[8] in 1955, 956 billion pesetas in 1980, and 1,141 billion pesetas in 2005-2010. We can observe the continuous growth in the Spanish agricultural production at almost 2% annually during more than 50 years. The highest growth was from 1955 to 1980, increasing at 3.3% annually. This growth coincides with the massive adoption of chemical products, agricultural machinery, and the construction of main hydraulic infrastructures during the Franco's dictatorship (Cazcarro et al., 2015a; Federico, 2005; Martín-Retortillo and Pinilla, 2015b)[9]. However, the

[8] If converted to euros, with a conversion of 166.386 pesetas per euro, it would be 2.52 million euros

[9] There was also a construction of hydraulic infrastructures before the Franco's dictatorship, especially from 1911 to 1936 (Herranz, 2004). However, the most significant building was in the 1950s, 1960s and 1970s.

growth was slower from 1980 to 2005-2010 (0.7% annually). Still in this case, the Spanish agriculture increased its production in contrast to other European countries where production was stable since the mid-1980s.

Figure 1: Monetary value of production in 1955 (size of the circles), absolute changes between 1955 and 2005-2010 (colour intensity of the circles) and relative (%) change between 1955 and 2005-2010 (colour of the provinces).



See Table A1 in the Appendix for the name of the provinces and and its relation to wider administrative regions. Own elaboration from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, and 2005 to 2010 (MAPAMA, 2010, 2005, 1980, 1955)

Table 1 and Figure 1 show that crop production was concentrated in the south and east of Spain, especially in Andalusia and Murcia, meanwhile the north-west lost importance in agricultural production (see these type of insights in a more general way in Cazcarro et al., 2015a; Reig Martínez and Picazo Tadeo, 2002). This concentration coincides with a period of vast construction of hydraulic infrastructures during the Franco's dictatorship, namely in the Mediterranean area and the Ebro basin (Cazcarro et al., 2015b). If at the beginning of the period the region of Andalusia had a share of 20.2% of the Spanish crop production, and 23.5% in 1980, at the end of the period this rose up to 31.9%. Other regions like Aragon, Extremadura and Murcia (all of them in the south or in the east of Spain) increased notably their importance in the Spanish crop production. On the

contrary, Castile and Leon and Galicia, situated in the northwest, almost lost half of their weighting in total crop production.

Looking at Figure 1, the largest increases in the Spanish crop production happened in the provinces of Almeria, Badajoz, Murcia, Seville, Zaragoza, Huesca, Valencia, Cordoba, Granada and Lleida, in the south and east of Spain. It is striking the case of Almeria, which is the most north-eastern province and the most arid. The role of increasing irrigated agriculture in this scarce water region (but with good soil and plenty of sun hours) becomes a dominant explanatory factor of the revolutions occurred. In this case we find a yearly growth of crop production of 6.3% along the whole period.

Table 2: Monetary production value (prices deflated with the base year 1980) by product group (in million pesetas).

Product group	1955	1980	2005-2010
Oil	22,143	55,483	127,276
Cereals	195,687	270,878	156,887
Industrial crops	25,422	69,295	33,185
Fodder	26,447	85,907	124,578
Citrus fruit trees	16,011	46,039	84,135
Non-citrus fruit trees	16,602	73,739	95,732
Nuts	10,276	23,964	42,915
Vegetables	43,739	170,987	363,843
Legumes	21,836	16,488	7,538
Olive consumption	1,954	5,372	13,851
Other woody crops	4,444	2,418	1,114
Tubers	32,878	58,854	30,504
Wine	2,719	76,747	59,489
Total	**420,158**	**956,170**	**1,141,047**

Own elaboration from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, and 2005 to 2010 (MAPAMA, 2010, 2005, 1980, 1955)

The different specialization of each province produced these differential growths. It is necessary to observe also the evolution of production in terms of groups of products to obtain a complete view, helping us to understand the changing crop patterns of the Spanish agriculture. As shown in Table 2 the major growth can be found in vegetables, which moved from representing 10% of the total production value in 1955 to 32% in 2005-2010. Table 2 also shows increases in the share of olive oil and wine, the latter until 1980. Both citrus and non-citrus fruits moved from representing about a 4% to about a 7-8% at the end of the period. All of these

products are high value-added crops. Besides, fodder crops also increased its importance in crop production, moving from a share of 6% to 11%.

We have then clearly seen this double concentration, reallocation to the south and east of Spain, and specialization in high value-added products. This occurred thanks to several factors. Firstly, exports of vegetables and fruits dramatically rose in Spain, becoming leading agricultural products in exports in recent years, since they are highly profitable, and the clearest representation of irrigated production (particularly in the southeast of Spain). This is not a new specialization pattern, as Spain has traditionally exported fruits and vegetables since the last decades of the nineteenth century, when its exports represented approximately one third of the global exports of Mediterranean horticultural products (Pinilla and Ayuda, 2010). During the second globalization, the diversification of agricultural exports and the greater importance of transformed products in international trade did not change the limelight that fruits and vegetables have had in the agricultural sector. In this line, Clar et al. (2015) indicate that, although fruits and vegetables weight on total exports decreased from 68% in 1950s to 42% in the first years of the twentieth first century[10], the production of these products augmented rapidly. The relative and absolute increase in the production of vegetables, fruits and oil was also driven by the internal demand. The augment of the Spanish population made necessary higher production to meet food needs. Besides, economic development triggered improvements in the Spanish diet, which moved towards higher contents of fruits, vegetables or oil. In the case of wine the internal Spanish demand fell abruptly in the second period, despite its increasing export orientation (Fernández and Pinilla, 2018). In that way, the Spanish wine production went progressively to the international markets. All these counter expansive effects in a few products explain the value of total production in Table 2 in the last period, which shows an increase with respect to the 80s, but more modest than before.

The changing diet of the Spaniards also involved larger meat consumption. Besides, there was a strong increase in meat exports, especially since the 1980s (Clar et al., 2015; González de Molina et al., 2017). This was reflected in the greater importance of livestock production during the second globalization (Domínguez

[10] This decrease is explained for the intense growth of the exports of meat, processed products and dairy and eggs products because of the more diversified agricultural system (Clar et al. 2015).

Martín, 2001) that, at the same time, required larger volumes of animal feed, domestically produced and imported (Duarte et al., 2016). During the first decades of the second half of the twentieth century there was also a strong increase in the production of non-wheat cereals for animal feed, such as barley and maize. To illustrate, at the beginning of the 1960s, 39% of the cereals production was for animal feed, but in the beginning of the 1980s this figure reached 72% (Clar, 2013). Notwithstanding, as shown in Table 2 notably cereals moved down from 47% in 1955 to 14% in 2005-2010 during the whole period. It is also striking the decline in some low valued products as legumes and other woody crops mainly due to the fall of their consumption, especially from 1980 (González de Molina et al., 2017).

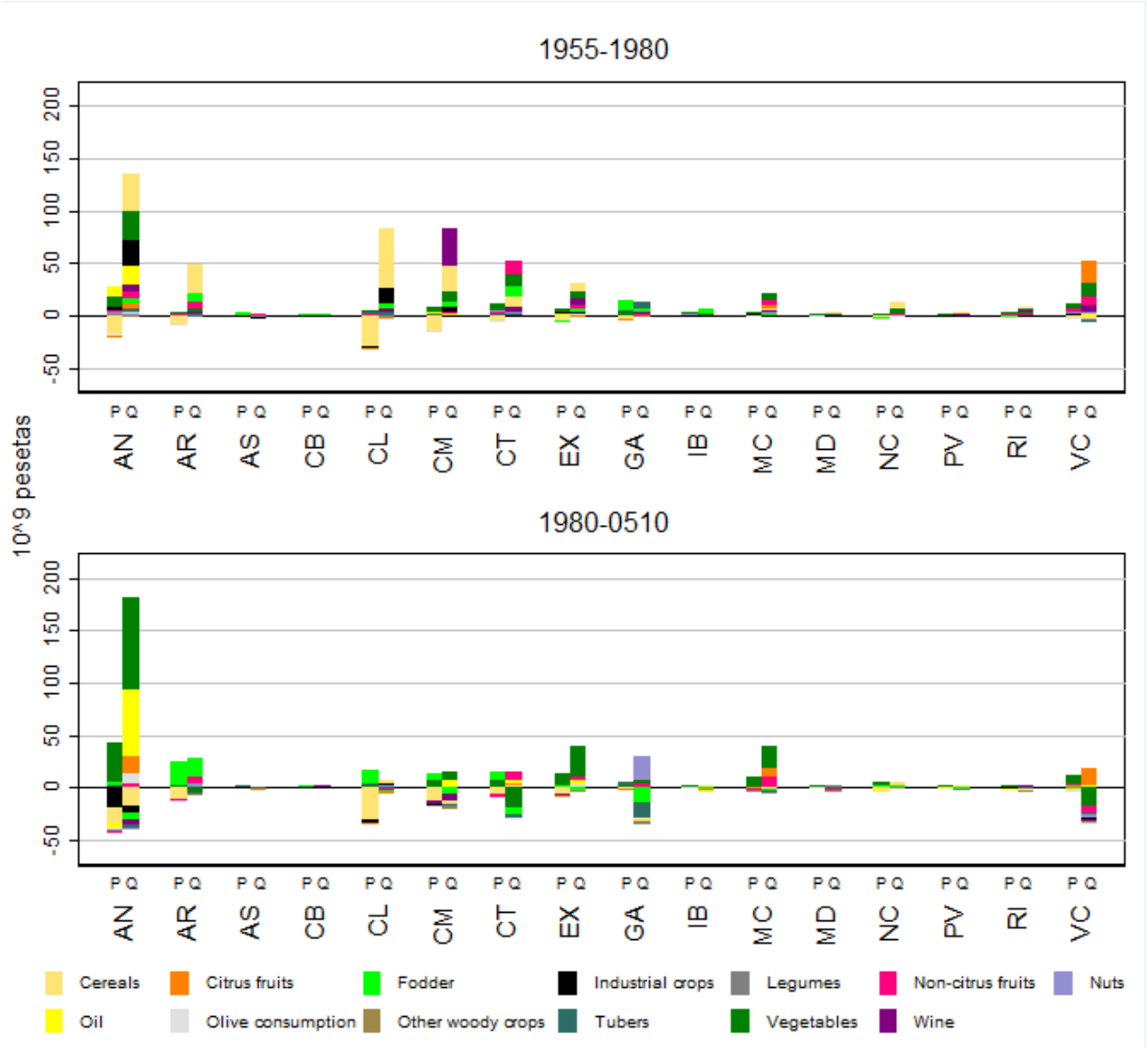
5. Decomposition Results

In this section, we quantify and develop on the causes for the double concentration seen in previous sections. For that purpose, first we examine the value decomposition which analyses the changes in the volumes and prices as drivers of monetary production. Then, we look at the decomposition on the products and regions that triggered the increases in crop production.

As indicated in the methodology, the reason for the existence of a price effect is that, although the effect of prices is removed at the aggregate level of the whole crop production, individual prices of products had a different evolution. These differences among prices can reflect the crops that experienced higher increases in their value added, encouraging their production and generating additional incomes. In this regard, for example if the total quantity of production had not changed from 1955 to 1980 in cereals, but their price had fallen, or remained stable when the general agricultural prices increased in the period, we would see a negative price effect. In particular, this is more or less what we find in Figure 3. We find a negative price effect of cereals, although the quantity effect was positive, i.e., there was an increase in production (in physical units) as well, which contributed to a net increase in the value of production from 1955 to 1980. In regional terms, this happened in Castile-La Mancha and notably Castile and Leon, two areas with a significant cereals production. As we have seen previously, the importance of cereals was decreasing over total production, but in aggregated terms cereals

production increased in these two regions until 1980. In fact, its harvested area in increased from 1960s to 1980s (Clar, 2013), especially in barley. The technical change adopted widely in European agriculture raised production, even in products with a low value added like cereals. From 1980 these regions also experienced decreasing price effects, which this time clearly lead to total decreases in production. The trend of producing higher value-added products or with ease of export decreased cereals production as agricultural resources were devoted to other crops as fodder in Castile and Leon and olive oil and vegetables in Castile-La Mancha.

Figure 3. Decomposition of the changes into the price and quantity effects (thousands of million pesetas)



Note on regional codes: AN: Andalusia; AR: Aragon; AS: Asturias; CB: Cantabria; CL: Castile and Leon; CM: Castile-La Mancha; CT: Catalonia; EX: Extremadura; GA: Galicia; IB: Balearic Islands; MC: Murcia; MD: Madrid;

NC: Navarra; PV: Basque Country; RI: La Rioja; VC: Valencian Community. Own elaboration from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, and 2005 to 2010 (MAPAMA, 2010, 2005, 1980, 1955)

Despite the general stronger impact of the quantity effect, the price effect explained more than 33% of the change, particularly for oil and vegetables. Andalusia gathers an enormous share of these groups of products. In the case of olive oil, the evolution of its production and exports was slightly erratic between 1980 and the first years of the twentieth-first century. Its growth was not continuous, as we can see in the slight reduction of its production in the first half of the 1990s (Infante-Amate, 2012). Besides, the entrance in the EEC probably generated a growing competition with other Mediterranean producers that provoked a moderate fall in the price of oil. This is shown by the negative price effects of Andalusia from 1980 (Figure 3). Regarding vegetables, during the last decades of our period of study, its production kept increasing via quantity effects, but also with a relatively higher importance of the price effects. These changes were geographically concentrated in Andalusia, Extremadura and Murcia (south and east of Spain), areas with optimal conditions for these crops: high sunshine hours per year and hydric resources from the expansion of the irrigation[11]. Furthermore, the increasing external demand of this type of products generated growing exports. The positive price effect was a strong incentive to produce more vegetables, substituting low value added for high value-added products, what reveals concentration in terms of products.

The case of fodder crops is also striking. Despite the fall in the quantities of production, prices moved-up the value of production. As shown in Figure 3, this happened in northern regions as Asturias, Cantabria, Vizcaya, Guipuzcoa and other northern provinces with high rainfall and yields (Cazcarro et al., 2015a; Santiago-Caballero, 2013). These provinces were traditionally specialized on livestock production, being able to feed high amounts of cattle compared to other provinces with difficulties to obtain biomass (González de Molina, 2001). The increasing internal demands for animal feeding in a country with an incipient farming industry and the growing external demand from 1986 could be behind these effects (Clar et al., 2015; González de Molina et al., 2017; Langreo and Germán,

[11] Nevertheless, the aridity of these provinces generates problems of availability of resources, especially water (Cazcarro et al., 2015b).

2018). As we find in Figure 3, Fodder production also increased in the Ebro Valley (mostly in Aragon and Lleida). The long term tradition in managing irrigation systems together with its specialization in livestock production (especially in pig farming), jointly integrated in the supply chain with the agroindustry, can explain this fact (García Pascual, 1993; Pinilla and Clar, 2011).

Finally, the value of wine production fell since 1980s both for the quantity and price effects. Despite exports augmented its share on total wine production, especially in 1990s and 2000s; the Spanish consumption of wine decreased sharply since 1970s, going from a consumption from 8 litres of alcohol in 1975 to less than 2 litres at the end of the 2000s (Fernández and Pinilla, 2018).

We move now to the evaluation of changes in regional and crop composition as determinants of the Spanish crop productive change. In Table 3 we observe that the Spanish value of crop production increased by 720,889[12] million pesetas from 1955 to 2005-2010. The findings from the LMDI decomposition indicate that this growth was essentially explained by the scale (SE) effect, by 84%. The composition effect (CE) also has some relevant share in explaining the change in the value of production of about 16%, while the regional effect was almost non-existent when accounting for all this long period. Differenciating into the first and second periods studied, we may observe how the scale effect was larger in the second period, while the composition effect was larger in the first. Although with small share, interestingly the regional changes lead to increasing the value of monetary production in the first period but to decreasing it in the second.

Table 3: LMDI-II multiplicative decomposition of value of crop production changes (million pesetas).

	CE	(%)	RE	(%)	SE	(%)	Prod
1955 to1980	87,016	16%	861	0.2%	448,136	84%	536,012
1980 to 2005-2010	25,136	14%	-1064	-0.6%	160,804	87%	184,877
1955 to 2005-2010	**112,152**	**16%**	**-203**	**0.0%**	**608,940**	**84%**	**720,889**

CE: composition effect. RE: regional effect. SE: scale effect. Own elaboration from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, and 2005 to 2010 (MAPAMA, 2010, 2005, 1980, 1955)

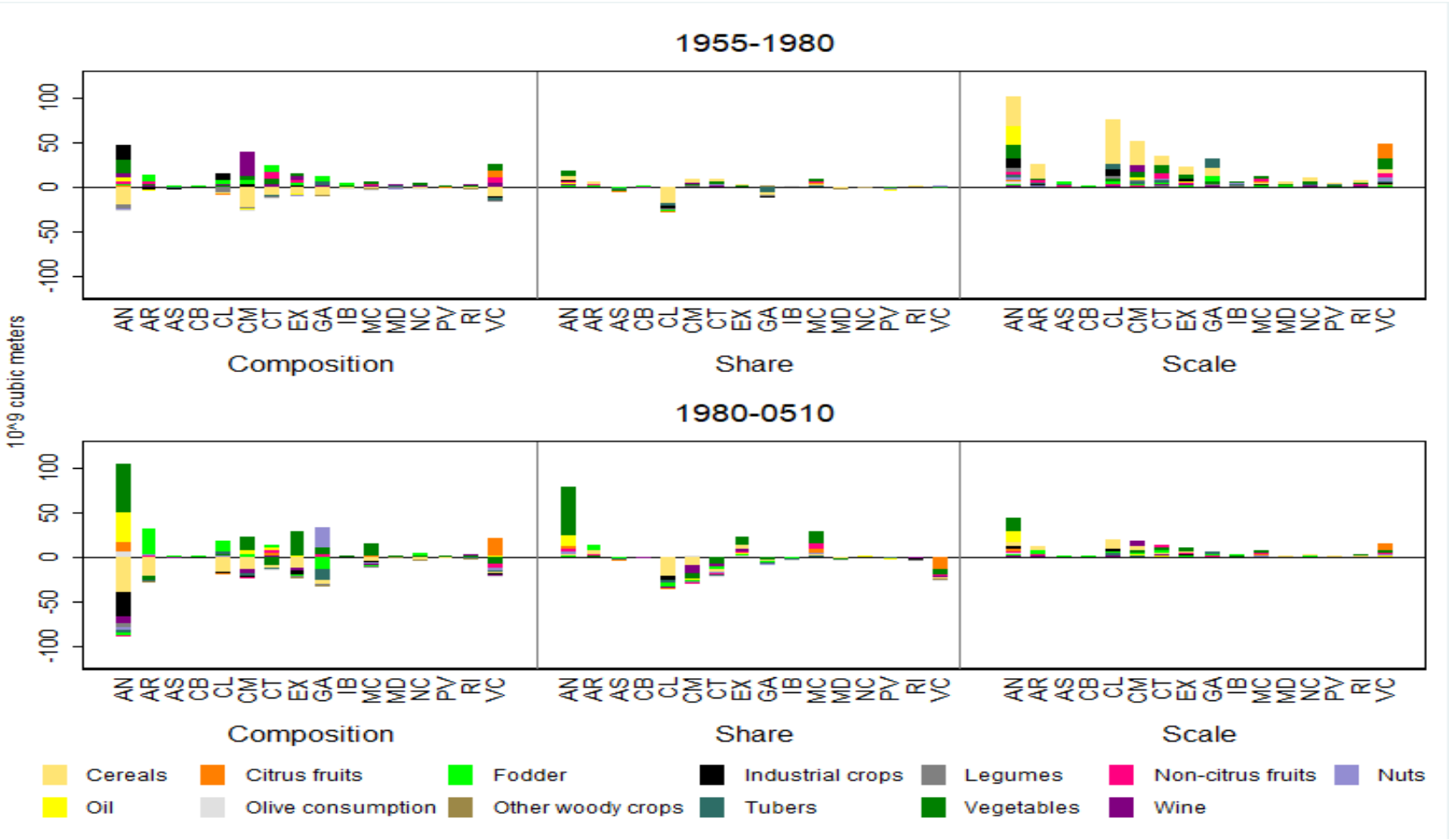
We had seen in Figure 3 that monetary production increased in most regions, and here, in Figure 4, we see that in general it is notably explained by scale effects, but

[12] This number obviously matches the differences shown in Tables 1 and 2 of value in 2005-2010, of 1,141,047 million pesetas and in 1955, of 420,158 million pesetas.

also basically positive composition effects are part of the story. Production tended to move to more valued products or high value added products. As in Figure 3, the case of Andalusia is very illustrative. This region had leaded the growth in value. We may see that although for this region there are purely scale effects (most regions increase their monetary production), there are also notable regional effects (productions moved to this region) and product composition effects (higher specialization into more valued products). This region deepened in the tradition of cultivate products for export and with high value-added (Hernández-Armenteros et al., 2016; Pinilla and Ayuda, 2010). The expansion of irrigation facilitated increasing vegetables production (6% annually along the studied period) and olive production (at 3.6% annually).

In this regard, the spatial concentration had negative regional effects in terms of production for regions such as Castile and Leon, Castile-La Mancha, Valencian Community, Cantabria, and many others such as Galicia, Madrid, Basque country, etc. This means that these regions reduced the production of some crops, not because these crops were less present in the whole production of Spain, but because production moved elsewhere. Those "elsewhere", as main destinations of productions were, as hinted above, Andalusia, Extremadura, Murcia and Aragon. Although globally regional effects seemed to have a small influence in changes in production, it has an important explanatory power when looking at the regional detail.

Figure 4. Decomposition of the changes into the CE, RE and SE by region (thousands of million pesetas)



Note on regional codes: AN: Andalusia; AR: Aragon; AS: Asturias; CB: Cantabria; CL: Castile and Leon; CM: Castile-La Mancha; CT: Catalonia; EX: Extremadura; GA: Galicia; IB: Balearic Islands; MC: Murcia; MD: Madrid; NC: Navarra; PV: Basque Country; RI: La Rioja; VC: Valencian Community. Own elaboration from the Spain's Agrarian Statistics Yearbooks for 1955, 1980, and 2005 to 2010 (MAPAMA, 2010, 2005, 1980, 1955).

6. Conclusions and discussion

In this work, we analyse the structural changes in agricultural production in Spain during the 2nd half of the twentieth century and the beginning of the twentieth-first, in a framework of major transformations in the agricultural sector itself, and in the institutional and political context. We firstly assess how changes in the volume and price of production have conditioned the value of crop production in the long term. Then, we examine changes in crop specialization and regional composition as drivers of monetary crop production. We found strong evidence on the existence of a double crop specific and regional concentration, with a trend to produce higher value added products, and spatially concentrated on the south and east of Spain.

In particular, crop production increased at 2% yearly from 1955 to 2005-2010, being this growth particularly more intense until 1980, when the annual growth rate reached 3.3%. Andalusia showed a growing importance in agricultural production, with a share that went from 20.2% of the value of production in 1955 to 31.9% at the beginning of the twentieth-first century. This relative increase mostly happened from 1980 onwards. Other regions like Extremadura, Murcia or Aragon, all in the south or east of Spain, also specialized in products with a strong demand, acquiring greater share in crop production. Regarding crop patterns, production concentrated in vegetables, which moved from 10% of the total production value in 1955 to 32% in 2005-2010. On the contrary, cereals moved down from 47% in 1955 to 14% in 2005-2010. Interesting increases were also reflected in the growth of oils, fodder, wine or fruits.

One of the main factors explaining this productive change was irrigation. During Franco's dictatorship, Spain expanded its hydraulic infrastructures that allowed irrigating some of the most arid regions. In that way, the large water availability, the relatively soft temperature and the high number of sunshine hours per year enabled taking advantage of the enormous agricultural potentialities in these areas. Furthermore, economic development entailed a changed in the Spanish diets that induced a higher demand for livestock production and the consumption of high value-added products. Also, the external demand had a fundamental role. The accession of Spain into the EEC involved the integration of agriculture into new

markets and benefited from the protection of the CAP. Finally, the technical change was other key factor explaining the regional and crop concentrations of production.

All in all then, in this work we have interrelated work and knowledge on the Spanish agricultural sector, and its socioeconomics, with a historical perspective. This may be of use for a systematic and detailed understanding of the evolution of Spanish agriculture, which has become relatively conspicuous within the European Union. Many policy implications may relate to the indicated role of institutional factors, in relation also to modifying the social and natural resource base. Several factors and societal changes guided and encouraged some key changes, such as the identified specialization and spatial concentration, which boosted the economic development in areas of concentration. A policy maker thought should also probably consider the wider picture, and see the additional hinted social and environmental effects. In this case for example in large rural areas of the centre and north of Spain farming households show reductions in the livelihood possibilities.

Furthermore, we consider that these insights, together with the novelty in the application of decomposition methods in this way, could be of further use and interest for its application to different contexts. Open and future lines of research which may follow up on this work could consist on comprehensively studying the interrelations of Spanish agriculture with trade balances, openness to trade, comparative advantage and other trade theories, additional specializations and integrations along the supply chain, demand and diets in Spain and abroad, and even management and productivity of other factors of production and resources, such as labour, energy or capital.

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Appendix

Table A1: Provinces and Autonomous Communities in Spain with ISO CODES

Province ISO code	Province	Autonomous Community ISO CODE	Autonomous community
ES-AL	Almería	AN	Andalusia
ES-CA	Cádiz	AN	Andalusia
ES-CO	Córdoba	AN	Andalusia
ES-GR	Granada	AN	Andalusia
ES-H	Huelva	AN	Andalusia
ES-J	Jaén	AN	Andalusia
ES-MA	Málaga	AN	Andalusia
ES-SE	Sevilla	AN	Andalusia
ES-HU	Huesca	AR	Aragon
ES-TE	Teruel	AR	Aragon
ES-Z	Zaragoza	AR	Aragon
ES-O	Asturias	AS	Asturias
ES-S	Cantabria	CB	Cantabria
ES-AV	Ávila	CL	Castile and Leon
ES-BU	Burgos	CL	Castile and Leon
ES-LE	León	CL	Castile and Leon
ES-P	Palencia	CL	Castile and Leon
ES-SA	Salamanca	CL	Castile and Leon
ES-SG	Segovia	CL	Castile and Leon
ES-SO	Soria	CL	Castile and Leon
ES-VA	Valladolid	CL	Castile and Leon
ES-ZA	Zamora	CL	Castile and Leon
ES-AB	Albacete	CM	Castile-La Mancha
ES-CR	Ciudad Real	CM	Castile-La Mancha
ES-CU	Cuenca	CM	Castile-La Mancha
ES-GU	Guadalajara	CM	Castile-La Mancha
ES-TO	Toledo	CM	Castile-La Mancha
ES-GC	Las Palmas	CN	Canary Islands
ES-TF	Santa Cruz de Tenerife	CN	Canary Islands
ES-B	Barcelona	CT	Catalonia
ES-GI	Gerona	CT	Catalonia
ES-L	Lérida	CT	Catalonia
ES-T	Tarragona	CT	Catalonia
ES-BA	Badajoz	EX	Extremadura
ES-CC	Cáceres	EX	Extremadura
ES-C	Coruña	GA	Galicia
ES-LU	Lugo	GA	Galicia
ES-OR	Orense	GA	Galicia
ES-PO	Pontevedra	GA	Galicia
ES-PM	Baleares	IB	Balearic Islands
ES-MU	Murcia	MC	Murcia
ES-M	Madrid	MD	Madrid
ES-NA	Navarra	NC	Navarra
ES-VI	Alava	PV	Basque Country
ES-BI	Vizcaya	PV	Basque Country
ES-SS	Guipúzcoa	PV	Basque Country
ES-LO	Logroño	RI	La Rioja
ES-A	Alicante	VC	Valencia
ES-CS	Castellón	VC	Valencia
ES-V	Valencia	VC	Valencia

Source: Own elaboration