UNIVERSIDAD DE EXTREMADURA

TESIS DOCTORAL

TRES ENSAYOS SOBRE EL COMERCIO INTERNACIONAL DE SOJA Y TÉCNICAS DE ANÁLISIS DEL CRECIMIENTO

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“Cuando se nace pobre,

estudiar es el mayor acto de rebeldía

contra el sistema”

(Tomás Bulat)

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ÍNDICE GENERAL

ÍNDICE DE TABLAS

ÍNDICE DE FIGURAS

INTRODUCCIÓN

La agricultura ha sido históricamente un importante actor de la economía mundial, principalmente en los países en desarrollo. Su relevancia está basada en la significativa contribución de este sector a la producción interna y al empleo mundial, así como en su papel protagónico para la seguridad alimentaria. De acuerdo con la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO, por sus siglas en inglés), el progreso económico del sector agrícola es de vital importancia para elevar los ingresos de las personas pobres y contribuir al aumento de los suministros alimentarios. Además, la agricultura sigue siendo la única fuente de ingresos de alrededor del setenta por ciento de la población rural en situación de vulnerabilidad en el mundo, por lo que la subsistencia de millones de personas depende directa o indirectamente de la agricultura.

El sector agrícola también se ha consolidado como un sector estratégico dentro del comercio internacional. El valor de las importaciones y exportaciones del mismo ha aumentado considerablemente en los últimos años. La mayor parte de este crecimiento ha sido consecuencia tanto del aumento en la demanda por parte de los países en vías de desarrollo, como del incremento de la liberación comercial. Así, la participación de las exportaciones agrícolas dentro de las exportaciones mundiales de bienes ha alcanzado un 11.22% del total en el año 2015, en términos relativos (Comtrade, 2017). Además, en los últimos cuarenta años, las exportaciones de productos agrícolas han crecido a un mayor ritmo que la producción mundial (FAO, 2017). Sin embargo, estos crecimientos no han sido iguales en todos los países del mundo. Es decir, no todos los países han presentado la capacidad competitiva necesaria para introducirse, operar y permanecer dentro del mercado agrícola mundial.

Los productos cárnicos, los cereales y las oleaginosas se han posicionado como actores estratégicos del comercio internacional agrícola. En particular, uno de los fenómenos que ha cobrado mayor notoriedad durante los últimos veinte años ha sido el crecimiento exponencial del comercio internacional del grano de soja sin ningún tipo de procesamiento. Este producto ha pasado de representar 1.54% de las exportaciones agrícolas mundiales en el año 1996 a alcanzar 3.32% de las mismas en el año 2015 (FAO, 2017). En particular, la demanda, producción y exportación de este producto han crecido a un ritmo mucho mayor que cualquier otro producto perteneciente a este sector. Según la FAO, el mundo ha duplicado su demanda de granos de soja durante el periodo 1996-2015. Este incremento sin precedentes se ha dado como consecuencia del aumento de la población global y del cambio en los ingresos de países en vías de desarrollo. Sin embargo, uno de los principales causantes de dicho incremento ha sido la multifuncionalidad del producto. En este sentido, el grano de soja no solamente es utilizado para su consumo final, sino que actúa como *input* para numerosos procesos industriales (Mallory *et al.,* 2011; McFarlane and O'Connor, 2014). Así, el grano de soja es empleado para producir aceite y harina de soja, pero principalmente es utilizado para la alimentación de ganado. Consecuentemente, el aumento registrado en el consumo de productos cárnicos también ha sido un factor relevante a la hora de explicar los grandes incrementos en la demanda. Recientemente, el desarrollo de *bio*-combustibles ha contribuido a la aceleración de la demanda de este bien (Fukase and Martin, 2016; Westcott *et al.,* 2016).

A pesar del gran incremento experimentado por el comercio internacional del grano de soja, la participación en este mercado está limitada a un grupo pequeño de países. El principal importador del producto durante las últimas dos décadas ha sido China, y en menor medida se han destacado, México, Japón, Holanda y España. Sin embargo, la demanda mundial de granos de soja ha sido suplida solamente por seis países: Brasil, Argentina y Paraguay (América del Sur), Estados Unidos y Canadá (América del Norte) y Ucrania (Europa del Este). Estos países en conjunto han sido responsables de más del 94% de las exportaciones mundiales del producto en el año 2015 (FAO, 2017).

El crecimiento del peso de este producto en las exportaciones totales mundiales, así como la concentración de los principales exportadores, muestran la relevancia de estudiar el comportamiento del sector y de los países líderes en materia de comercio de este producto agrícola. El objetivo principal de abordar este complejo mercado es explicar las razones por las cuales dichas naciones se han destacado y han aprovechado el progreso del mercado de grano de soja, considerando que un análisis del desempeño comercial de estos países podría revelar patrones comerciales que afecten el futuro abastecimiento de la demanda mundial de tan importante producto.

Por lo tanto, esta tesis se centra en el estudio de la competitividad en sectores agrícolas, específicamente de las exportaciones de grano de soja a nivel mundial.

Adicionalmente, algunas propuestas metodológicas son ilustradas mediante el análisis del sector agrícola de 47 provincias peninsulares españolas. De acuerdo con la teoría económica, la competitividad en la agricultura depende de factores tales como la dotación de recursos naturales, tecnología, costos de producción, infraestructura, así como la ubicación geográfica de la región estudiada. Por esta razón, en esta investigación se busca la integración de la economía regional al estudio de la competitividad. De esta manera, se hace posible la evaluación de las capacidades competitivas del sector agrícola desde el punto de vista interno, regional y global. Así, tomando como hilos conductores la importancia de la agricultura y el desarrollo de nuevas metodologías para el estudio de la competitividad en dicho sector, el estudio que se lleva a cabo en esta Tesis se ha estructurado en tres capítulos. Aunque los diferentes capítulos tienen elementos en común en términos metodológicos, se ha pretendido mantener la independencia de cada ensayo. De esta forma, la Tesis se desarrolla como sigue.

En el **Capítulo 1** se presenta un análisis exploratorio, así como un modelo empírico de los factores que determinan la competitividad de las exportaciones mundiales de grano de soja. La metodología utilizada se centra en el análisis de la capacidad competitiva relativa de los principales exportadores de granos de soja a nivel mundial durante el periodo 1996-2015. De esta manera, el principal aporte de este capítulo consiste en proporcionar un enfoque global sobre el mercado mundial de soja y sus principales actores. La base teórica del análisis exploratorio de este estudio subyace en la evaluación de la sensibilidad de las cuotas de exportaciones de los países analizados a los cambios en la demanda que han tenido lugar durante el periodo de estudio. Este marco permite la elaboración de hipótesis sobre las diferencias detectadas entre los desempeños de cada país exportador. A continuación, se plantea un modelo explicativo con el objetivo de contrastar las hipótesis planteadas. Para este propósito, la directriz teórica seguida está enmarcada en los factores que determinan el crecimiento de las exportaciones agrícolas, de acuerdo con las teorías del comercio internacional. En particular, se propone un modelo basado en la Función de Producción de Cobb-Douglas, adaptado a la actividad exportadora. Las estimaciones del modelo muestran evidencia de los factores significativos que impulsan la competitividad en cada país del mercado global. Los resultados resaltan comportamientos diferentes por país y la sobreexplotación de recursos naturales asociada a la competitividad mundial en este sector. Adicionalmente, a partir del sistema estimado se obtiene la tendencia seguida por el mercado global. Finalmente se sugieren implicaciones de políticas públicas con el objetivo de mejorar la capacidad competitiva sin afectar el desarrollo sostenible.

En el **Capítulo 2**, se introduce una nueva metodología para el análisis del comercio internacional. En este sentido, se propone el uso de la técnica exploratoria *shift-share* para la descomposición del crecimiento de variables relacionadas al comercio internacional. El *shift-share* se ha consolidado como una de las técnicas más populares en términos de economía regional. A pesar de ello y de sus múltiples aplicaciones especialmente al empleo, la descomposición ha sido escasamente utilizada para estudiar el comercio internacional. Sin embargo, la técnica puede ofrecer ideas muy útiles para el análisis de este campo, a través de comparaciones de las exportaciones sectoriales de una región respecto a otras regiones y otros sectores. Uno de los principales aportes de este capítulo consiste en la descripción de los beneficios de adoptar esta sencilla técnica para elaborar hipótesis sobre los motores del crecimiento de las exportaciones de un producto o sector. Adicionalmente, se propone una extensión del *shift-share* tradicional propuesto por Dunn (1960) que analiza a fondo todas las interacciones existentes entre las variables analizadas. Esta extensión combina los efectos clásicos e introduce nuevos efectos que proporcionan información sobre la estructura industrial interna de la región analizada. Partiendo de dichos efectos, se propone una clasificación de los exportadores en base a su desempeño, siguiendo la clasificación de Boudeville (1966), constituyéndose la primera clasificación basada en los efectos del *shift-share* aplicada al comercio internacional. Esta clasificación permite el planteamiento de políticas públicas adecuadas a cada región para la mejora de su estructura industrial y, por tanto, del dinamismo de sus exportaciones. La nueva propuesta es aplicada al caso del comercio de granos de soja a nivel mundial. Así, se pretende conocer la influencia sectorial global y local en la competitividad de los principales exportadores de grano de soja. Además, mediante la clasificación de los principales exportadores de acuerdo a su desempeño, se ofrece un nuevo conjunto de políticas para potenciar la presencia de los mismos en los mercados mundiales. En otras palabras, se busca complementar la información obtenida en el **Capítulo 1**, a través del diseño de una estrategia de política pública diferente para cada exportador, dependiendo de las características internas encontradas mediante el análisis *shift-share.*

En el Capítulo **3** se aborda otra nueva contribución metodológica a partir del análisis *shift-share.* Sin embargo, este apartado de la Tesis está dedicado al estudio y consideración de las influencias espaciales dentro de esta técnica. En este sentido, el *shift-share* espacial cuantifica el efecto que las regiones vecinas pueden tener en el crecimiento de las variables económicas de una región en particular. Este punto de vista se constituye clave, teniendo en cuenta que, en la práctica, todas las regiones forman parte de un sistema económico y no se encuentran aisladas unas de otras. Por lo tanto, las regiones reciben influencias del desempeño de sus regiones vecinas. Desde que Nazara y Hewings (2004) incorporaron el espacio, es decir, la localización geográfica de las regiones analizadas dentro de la descomposición original, numerosos autores han mejorado e introducido nuevas variables a dicha propuesta. Por ello, el primer paso llevado a cabo en este capítulo consiste en la elaboración de una revisión bibliográfica exhaustiva sobre dichas extensiones y propuestas. De este modo, se analizan los beneficios y las limitaciones de las principales aportaciones metodológicas realizadas a la técnica espacial. Teniendo en cuenta dicho análisis, se propone una nueva extensión del *shift-share* espacial, que incorpora todos los efectos resultantes de las interacciones entre las variables de estudio. Es decir, no solamente se presenta una descomposición que compara el desempeño de la región analizada con la de sus regiones vecinas, sino que también se toma en cuenta la influencia de la estructura interna de la propia región estudiada. Como consecuencia, se pueden detectar patrones de comportamiento similares entre regiones, que son producto de las influencias recibidas a nivel regional. Siguiendo en la línea del análisis de las actividades agrícolas, esta propuesta se aplica al estudio del crecimiento del Valor Añadido Bruto (VAB) del sector agrícola de 47 provincias españolas. Los hallazgos demuestran una fuerte influencia regional en el declive observado en el VAB agrícola de las unidades geográficas estudiadas. Además, dichos resultados también sustentan la importancia de la competitividad sectorial en todos los niveles económicos: nacional, regional e interno.

Finalmente, las principales conclusiones derivadas de esta Tesis Doctoral se ofrecen en el apartado **Conclusiones y Consideraciones Finales**. Dicho apartado recoge una síntesis de las conclusiones propias de cada capítulo, destacándose tanto las aportaciones originales de esta Tesis como las líneas de investigaciones futuras que se derivan de los resultados obtenidos en este trabajo.

CHAPTER 1: LAND USE AS MAIN DRIVER OF COMPETITIVENESS IN SOYBEAN INTERNATIONAL MARKETS

Abstract

The overexploitation of land that is being generated by the production and trade of soybeans at the world level could compromise sustainable development in the near future. Our estimates show that investments in technology and land use are the most important factors explaining world soybean trade competitiveness. As deforestation and grassland conversion are global challenges of great environmental importance, land use conversion should be avoided as a way to increase a country's soybean trade competitiveness. Our findings provide policy guidelines to improve the participation in soybean global market for the leading export countries.

Keywords: soybean trade, international competitiveness, land use

CAPÍTULO 1: EL USO DE LA TIERRA COMO FACTOR DETERMINANTE DE LA COMPETITIVIDAD EN EL COMERCIO MUNDIAL DE GRANOS DE SOJA

Resumen

La sobreexplotación de la tierra que ha sido generada por la producción y comercio de granos de soja a nivel mundial podría comprometer el desarrollo sustentable en el futuro cercano. Nuestras estimaciones muestran que la inversión en tecnología y el uso de la tierra son los factores más importantes en la explicación de la competitividad del comercio mundial de granos de soja. Como la deforestación y la conversión de pastizales son desafíos globales de gran importancia medioambiental, el incremento de la competitividad de un país en el comercio internacional de granos de soja a través de la conversión de suelos debería ser evitado. Nuestros hallazgos proveen políticas para mejorar la participación de los países líderes de la exportación en el mercado mundial de soja.

Palabras clave: comercio internacional de soja, competitividad internacional, uso de tierra

1.1 Introduction

This paper investigates the main drivers behind soybean seed competitiveness in world markets, and establishes the key role of land use for successful exports.[1] Over the last two decades, the analysis of soybean markets has taken on a progressively more central role in discussions regarding global agricultural policy. This is primarily because soybean production and trade have led to environmental and socio-economic impacts at world level (Eriksson *et al.*, 2018), but it is also due to the fact that patterns of trade in unprocessed soybeans can affect the sustainability of food security in countries (McFarlane and O'Connor, 2014). Furthermore, soybeans have become the fourth leading crop produced globally and one of the world's most rapidly growing industries in the last two decades (FAOSTAT, 2017).

Population growth, economic development, urbanization and improvements in people's living standards worldwide are leading to a global dietary transition from staple crops towards a higher protein diet,[2] with more processed foods, meats, oils and other high-value added agricultural products (see Fukase and Martin, 2016). This trend, that is expected to continue (Westcott *et al.*, 2016), has generated significant increases in the world demand for food, particularly soybeans. Global soybean consumption has expanded more than twofold since the late 1990s (FAOSTAT, 2017), in large part because this product is mainly used as an important intermediate input in the food supply chain in livestock feed, vegetable oils and biofuels[3] (Mallory *et al.,* 2011, McFarlane and O'Connor, 2014). Moreover, changes in policies, developed by many governments – especially by Chinese government - and applied to soybeans and their derivatives or livestock products, have also influenced the soybean market.[4]

[1]It is important to highlight that this paper is only focused on the soybeans as primary agricultural product (unprocessed soybeans).
[2]The soybean seed has the highest protein and oil contents among the cultivated crops in the world, making them a popular choice for high protein diet (Medic *et al.*, 2014).
[3]According FAOSTAT (2017) more than 85 per cent of the crop is not used directly, but it is processed through crushing. From the soybean crushing process is extracted mostly soy meal to be used as protein source in livestock feeds –approximately 80% of crushed soybeans-; but it is also extracted soy oil for human consumption and for biodiesel.
[4]For example, from 2008 to 2012, Chinese government developed commodity support programs to influence the decisions of grain productions, damaging China's soybean production and favoring soybean imports. On the other hand, environmental regulations affecting feedstuffs for livestock production in markets such as the European Union, Taiwan and Korea, have also reduced the advance of their livestock and feed industries, altering their soybean imports (Lee *et al.*, 2016).

This unprecedented global growth in demand has generated the increases in soybean production and trade. However, the growth in production has been mainly associated with the expansion in the cultivated area rather than with significant improvements in crop yields.[5] This fact has produced changes in the land use, leading to land degradation and deforestation, generating a great concern for potential negative environmental impacts (Cattaneo, 2001; Deininger, 2013; Le Polain de Waroux *et al.*, 2017; Lambin and Meyfroidt, 2011; López and Galinato, 2005). The negative environmental effects have been exacerbated by the increasing international trade of soybeans, through the impact of the expansion of production in the exporting countries, as well as the effect on importing countries (e.g. Boerema *et al.,* 2016).[6] Since the second half of the 1990s, while worldwide production has doubled, global soybean trade has increased threefold, at a rate that is higher than the average of all agricultural products. As a result, soybeans have become the most traded agricultural commodity, accounting for over 10 percent of the total value of global agricultural trade (FAOSTAT, 2017).

Nowadays, due to advances in biotechnology soybeans are easier to cultivate in more countries. However, just a few countries, such as United States, Brazil, Argentina, Canada, Paraguay, China, India and Ukraine, remain responsible for almost the entire world production (see Table 1.2). Similarly, soybean trade is also dominated by the same group of countries, except India, although they play different roles in world trade. Whereas China dominates the global imports, the rest of the countries are the major exporters. Hence, an examination of the competitiveness in the world soybean markets will focus on these six leading exporters.

The high concentration of soybean production and global trade in a small group of countries could lead to problems of sustainability, food security and even of viability of many productive processes, since soybeans serve primarily as intermediate inputs. Consequently, more research on the evolution of the main actors implicated in the global soybean market, how they have interacted and what determines and improves the soybean international competitiveness is needed. Many factors such arable land, productivity

[5]Soybean production was the only crop with a greater advance in land use than in yields per hectare. In addition, this oilseed has shown the lowest yield per hectare (see Table 1.1).
[6]Boerema *et al.* (2016) pointed out that the soybean boom in the main exporting countries in South America, Brazil and Argentina, generated a severe threat to their rainforest preservation, while the increase of production in their main importers (European countries) produced a decrease in permanent grassland by substitution of grass as feed.

factor endowments, technology or international commodities prices can affect the competitiveness of countries in world market. These aspects, in turn, can be influenced by government policies implemented by agricultural importers and exporters, such as tariffs and domestic subsidies. A deeper understanding of factors behind soybean competitiveness could provide useful information for policy recommendations with respect to soybean development, as well as the appropriate use of natural resources in a sustainable manner.

In general, research on sources of competitiveness for the agricultural sector, and particularly, for unprocessed agricultural commodities such as soybean seed, is limited. The majority of previous studies have focused on the main determinants affecting global soybean demand (e.g., Fukase and Martin, 2016; Tilman and Clark, 2014) and the efficiency in yields and harvesting areas (Goldsmith, 2008; Masuda and Goldsmith, 2009; Sanders *et al.*, 2014). There are some studies, more closely related to this paper, which evaluated soybean international competitiveness for a particular country (Chekhov, 2015; Goldsmith and Hirsch, 2006; Regunaga, 2010; US International Trade Commission, 2012), or for a group of countries, mainly the United States, Brazil and Argentina (among others, see Andino *et al.,* 2005; Larson and Rask, 1992; Meade *et al.*, 2016).

However, none of these previous studies has analyzed the soybean worldwide competitiveness, providing empirical evidence about its drivers. Thus, the principal purpose of this paper is to determine the factors behind soybean competitiveness in world markets. This study differs from the previous ones in several ways. First, it assesses soybean worldwide competitiveness focusing on export countries during the period 1996-2015, thus facilitating objective comparisons among them over time. Secondly, it proposes a new framework to examine the sensitivity of soybean export shares of each country to changes in the total exports in the world (global import demand). Thirdly, it provides empirical evidence about the determinants of soybean competitiveness of each country, through an empirical model. In addition, from the estimated system as a whole, it is possible to rank the relevance of every factor in the world market. Although the results vary by country, it seems that technology and the area of soybean harvested lands are the main factors that determine the soybean trade competitiveness worldwide. From our results, it is possible to provide general guidelines that favor the adoption of policy recommendations that mitigate the negative impact of soybean trade on land use.

The remainder of the paper is organized as follows: section 2 includes an exploratory analysis of the soybean world market situation, determining the international competitiveness of the leading export countries and compares their responses to changes in global import demand. Section 3 introduces the data and presents the econometric specification of the model used to identify the determinants of soybean competitiveness in each of the major exporting countries. Section 4 presents the estimation results; while section 5 features some concluding remarks.

1.2 Global soybean market

Soybeans have become one of the most dynamic crops over the last two decades. The spectacular rise in their demand has generated the acceleration of their production. As can be seen in Table 1.1, soybean production has experienced an important cumulative growth rate of 4.90 per cent from 1996 to 2015. This increase has been greater than the other major crops in the world. Similarly, the areas dedicated to harvest soybeans have advanced faster within the group of main crops, growing from 9.53 per cent of total global crop lands in 1996 to 16.43 per cent in 2015. In contrast with the other crops, this oilseed has had the lowest yield per hectare (see Table 1.1). Soybean production was the only crop with a greater advance in land use than in yields per hectare. Consequently, the growth of soybean production has been more related to the use of land than to improvements in crop yields. On contrary, the trend in the most productive crops (wheat, maize, rice and barley) has been to favor efficiency per hectare over expansion of land use.

This peculiarity has derived from the advances in biotechnology such as the adoption of Genetic Modified Soybeans (GMS) (e.g. Bianchi and Szpak, 2017; Qaim and Traxler, 2005), that seem to have favored the expansion of soybean cropland over improvements in productivity. The advantage of biotech soybean is its ability to make more efficient the use of land, as well as the development of improved varieties that can be more easily adapted to different agro-ecological conditions (Saha et al., 2014). Now cultivation of previously unsuitable acid soils has become possible, using specifically designed varieties and through the complementary adoption of conservation tillage (Deininger, 2013). As a result, the advance of soybean production has caused great damage to the environment, mainly due to the deforestation, biodiversity loss and grassland conversion that is carried out to obtain more available hectares to cultivate (Arima et al., 2011; Cattaneo, 2001; Lambin and Meyfroidt, 2011). The strategy based on the overexploitation of land followed by the soybean industry has generated concern, as it may compromise sustainable development in the near future.

Table 1.1: Area harvested, production, yield and exports of main crops at the world level, 1996-2015

	Area harvested (1000 ha)		**Production (1000 tn)**		**Yield (Hg/ha)**		**Exports (1000 tn)**		**Cumulative Average Growth Rate (CAGR) (%)**			
	1996	2015	1996	2015	1996	2015	1996	2013	1996-2015			
	% total		**% total**		**Qty.**		**% total**		**Harv.**	**Prod.**	**Yield**	**Exp.**
Barley	10.24	6.66	7.68	5.02	23619	30335	9.87	8.04	-1.53	-0.23	1.33	2.23
Maize	21.74	24.82	29.04	34.15	42061	55379	26.86	24.90	1.43	2.91	1.46	2.93
Rice	23.45	21.87	28.17	25.01	37840	46036	7.34	8.02	0.36	1.40	1.04	2.93
Soybeans	**9.53**	**16.43**	**6.45**	**10.92**	**21316**	**26757**	**12.65**	**20.68**	**3.65**	**4.90**	**1.20**	**6.04**
Wheat	35.04	30.22	28.66	24.90	25765	33174	43.27	38.36	-0.06	1.28	1.34	2.69
TOTAL	100	100	100	100			100	100				

Source: Author's elaboration with data from FAO-STAT.

Soybeans have also experienced an important expansion in their international trade during the last two decades. No other crop shown increases in trade at such an accelerated rate. Furthermore, soybeans displaced other products within its category in terms of exports (see Table 1.1). The increases in soybean trade were mainly influenced by the positioning of China7 as the most important importer of soybeans at the world level.

Another important feature of the soybean market is the high concentration of its production in a small group of countries. During the period 1996-2015, the United States (USA), Brazil (BR), Argentina, China (CHI), India (IND), Paraguay (PAR), Canada (CAN) and Ukraine (UKR) concentrated around the 94% of global soybean production, and registered more than 90% of the world harvested area (Table 1.2). Note that United States, Brazil and Argentina account for a larger share of this production in comparison with the other countries analyzed, that are considered as minor producers[8].

The top producers, with exception of China, improved their amount of production over time. They also have expanded their harvested area and in general, increased their efficiency. But, globally, their increments in land use were much greater than yields improvements. The United States has shown the highest yield per hectare, while the rest of producers presented a significant margin to reach its level (Table 1.2). This suggests

[7]The emergence of China had a huge effect on soybean international trade. This country was responsible for the 64% of total imports in 2015 (UN Comtrade, 2017).
[8]The denomination of "minor producers" corresponds to those countries which participation in world production does not exceeded 5%.

the existence of possibilities to improve the efficiency per hectare and overcome the extreme pressure on the land that currently generates the major source of increase in soybean production.

Table 1.2: Area harvested, production yields, and export share of the main producers of soybeans at the world level, 1996-2015.

	Area harvested (1000 Ha)					Production (1000 tn)				
	96-05 (AVG)		06-15 (AVG)		96-15	96-05 (AVG)		06-15 (AVG)		96-15
	Qty.	% of world	Qty.	% of world	CAGR*(%)	Qty.	% of world	Qty	% of world	CAGR*(%)
ARG	9864	12.56	17675	16.98	6.43	24389	13.73	47102	18.32	8.76
BRA	15516	19.87	24824	23.69	6.18	37734	21.55	70287	27.14	7.86
CAN	1045	1.37	1601	1.52	5.05	2557	1.51	4485	1.72	5.83
PAR	1331	1.70	2815	2.69	7.91	3254	1.89	3254	2.60	7.13
UKR	120	0.14	1130	1.05	29.38	159	0.08	159	0.75	34.05
USA	28770	37.86	30636	29.48	1.36	74882	44.06	74882	35.00	2.67
IND	6464	8.44	10151	9.73	4.31	6495	3.81	11012	4.36	2.46
CHI	8829	11.56	8005	7.82	-0.73	15383	9.04	13681	5.46	-0.61
∑		**93.50**		**92.94**			**95.66**		**95.35**	
WORLD	**76884**	**100**	**104254**	**100**	**3.65**	**172241**	**100**	**257045**	**100**	**4.90**

	Yield (Hg/ha)					Export share (% of world exports)				
	96-05 (AVG)		06-15 (AVG)		96-15	1996	2015	96-05	06-15	96-15
	Qty.	% USA yield	Qty	% USA yield	CAGR*(%)	% of world exports		CAGR*(%)		
ARG	24251	93.73	26600	91.43	2.19	8.20	7.70	7.69	-5.30	-0.33
BRA	24294	94.04	28174	96.91	1.58	14.10	49.30	11.75	1.76	6.48
CAN	24492	94.37	27855	95.95	0.75	1.70	3.00	-0.35	4.47	3.07
PAR	25175	97.76	23834	81.76	-0.73	4.00	3.00	0.71	0.35	-1.49
UKR	11946	45.90	17097	58.58	3.61	0.00	1.60	27.29	17.52	25.37
USA	26019	100.00	29142	100.00	1.30	67.60	31.40	-8.04	-1.08	-3.77
IND	10048	38.89	10931	37.91	-1.77	…	…	…	…	…
CHI	17453	67.33	17188	59.14	0.12	…	…	…	…	…
∑						**95.60**	**96.00**			
WORLD	**22344**	**86.20**	**24575**	**84.46**	**1.20**	**100.00**	**100.00**	**100**	**100**	**100**

Note: *Cumulative Average Growth Rate.
Source: Author's elaboration with data from FAO-STAT and UN-Comtrade.

Although China and India were important actors in soybean production worldwide, they do not produce enough to satisfy their domestic demand, resulting in a low propensity to export (around 1% in both cases) and a great major source of international demand. In contrast, according to FAOSTAT (2017), the majority of the other top producers have dedicated more than 50% of their production to export in 2015, with exception of Argentina and United States (18% and 45% respectively). Thus, in general the countries analyzed have been taking advantage of the trends in soybean demand and controlled more than 95% of global exports (UN Comtrade, 2017).

In conclusion, the outstanding growth of soybeans promises bright prospects for its future. However, sustainable development may be damaged since the advance in their production and international trade may generate important negative environmental effects. Until now, the number of leading exporters has been very limited. This high concentration could imply problems in terms of supply for consumption and production processes. For this reason, the analysis of the drivers behind international competitiveness of the countries that have been controlling the soybean market is an important issue. In the next section, we will focus on the performance, in terms of competitiveness, of the six main export countries.

1.3 International competitiveness in soybean sector

As the economic literature reveals, there is no one clear universal definition of competitiveness (see, among others, Harvey *et al.* 2017). It is a broad concept since it could encompass different levels of the economy, from the individual firm to the whole economy, as well as to both the domestic and the international markets. While competitiveness is readily defined at the firm level, the concept becomes very ambiguous when it is applied at industry or national levels. Consequently, competitiveness is multidimensional in nature and difficult to deal with theoretically as well as empirically (Fischer and Schornberg, 2007). Thus, there are many studies that adopt their own definition, choosing a specific method to measure it while also considering different sources of competitiveness.

According to Latruffe (2010), sectoral competitiveness can be defined as the ability of a sector to maintain or increase its market share over time with respect to other competitors in international markets. From this point of view, the competitiveness of a single sector takes as reference the theories of international trade, focusing on the success of its trade in international markets. Hence, trade-based measures have been the most widely used approaches for measuring the competitiveness of global agriculture (Balassa, 1965; Bojnec and Fertö, 2015).

In this paper, to evaluate the competitiveness in the world unprocessed soybean market, we use the export market share at country level (e.g., Carraressi and Banterle, 2015; Sarker and Ratnasena, 2014). The market share is an ex-post indicator and is defined as follows:

$$w_{it} = \frac{export_{it}}{export_{gt}} \qquad (1.1)$$

$$i = ARG, BRA, CAN, PAR, UKR, USA, \qquad t = 1996, \dots, 2015$$

where $export_{it}$ denotes the soybean exports of country i at time t, and $export_{gt}$ represents the world soybean exports at time t. An increase (loss) for the export share of a country will be interpreted as a loss (gain) for another country, informing about the gain (loss) of relative competitiveness of that country in the world market.

The calculation of the shares for the main exporters of soybeans is shown in Table 1.2. Important changes have taken place during these twenty years. Notwithstanding the shifts that have occurred, Argentina, Brazil and United States still control more than 85%

of the world soybean exports. Apart from Paraguay, Canada and Ukraine, no other significant competitor[9] appeared within the global system.

These changes can be traced to different tends in their competitive abilities. Indeed, Brazil, Canada and Ukraine have improved their shares in global exports, this growth being particularly important for Brazil, the second largest producer. Brazilian exports now exceed those of the United States, and they currently capture almost the half of the soybean export market. In contrast, Argentina, Paraguay and United States experienced a decline in their export shares. Whereas the Argentinean share of soybean has declined sharply since the mid-2000s, the shares of the United States and Paraguay have steadily diminished over the past 20 years. This loss of share in the last years seems to be related to the sophistication of their soybean industrial complex, especially in the cases of Argentina and the United States. A key factor has been their rapid growth in crushing capacity to produce soybean meal and oil[10] (Saghaian, 2017). Consequently, during the analyzed period, Argentina, Paraguay and the United States have increased their participation in world exports of these two higher added value products to the detriment of Brazil.[11] As a result, Argentina has become the world's leading exporter of both products, followed by Brazil and USA. This fact has also been encouraged by the policies of the Argentinean government that imposed higher tariffs on unprocessed soybean exports than on soybean oil and soybean meal. In the case of the United States, another important factor has been the recent expansion of its meat exports, which has stimulated the domestic use of soybean meal (as livestock feed), discouraging the exports of soybean seed (Oviedo, 2015; Regunaga, 2010).

It is important to highlight that since China became a big buyer of foreign soybeans, the leading exporters have modified their export geographic pattern. In particular, it is remarkable that in 1996, the main destinations of the top four exporters were the European

[9] Significant competitors are those exporters which have export shares equal or greater than 1%.

[10] In future studies, it would be interesting to analyze the exports of products related to soybean seed, but with higher value-added, like soybean meal and soybean oil. In this way, the study of these products would provide a complete picture of the soybean complex and the links between the competitiveness of each category of product. This paper is only focused on the soybeans as primary agricultural product.

[11] In this sense, for example, in 2005, the export shares of soybean oil of Brazil, Argentine, Paraguay, and United States were 23%, 40%, 1.5%, and 6.4%, while in 2015, they were 12%, 41%, 4.4%, and 8.6%, respectively. On the other hand, whereas in 2005 the export share of soybean meal of Brazil, Argentine and United States were 27%, 35%, 1.9%, and 12%, these shares were 21%, 40%, 3.5% , and 14%, respectively in 2015, (Comtrade, 2018).

markets, but in 2015, they transferred most of their exports to the Asia, particularly to China.[12] This geographic change has been favored by the different policies implemented by these regions. Chinese policy has encouraged the purchase of genetically modified soybeans and has fostered significant investments to expand the capacity of its own crushing industry. In contrast, in the European Union, the restrictions imposed by agricultural policy, along with general rejection of genetically modified soybeans, have restricted the expansion of the soybean trade.

This redirection indicates that the intensive margin[13] has played an important role explaining the export growth of the main exporters (especially in the case of Argentina, Canada, Brazil and the United States). Thus, these countries have deepened their trade relationships with China, instead of diversifying their destinations, despite of the risk that this strategy could imply. On the other hand, Paraguay and Ukraine have followed a different path, through the diversification of their trade partners that have seen them capture the markets that the top exporters left to supply to China. Therefore, we could suggest that the increments in the volume of soybean world exports have been supported by an intensive margin strategy that has emerged in response to the increases in the world import demand leading by China.

In this regard, we could hypothesize the existence of an influence of global demand on soybean exports. Following classical demand theory, the size of the world market could condition the exports of each country. Therefore, to establish the relationship between the export market share of soybean and its demand, a new framework is proposed. The proposal analyzes the sensitivity of soybean export shares to changes induced by the demand. The hypothesis claims that changes in the volume of global demand (world exports) could affect positively, negatively or could have a null effect on export market shares. To show statistical evidence of this hypothesis, this paper suggests the use of the so called “export curves”.

[12]In fact, in 1996, Argentina, Brazil, Canada and USA directed 11.58%, 0.42%, 0.55%, and 5.56% of their soybean exports to China, respectively. In contrast, for the year 2015, the percentages increased to 82%, 75%, 26%, and 55%, respectively (UN Comtrade, 2018).

[13] The intensive margin of trade refers to the growth of exports in goods or markets that are already being exported.

Accordingly, the specification of the “export curves” is based on the next statistical relationship:

$$\ln w_{it} = \beta_0^i + \beta_1^i \ln\left(demand_{gt}\right) + \mu_{it} \quad (1.2)$$

where w_{it} denotes the export share for country i at time t and $demand_{gt}$ represents the global exports of soybeans (which is used as a proxy for global demand). The sign of β_1^i indicates whether the soybean export share for each country increases or decreases when the soybean global demand increases. It is pertinent to note that the proposed specification refers only to changes at the world level. Thus, since export shares are used, the results do not contemplate the performance in absolute.

In order to deal with the endogeneity of global exports[14] equation (2) was estimated by Two Stage Least Squares (TSLS). Consequently, the use of instrumental variables was necessary. Since the soybean production and crushing were mainly motivated by population and income growth (Fukase and Martin, 2016; Meade et al., 2016), the world's population and world's Gross Domestic Product were used as instrumental variables. The estimation results are presented in presented in Table 1.3.[15] The calculation of the elasticities for each country shows evidence of different statistical responses to global demand changes. The top exporters could be grouped according to the sign of their elasticities (β_1^i).

If the elasticity is positive and significant $\left(\delta \ln(w_{it})/\delta \ln(demand_{gt}) = \beta_1^i > 0\right)$, the changes in global demand of soybeans affect positively the export share of country i. Brazil, Canada and Ukraine belong to this group of countries. Therefore, when the demand for soybeans increased at world level, these exporters reacted by improving their respective export shares. In contrast, if the elasticity is negative and significant $\left(\delta \ln(w_{it})/\delta \ln(demand_{gt}) = \beta_1^i < 0\right)$, the growth of soybean global demand has a negative effect on the export shares. The negative and significant elasticities of Paraguay and United States reflect that these two countries did not increase their relative market shares when global demand increased.

[14]There is possibility of endogeneity, since the export share for each country is defined as part of global exports of soybeans, which in turn is used as proxy for global demand.
[15]These equations were estimated individually.

Table 1.3: Estimation of export curves- Equation (1.2)

	$\ln(demand_{gt})$	R^2	Prob (F-statistic)	Sargan's statistic
ARG	0.057	0.002	0.789	3.181*
BRA	0.273***	0.316	0.009	0,081
CAN	1.784***	0.506	0.000	2.795*
PAR	-0.270***	0.317	0.009	0.538
UKR	3.391***	0.774	0.000	1.696
USA	-0.194**	0.241	0.027	6.235

Notes: (1) *, **, *** indicate statistical significance at levels of 10, 5 and 1%.(2) Sargan's statistics shows that the null hypothesis is accepted for all the countries at 5% level of significance, thus the instruments used are valid. (3) Dickey Fuller Test and PP Test results indicates that $\ln w_{it}$ rejects the null hypothesis for Argentina, Brazil, Paraguay and United States and accepts it for Canada and Ukraine. $\ln(demand_{gt})$, which uses as proxy $\ln(exports_{gt})$ accepts the null hypothesis for the whole sample. (4) $demand_{gt}(exports_{gt})$ is expressed in constant dollars 2010 and the data were obtained from UN Comtrade Database. (5) the instrumental variables GDP (constant dollars 2010) and population were obtained from the World Development Indicators Database.

The countries with the greatest elasticities in absolute values were Canada and Ukraine, both with positive values. These exporters were the most sensitive to changes in soybean demand. In contrast, the most inelastic export shares belong to United States and Brazil. On the other hand, Argentina is the only country that showed no significant relationship between its export market share and the global demand.

In summary, during the last 20 years, the soybean market did not change in terms of the main actors, but there have been significant variations in the distribution of export shares and destinations. These changes could be influenced by the different reactions of the analyzed countries to changes in world demand, as the export curves confirms. This approach reveals that top exporters did not respond in the same way to the growing global demand. These findings motivate a confirmatory analysis of the main determinants of international competitiveness in this market.

1.4 The empirical model, variables and data description

The main purpose of this section is to examine the different factors affecting the export shares of the top exporter countries of soybeans worldwide.

In the context of classical theories of trade, based on the concept of comparative advantage, the ability of a sector to be competitive in international markets could depend on factors related to prices and costs (e.g. Gorton, 2001; Porter, 1980). These advantages in costs and prices can be traced to the differences among countries related to endowments of productive factors, technology and the intensity with which these factors are used in production.

In the context of the new theories of international trade, the competitiveness could be conditioned by non-price factors, such product differentiation and product quality, (Latruffe, 2010). Hence, there is a consensus on the need to invest in technology to improve production processes and make them more efficient and competitive (Alston *et al.,* 2009; Fugile, 2016).

Along the same line of the new theories of international trade, based on Helpman and Krugman (1985), several authors such as Feenstra *et al.* (2001), Jensen (2006), Serrano and Pinilla (2014) focused on the presence of home market advantage to understand the pattern of international trade. This home market effect is mainly associated with differentiated products instead of homogenous products[16] (Serrano and Pinilla, 2014), since they are subject to economies of scales in production and transportation costs. The home market effect suggests that local producers may obtain larger market shares in their domestic markets despite openness of international trade. Such home preference could derive from several sources including among others, trade costs, investment frictions, home preference in demand, as well as distinct differences in tastes for characteristics across countries (Coşar *et al.,* 2018).

On the other hand, Gupta (2015), starting from Porter's diamond framework (based on firm level), stated that competitive and comparative advantages are complementary as sources of competitiveness in international trade. Therefore, Jambor and Babu (2016) emphasized that the quantity and quality of physical, human and technology capital, as

[16]It is important to note that since this study is only focused on unprocessed soybeans, the product differentiation is barely noticeable.

well as, demand, market size and international trade policies could be considered as drivers of competitiveness.

Hence, this paper analyzes the determinants of soybean competitiveness on the basis of these trade theories, taking into account that the competitiveness of this agricultural raw commodity is defined at country level.[17] The empirical analysis is grounded in the specification of an econometric model for export share. The independent variables in our econometric specification are: land endowment, physical capital, employment, human capital, technological capital, exchange rate, and Gross Domestic Product.

Regarding the variables used in the empirical analysis, our data cover the time period 1996-2015 for a sample of six countries and one product of the soybean complex: unprocessed soybeans. The export dataset is based on the Standard International Trade Classification of the United Nations (SITC, Rev 3) and it was obtained from United Nations Comtrade Database. The annual values of soybean exports are expressed in constant US dollars, deflated by the Agriculture Value Added deflator (with a base year of 2010) calculated with data from the World Bank´s World Development Indicators (WDI).

With respect to the explanatory variables, land endowment is considered an important factor for production in the agricultural sector. Agricultural land increases could be associated to changes in land use due to deforestation or the land conversion activities (Kalkuhl and Edenhofer, 2017). It is expected that greater land use will have a positive impact on export market shares. However, some authors suggested that the expected sign is not clear for this variable (e.g. Jambor and Babu, 2016). A plausible explanation may be that this variable is not directly linked to comparative advantages.

In the literature, it is usual to find as a determinant of agricultural trade patterns both "domestic stock of capital" and "number of workers" (Peterson and Valluru, 2000). A positive correlation of these variables with export share is expected. The endowment of skilled workforce is included as proxy of the farmer's management capacity (e.g. Huffman, 2001; Latruffe, 2010). It is assumed that greater quality of human capital will

[17]Following Moon *et al.* (2016) to delimit the international competitiveness of agricultural products, an important issue is the differentiation between agricultural commodities and processed products. They highlighted that whereas international competitiveness of the processed products is defined at firm level, the competitiveness of agricultural raw commodities is defined at country level

have a positive impact on export share. The effect of innovation in the productive process is another important factor to be analyzed in competitiveness of agricultural crops (e.g., Alene, 2010; Fernández-Núñez and Márquez, 2014). However, following Moon *et al.* (2016), in the case of unprocessed agricultural product, the technology is mainly determined by public investments in research and development (R&D) instead of the farm producers' strategies. For this reason, it is pertinent to include the public expenditure in R&D within the model. A positive relation between innovation and export share is expected.

The effective exchange rate is included as an indicator of prices of each country in international trade (e.g. Basarac et al., 2015; Jenkins, 1996), through the Real Effective Exchange Rate (REER). Increments in real exchange rate that reflect currency appreciation will usually dampen export growth. Then, a negative sign is assumed. Following Porter (1990), demand conditions are also considered. In line with trade theory, the size of demand matters for trade. A country's market size is frequently measured by its GDP. A positive influence of this variable on the dependent variable is expected. Finally, as a control variable, the level of unemployment in each country is included.

Table 1.4 presents the complete list of explanatory variables, a summary of definitions of each one, their data sources, and their expected impact on export market share. The main descriptive statistical properties of the explanatory variables are displayed in Table 1.5. The differences in the means may cause heterogeneity in the responses of the export shares of the top exporter countries to the explanatory variables. These effects will be estimated in the next section.

To clarify the main drivers behind soybean competitiveness at the world level, and as point of departure, a model based on a Cobb Douglas Production Function is considered. This is a standard approach in the efficiency and productivity literature, but also it is used to explain cost measures of competitiveness (Latruffe, 2010). The econometric specification is shown in equation (1.3).

$$\ln w_{it} = \beta_0 + \beta_1 \ln LAND_{it} + \beta_2 \ln PK_{it} + \beta_3 \ln LK_{it} + \beta_4 \ln HK_{it} + \beta_5 \ln TK_{it} + \beta_6 \ln REER_{it} + \beta_7 \ln GDP_{it} + \beta_8 \ln UNEM_{it} + \mu_{it} \qquad (1.3)$$

where the dependent variable, w_{it} is the export share for country i at time t. As explanatory variables different measures of factors endowments are included (see the definition of these variables in Table 1.4). Finally, μ_{it} is the error term.

Table 1.4: Description of variables and sources

Variable	Description	Source	Expected sign
$\ln LAND_{it}$	Natural log of share of soybean harvested area in the country area relative to the world average (in hectares).	FAOSTAT	(+)
$\ln PK_{it}$	Natural log of net capital stock per agricultural employment in each country relative to the world average (millions of dollars).	FAOSTAT ILO	(+)
$\ln LK_{it}$	Natural log of share of total agriculture employment in total employment relative to the world average (in thousands of employees)	ILO	(+)
$\ln HK_{it}$	Natural log of Secondary School Enrolment in each country relative to the world (in gross %). Gross enrolment ratio is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.	WDI	(+)
$\ln TK_{it}$	Natural log of public expenditure in R&D as percentage of GDP relative to the world average (in millions of US$).	WDI	(+)
$\ln REER_{it}$	Natural log of Real Effective Exchange Rate (in constant dollars 2005)	UNCTAD	(-)
$\ln GDP_{it}$	Natural log of share of GDP of a country in world GDP (in constant dollars 2010)	WDI	(+)
$\ln UNEM_{it}$	Natural log of unemployment rate (percentage of labor force, modeled ILO estimates) relative to the world average (in thousands of employees)	WDI	(-)

Source: Author's elaboration

It is worth noting that the explanatory variables that collect the measurement of production factors were constructed in order to compare the differences between a particular country and the world. Then, these explanatory variables were expressed as the quotient between the values of the variable for each country and the value of the same variable for the world. An increase in these variables implies a relative enhancement of a particular country performance in comparison to the world.

Table 1.5: Summary of explanatory variables for each country (average 1996-2015)

	$LAND_{it}$		PK_{it}		LK_{it}		HK_{it}	
	Mean	Mean	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ARG	7.153	7.153	45.470	15.712	0.035	0.021	1.454	0.090
BRA	3.444	3.444	2.660	0.310	0.532	0.041	1.450	0.227
CAN	0.195	0.195	19.570	1.948	0.077	0.010	1.600	0.142
PAR	7.265	7.265	0.799	0.083	0.804	0.071	1.002	0.094
UKR	1.330	1.330	1.774	0.286	0.671	0.084	1.522	0.181
USA	4.611	4.611	48.249	10.341	0.053	0.010	1.457	0.126
	TK_{it}		$REER_{it}$		GDP_{it}		$UNEM_{it}$	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ARG	0.239	0.038	149.182	70.138	0.0061	0.0005	1.846	0.608
BRA	0.516	0.047	79.985	15.782	0.032	0.001	1.759	0.356
CAN	0.898	0.084	86.885	10.523	0.026	0.001	1.207	0.127
PAR	0.039	0.008	96.649	13.449	0.0003	0.0000	1.048	0.200
UKR	0.459	0.099	102.011	13.668	0.0020	0.0002	1.410	0.225
USA	1.290	0.048	108.331	8.697	0.239	0.013	0.981	0.295

Source: Author's elaboration with data from UN-Comtrade, FAOSTAT, ILO, WDI and UNCTAD.

1.5 Estimation Results

This section presents the estimation results of the equation (1.3) for the six top exporter countries worldwide in the period 1996-2015 ($i = 1, \dots, 6$; $t = 1996, \dots 2015$). Due to the existence of common factors that might influence all countries at the same time, correlations between the error terms may occur. Performing the estimation of these six equations separately using ordinarily least equation (OLS) could lead to inefficient estimates. For this reason, the use of the Seemingly Unrelated Regression (SUR) model is more suitable for fitting this system of equations if the null hypothesis of independence is rejected.[18] The SUR model was estimated because the null hypothesis was rejected (p-val = 0.0076). Therefore, the estimation of the proposed model is presented in Table 1.6. The SUR framework estimates one equation for each country, that is, six regression blocks. This is important because, as the six countries have differences in production factors, export shares and sensitivity to soybean demand, there could be disparities in their responses to the variables of the model[19].

The analysis is divided into two parts. First, to examine the different behavior of every country, the estimations for each regression block are considered. Secondly, the results for the global system are analyzed.

1.5.1 Individual analysis (by country)

In general, the results shown in Table 1.6 are well fitted in terms of significance. In summary, the six countries showed different responses to the variables. Thus, our results suggest that top exporters intensified different combinations of factor endowments in order to increase their production and export volumes. The following sections collect the main results for each country.

[18]This framework was proposed by Zellner (1962) and has been widely used to manage the correlations between the error terms (e.g. Maertens, 2009; Narayanan, 2016; Sanders *et al.*, 2014).
[19]In addition, an increase in share of one country will affect other countries. Therefore, it would be interesting to measure the existence of spatial spillover effects (see White and Hewings, 1982). However, this analysis is beyond of our research.

Argentina

The results indicate that land use, capital stock, labor endowments and skilled workforce were positive and significant sources of comparative advantage for the case of Argentina. These results are in line with previous studies (e.g. Grau *et al.*, 2005; Panichelli *et al.*, 2008). On the other hand, technological capital had a negative and significant impact on export share. This unexpected result is consistent with Ghazalian and Furtan (2007), who also obtained negative relationship between agricultural food exports and capital invested on R&D. This result can be attributed to the fact that the technological changes occurred in the local industry, have encourage the further processing of soybeans (Oviedo, 2015, Regunaga, 2010) generating a reduction in the amount of unprocessed soybeans available to be exported.

Brazil

Estimations show that land endowment was the only significant source of comparative advantage in Brazil. The positive influence of land use is in line with Barretto *et al.* (2013) and Evenson and Alves (2009). This finding is key to understand the deforestation and grassland conversion in this country and provides empirical evidence of the importance of the expansion strategy in Brazilian production. Indeed, Brazil expanded its harvested areas from the Southern States of Paraná and Rio Grande do Sul to the Central and Northern regions, specifically the Brazilian *Cerrado.*[20] This was supported by the state-owned company affiliated with the Brazilian Ministry of Agriculture, *Empresa Brasileira de Pesquisa Agropecuárica (Embrapa)*,[21] thanks to the development of soybeans for lower (warmer) geographical latitudes and the infrastructure improvements. In this way, since the end of the 2000s, soybean production was also extended to others Brazilian regions, in particular to MATOPIBA[22] due to lower cost of land and the proximity to transport and ports (Boerema *et al.*, 2016; Macedo *et al.*, 2012; Meade *et al.*, 2016). Hence, changes in the land use were mainly favored by the low cost of land (Arima *et al.*, 2011; Huerta and Martin, 2002; US Trade Commission, 2012).

[20]The *Cerrado* is a sprawling savanna stretching across 1.2 million square miles of central Brazil and cover mainly the following states: Goiás, Mato Grosso do Sul, Mato Grosso, Tocantins and Minas Gerais.
[21]EMBRAPA is a firm of technological innovation focused in the generation of knowledge and technology for Brazilian agriculture.
[22]MATOPIBA is an acronym for the states of Maranhão, Tocantins, Piauí, and Bahia.

Canada

Technological capital is positive and statistically significant at the 1% level, and appears as the only source of comparative advantage. Similar results were also obtained by Saha *et al.* (2014). These authors pointed out that the adoption of genetic engineering technologies generated improvement in soybean production costs and reduced the use of fertilizers, chemicals and machinery in Canada.[23] In contrast, physical and human capitals had a negative and significant impact on export share. These results are in line with Huffman and Evanson (1993) and Craig *et al.* (1997).

Paraguay

The significant sources of comparative advantage were physical capital endowment and the number of workers. These results are in line with those of Hausmann and Klinger (2007), who asserted that the adoption of GM technology without tillage produced a positive impact on the physical capital, but also of the land use in soybean production. Moreover, the significant and positive effect of labor endowment could be associated to the labor intensity. Note also the high percentage of agricultural workers in the Paraguayan economy (see Table 1.5).

Ukraine

Results evidence that land use, physical capital and labor endowment had a positive and statistically significant effect on Ukraine's competitiveness. Some authors such as Chekhov (2015) and van Leewen *et al.* (2012) also found a positive effect of land use. In addition, the result is in line with Brookes and Blume (2012), who affirmed that the dependence of the soybean industry on physical and human capital may be a consequence of the lack of technological changes in this sector. On the other hand, increments in real exchange rate show a negative and significant impact on export share. Finally, a negative and significant but weak interaction with the unemployment ratio (control variable) was detected.

[23]The results belong to Ontario and Quebec, which are the most productive regions of Canada, computing about 95% of Canada's grain soybean and corn production.

United States

Land use was positive and statistically significant (at the level of significance of 1%), being the only source of comparative advantage in USA (like the Brazilian case). This finding reveals that the access to new suitable land for cultivation had a key role in its soybean exports. This result is in line with Masuda and Goldsmith (2009) and US International Trade Commission (2012). By contrast, the real exchange rate and the size of the economy had a negative impact on the dependent variable. The better prices offered by Brazil and Argentina, due to their devaluation currencies, were a determining factor in the loss of market share shown by United States (Andino *et al.,* 2005, Huerta and Martin, 2002; Zhang *et al.,* 2010). In the same way, increases in the size of USA local market (supported by the local crushing industry) generated a negative impact on its export share.

Table 1.6: SUR estimations of Equation (1.3)

Variable	ARG	BRA	CAN	PAR	UKR	USA
ln $LAND_{it}$	2.135***	1.094***	1.861	0.202	1.320***	1.909***
	(0.631)	(0.381)	(1.770)	(0.415)	(0.466)	(0.577)
ln PK_{it}	4.909**	0.608	-10.981**	5.522***	15.740**	-1.709
	(1.936)	(0.652)	(5.183)	(2.772)	(7.589)	(1.256)
ln LK_{it}	4.660**	0.682	1.805	9.071***	17.964**	-1.976
	(1.888)	(0.616)	(3.296)	(2.816)	(8.791)	(1.430)
ln HK_{it}	3.502*	0.425	-9.541***	-0.065	-4.132	0.888
	(2.020)	(0.342)	(3.646)	(0.618)	(5.249)	(0.850)
ln TK_{it}	-6.140***	0.876	11.517***	0.108	1.717	0.913
	(1.083)	(0.555)	(3.907)	(0.238)	(2.012)	(0.681)
ln $REER_{it}$	1.040	-0.275	-2.899	-0.982	-4.7333**	-0.688**
	(0.788)	(0.242)	(2.702)	(0.633)	(2.402)	(0.338)
ln GDP_{it}	0.264	-3.477	-10.161	1.208	-3.279	-4.744***
	(2.780)	(2.287)	(13.375)	(1.317)	(3.009)	(1.273)
ln $UNEM_{it}$	-1.251	-0.763	1.809	-0.245	-3.843*	0.094
	(0.855)	(0.526)	(1.767)	(0.217)	(2.249)	(0.113)
R^2	0.743	0.840	0.922	0.555	0.947	0.871
χ^2	96.87	121.76	264.63	31.97	373.84	151.16
p-values	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
Observations	20	20	20	20	20	20
Parameters	8	8	8	8	8	8

Notes: (1) Breusch-Pagan test of independence: chi2 (15) = 31,455 and p-val = 0.0076 indicate that the null hypothesis of independence is rejected and these equations must be estimated as a system (2) *, **, *** indicate statistical significance at levels of 10%, 5% and 1%; standard errors are in brackets.

1.5.2 The whole system

In order to determine the main drivers behind the changes of soybean competitiveness in world markets, a significance analysis was performed of each of the independent variables used in the SUR model. The results of these tests and the ranking of the variables according to their level of statistical significance are shown in Table 1.7. All the explanatory variables were statistically significant at the 5% level. However, the influence of the different explanatory variables was not similar, and the disparate responses obtained for each country (see Table 1.6) could hide the main factors driving changes within the system. In other words, the information displayed in Table 1.7 clarifies the determinants of competitiveness in soybean trade from a global point of view. The results obtained through the significance contrasts reveal that the most important driver of competitiveness in soybean world trade was the relative increase in public expenditure on R&D. The second was the relative advance in harvested land. The rest of variables in order of statistical significance were capital stock, employment and the size of the economy (with a 1% level of significance), followed by skilled workforce, real effective exchange rate, and unemployment rate (significant at 5%).

Table 1.7: Ranking of statistical significance of the explanatory variables of the SUR model (Wald statistic)

Variable	χ^2	p-value	Ranking
$\ln TK_{it}$	57.49	0.000***	1
$\ln LAND_{it}$	32.42	0.000***	2
$\ln PK_{it}$	28.14	0.000***	3
$\ln LK_{it}$	22.61	0.000***	4
$\ln GDP_{it}$	20.74	0.002***	5
$\ln HK_{it}$	15.51	0.017**	6
$\ln REER_{it}$	14.67	0.023**	7
$\ln UNEM_{it}$	12.71	0.048**	8

Note: *, **, *** indicate statistical significance at levels of 10%, 5% and 1% respective

Comparing results from Tables 1.6 and 1.7, it can be concluded that no country followed the same pattern. The determinants of the international trade competitiveness of soybeans were different in every country, but the global pattern is indicative of the main variables operating within the world system. For example, while, in Canada, improvements in R&D generated a positive impact in its export share, in Argentina, they produced the contrary effect. On the other hand, the expansion of soybean cultivated land contributed positively and significantly to the competitiveness of the top exporters (except for Canada and Paraguay).

Further, while the relative increase in public expenditure on R&D was the most important variable explaining the changes of soybean competitiveness in world trade, the relative advance in harvested land occupied the second position within the ranking of statistical significance. Nevertheless, the improvement in competitiveness based on increases in harvested areas could be very troublesome for two reasons. First, an extensive strategy could create a competition between soybean crops and other arable crops and grasslands. Secondly, such an expansion could entail negative environmental consequences (see, among others, Eriksson *et al.,* 2018; Foley *et al.,* 2005; Macedo *et al.,* 2012). Hence, countries may be better off investing more in public expenditure on Research and Development to increase production yield (Alene, 2010; Saha *et al.*, 2014; Sanders *et al.*, 2014). This economic guideline might improve the competitive presence of a country in the soybean world market, while preventing the loss of natural resources and ecosystem services, as well as halting further deforestation. However, some studies suggest that the lack of investment in R&D is a common problem in the agricultural sector (Alston *et al.,* 2000; Naseem *et al.*, 2010; Pardey *et al.,* 2006). One of the fundamental reasons for increasing harvested land instead of public expenditure on R&D is the time lapse that exists between the initial investments in R&D and the returns. However, the return on investment may take a while to be realized, but the impact of R&D on productivity is also more durable. Other authors have pointed out that the responsibility to develop new technologies does not depend on farm producers, but on national governments (e.g. Moon *et al.*, 2016). Therefore, in the long term, the world soybean market could have greater benefits if the exporters invest more in R&D based on technologies that improve productivity per hectare. Consequently, it would be possible to produce larger volumes of soybean in those lands that are already used, avoiding the creation of new harvest areas through deforestation. In other words, investing in technologies, which improve efficiency instead of allowing cultivation in any type of soil, could be less dangerous, both for the environment and for the sustainability of this sector.

1.6 Final remarks and conclusions

This paper analyzed the soybean international competitiveness at the world level. It provided empirical evidence about the main drivers behind top exporter's competitiveness during the 1996-2015 period, revealing the important role played by the expansion of the land use (and its possible negative environmental consequences).

The study contributes to the previous economic literature in different ways. Firstly, it highlighted that the current strategy based on the overexploitation or expansion of land devoted to soybeans instead of focusing on improvements in crop yields has generated concern, as it may harm the sustainable development in the near future (see, among others, Arima, 2011; Deininger, 2013; Eriksson, 2018; Le Polain de Waroux *et al.*, 2017). Additionally, it was stressed that the extreme geographic concentration of soybean production and trade could compromise the productive processes which employ soybeans as intermediate input. This may prove to be a real concern as climate change alters the conditions in regions currently favored for soybean production.

Secondly, the competitiveness at the world level of the main exporters of soybeans was assessed and compared over time. Although the same economies have controlled the market during this period and no other country has entered into this market in a significant way, changes of export share for each country were found. Thus, Brazil has consolidated its position as one of the most powerful exporters of soybeans, the United States, Argentina and Paraguay have lost participation shares within soybean markets, and meanwhile Canada and Ukraine have increased their importance in this sector. These shifts were also joined by variations in geographic destinations of exports. Almost two third parts of the world exports have moved to Asia, mainly to China. Given current (2018) problems stemming from a potential, protracted tariff war between China and the US, the US's continued soybean market share in China may be irreparably damaged.

Thirdly, the concept of "Export Curves" was introduced as a new framework to establish the relationship between the export share of each country and the global demand. This analysis revealed that the leading exporters have had different responses to the world import demand changes: Brazil, Canada and Ukraine have reacted improving their export shares, while the United States and Paraguay have lost shares. This empirical result suggests that every country have had different factors which lead them to maintain (improve or decrease) their presence in this market.

Fourthly, an empirical model was proposed based on a Cobb Douglas production function to highlight evidence of the determinants explaining soybean competitiveness in world exports. The model was estimated by means the Seemingly Unrelated Regressions (SUR) technique, obtaining one equation for each country. Our results suggest that exporters did not follow the same pattern to maintain its export share in the global market. The results revealed that the most important driver of competitiveness in a global sense was the relative increase in public expenditure on R&D, followed by the relative increase in land area devoted to soybeans. This implies that more public investment in R&D is needed since the adoption of new technology historically drives important improvements in productivity[24] and the continuous growth of global demand will require greater production and trade. However, these improvements in productivity should be supported by the increment of yields, instead of the increase of land use, in order to reduce the damage to the environment.

In recent years, countries redirected their expenditures in R&D from productivity toward other objectives as environmental issues, food quality, biofuels, and improvement in the industrial uses of agricultural products (Alene, 2010; Fuglie, 2016; Naseem *et al.*, 2010). Thus, with a world scope and thinking about meeting the future global demand in a sustainable way, our findings carry policy implications. Countries should keep investing in R&D but redirecting again one part of their efforts to gain productivity without compromising the environment (improving yields per hectare). In this way, the expansion of this crop at the cost of removal of tropical forests could be reduced. Additionally, country governments also could improve their R&D indicators, applying policies to attract private investment such as institutional stability, adequate regulations and farm credits for early adopters of new technology.

All the implications given for technology-enhancing strategies have as their objective the minimization of the increase in soybean land use, in favor of improvements in efficiency per hectare, since the strategy that top producers have used in the last years are compromising the environmental sustainability in the long term.

Finally, the use of soybeans in a wide variety of sophisticated process in industry, the incorporation of more soybeans into human diet, and the association of this product with protein and healthy diets (Fukase and Martin, 2016; Tilman and Clark, 2014) provide a

[24]For researches which obtained positive relationship between technology and productivity, see Alene (2010); Alston *et al.* (2009); Saha *et al.* (2014); Sanders *et al.* (2014).

favorable scenery for the growth of soybean demand. Although this product is a primary commodity and currently the world economies are more focused on boosting their food processing sectors, the bright perspectives for this product should encourage the main exporting countries to improve their productivity.

References

- Alene, A. D. (2010). Productivity growth and the effects of R&D in African agriculture. *Agricultural Economics, 41*(3-4), 223-238.
- Alston, J. M., Chan-Kang, C., Marra, M. C., Pardey, P. G., and Wyatt, T. J. (2000). A meta-analysis of rates of return to agricultural R&D: Ex pede Herculem? *Intl Food Policy Res Inst.*
- Alston, J. M., Beddow, J. M., and Pardey, P. G. (2009). Agricultural research, productivity, and food prices in the long run. *Science (New York, N.Y.), 325*(5945), 1209-1210.
- Andino, J., Mulik, K., and Koo, W. W. (2005). The impact of Brazil and Argentina's currency devaluation US soybean trade *Center for Agricultural Policy and Trade Studies, Department of Agribusiness and Applied Economics, North Dakota State University.*
- Arima, E. Y., Richards, P., Walker, R. and Caldas, M. M. (2011). Statistical confirmation of indirect land use change in the Brazilian Amazon. *Environmental Research Letters, 6*(2), 024010.
- Balassa, B. (1965). Trade liberalisation and “revealed” comparative advantage. *The Manchester School*, 33(2), 99-123.
- Barretto, A. G., Berndes, G., Sparovek, G., and Wirsenius, S. (2013). Agricultural intensification in Brazil and its effects on land-use patterns: An analysis of the 1975–2006 period. *Global Change Biology, 19*(6), 1804-1815.
- Basarac Sertić, M., Vučković, V., and Škrabić Perić, B. (2015). Determinants of manufacturing industry exports in European Union member states: A panel data analysis. *Ekonomska Istraživanja, 28*(1), 384-397.
- Bianchi, E. and Szpak, C. (2017). *Soybean prices, economic growth and poverty in Argentina and Brazil*. FAO
- Boerema, A., Peeters, A., Swolfs, S., Vandevenne, F., Jacobs, S., Staes, J., and Meire, P. (2016). Soybean Trade: Balancing Environmental and Socio-Economic Impacts of an Intercontinental Market. *PloS one*, *11*(5), e0155222.

- Bojnec, Š, and Fertő, I. (2015). Agri-food export competitiveness in European Union countries. *JCMS: Journal of Common Market Studies, 53*(3), 476-492.
- Brookes, G., and Blume, Y. (2012). The potential economic and environmental impact of using current GM traits in Ukraine arable crop production. *Institute of Food Biotechnology and Genomics, Kiev, Ukraine*.
- Carraressi, A. and Banterle, l. (2015). Agri-food Competitive Performance in EU Countries: A Fifteen-Year Retrospective. *International Food and Agribusiness Management Review,* 18 (2), 27-62.
- Cattaneo, A., Barbier, E. B., and Burgess, J. C. (2001). Deforestation in the Brazilian Amazon: comparing the impacts of macroeconomic shocks, land tenure, and technological change. *Land Economics*, 77(2), 219-240.
- Chekhov, S. (2015). Functioning of the market of soybean in Ukraine. *ЕкономікаIРегіон,* (4), 61-66.
- Craig, B.J., P.G. Pardey and J. Roseboom (1997), International productivity patterns: Accounting for input quality, infrastructure, and research. *American Journal of Agricultural Economics*, 79, 1064-1076.
- Coşar, A. K., Grieco, P. L., Li, S., and Tintelnot, F. (2018). What drives home market advantage? *Journal of International Economics*, *110*, 135-150.
- Deininger, K. (2013). Global land investments in the bio-economy: Evidence and policy implications. *Agricultural Economics, 44*(s1), 115-127.
- Eriksson, M., Ghosh, R., Hansson, E., Basnet, S., and Lagerkvist, C. J. (2018). Environmental consequences of introducing genetically modified soy feed in Sweden. *Journal of Cleaner Production*, 176, 46-53.
- Evenson, R. E., and Alves, D. C. (2009). Technology, climate change, productivity and land use in Brazilian agriculture. *Planejamento e politicas publicas*, (18).
- Feenstra, R.C., Markusent, J.A., and Rose, A.K. (2001). Understanding the home market effect and the gravity equation: The role of differentiating goods. Working Paper, 6804, NBER, Cambridge, MA.

- Fernández-Núñez, M.T., and Márquez, M. (2014). The dynamics of trade composition: Do trade-type interdependencies matter? *The Journal of International Trade & Economic Development, 23*(5), 710-734.
- Fischer, C. and Schornberg, S. (2007). Assessing the Competitiveness situation of EU food and drinnk manufacturing industries: an index- based approach. *Agribusiness, 23(4*), 473-495.
- Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., and Helkowski, J. H. (2005). Global consequences of land use. *science*, *309*(5734), 570-574.
- Food and Agriculture Organization of the United Nations. (2017).
- Fukase, E., and Martin, W. (2016). Who will feed china in the 21st century? Income growth and food demand and supply in china. *Journal of Agricultural Economics, 67*(1), 3-23.
- Ghazalian, P. L., and Furtan, W. H. (2007). The effect of innovation on agricultural and agri-food exports in OECD countries. *Journal of Agricultural and Resource Economics*, 448-461.
- Goldsmith, P. D. (2008). Economics of soybean production, marketing and utilization. *Soybeans Chemistry, Production, Processing, and Utilization,* 117-150.
- Goldsmith, P., and Hirsch, R. (2006). The Brazilian soybean complex. *Choices, 21*(2), 97-103.
- Gorton, M., and Davidova, S. (2001). The international competitiveness of CEEC agriculture. *The World Economy*, 24(2), 185-200.
- Grau, H. R., Gasparri, N. I., and Aide, T. M. (2005). Agriculture expansion and deforestation in seasonally dry forests of north-west Argentina. *Environmental Conservation*, *32*(2), 140-148.
- Gupta, S. (2015). Comparative Advantage and Competitive Advantage: An Economics Perspective and a Synthesis. *Athens Journal of Business and Economics*, 1(1) 9-23.

- Harvey, D., Hubbard, C., Gorton, M. and Tocco B. (2017). How Competitive is the EU's Agri-Food Sector? An introduction to a Special Feature on EU Agri-Food Competitiveness. *Journal of Agricultural Economics, 68 (1)*, 199-205
- Hausmann, R., and Klinger, B. (2007). Growth diagnostic: Paraguay. *Centre for International Development. Harvard University*.
- Helpman, E., and Krugman, P. R. (1985). Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy. *MIT press*.
- Huerta, A. I., and Martin, M. A. (2002). Soybean production costs: An analysis of the United States, Brazil, and Argentina. *AAEA Annual Meeting. Long Beach, CA*.
- Huffman, W.E., and R. Evenson (1993), Science for Agriculture. *Iowa State Press, Ames, IA*.
- Huffman, W. E. (2001). Human capital: Education and agriculture. *Handbook of Agricultural Economics, 1*, 333-381.
- Jambor, A., and Baabu, S. (2016). Competitiveness of Global Agriculture. *Springer International Publishing Switzerland*.
- Jenkins, R. (1996). Trade liberalization and export performance in Bolivia. *Development and Change, 27*(4), 693-716.
- Jensen, P.E. (2006). Trade, entry barriers, and home market effects. *Review of Inernational Economics*, 14(1), 104-118.
- Kalkuhl, M., and Edenhofer, O. (2017). Ramsey meets Thünen: the impact of land taxes on economic development and land conservation. *International Tax and Public Finance*, *24*(2), 350-380.
- Lambin, E. F., and Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences of the United States of America, 108*(9), 3465-3472.
- Larson, D. W., and Rask, N. (1992). Changing competitiveness in world soybean markets. *Agribusiness, 8*(1), 79-91.

- Latruffe, L. (2010). Competitiveness, productivity and efficiency in the agricultural and agri-food *sectors*. *OECD Food, Agriculture and Fisheries Papers, 30,* OECD Publishing, Paris.

- Le Polain de Waroux, Y., Garrett, R., Graesser, J., Nolte, C., White, C and Lambiem, E. (2017). The Restructuring of South American Soy and Beef Production and Trade under Changing Environmental Regulations. *World Development*.

- Lee, T.S.; Tran A., Hansen J. and Ash M. (2016). Major Factors Affecting Global Soybean and Products Trade Projections. *USDA ERS Amber Waves*.
- López, R., and Galinato, G. I. (2005). Trade policies, economic growth, and the direct causes of deforestation. *Land economics*, *81*(2), 145-169.
- Macedo, M. N., DeFries, R. S., Morton, D. C., Stickler, C. M., Galford, G. L., and Shimabukuro, Y. E. (2012). Decoupling of deforestation and soy production in the southern Amazon during the late 2000s. *Proceedings of the National Academy of Sciences of the United States of America*, 109(4), 1341–1346.
- Maertens, M. (2009). Horticulture exports, agro-industrialization, and farm–nonfarm linkages with the smallholder farm sector: Evidence from Senegal. *Agricultural Economics, 40*(2), 219-229.
- Mallory, M. L., Hayes, D. J., and Babcock, B. A. (2011). Crop-based biofuel production with acreage competition and uncertainty. *Land Economics*, *87*(4), 610-627.
- Masuda, T., and Goldsmith, P. D. (2009). World soybean production: Area harvested, yield, and long-term projections. *International Food and Agribusiness Management Review, 12*(4), 143-162.

- McFarlane, I., and O'Connor, E. (2014). World soybean trade: Growth and sustainability. *Modern Economy, 5*(5), 580-588.

- Meade, B., McBride, W. D., Puricelli, E., Valdes, C., Hoffman, L., Foreman, L., and Dohlman, E. (2016). Corn and soybean production costs and export competitiveness in Argentina, Brazil, and the United States. *Economic Research Service, United States Department of Agriculture.*

- Medic, J., Atkinson, C., and Hurburgh, C. R. (2014). Current knowledge in soybean composition. *Journal of the American oil chemists' society*, *91*(3), 363-384.
- Moon, W., Shin, H.J. and Pino, G. (2016). The state as a determinant of the pattern of agricultural trade, in Santos (2016), Trade Liberatization. *Nova Science Publishers, Inc*.
- Narayanan, S. (2016). The productivity of agricultural credit in India. *Agricultural Economics, 47*(4), 399-409.
- Naseem, A., Spielman, D. J., & Omamo, S. W. (2010). Private-sector investment in R&D: a review of policy options to promote its growth in developing-country agriculture. *Agribusiness*, *26*(1), 143-173.
- Oviedo, E. D. (2015). Argentina and China: An analysis of the actors in the soybean trade and the migratory flow. *Journal of Chinese Political Science, 20*(3), 243-266.
- Panichelli, L., Dauriat, A., and Gnansounou, E. (2009). Life cycle assessment of soybean-based biodiesel in Argentina for export. *The International Journal of Life Cycle Assessment, 14(2)*, 144-159.
- Pardey, P. G., Alston, J. M., and Piggott, R. (2006). Agricultural R and D in the developing world. *Intl Food Policy Res Inst.*
- Peterson, E. and Varullu, S. (2000). Agricultural comparative advantage and government policy interventions, *Journal of Agricultural Economics,* 51(3), 371-387.
- Porter, M. (1980). Competitive strategy: Techniques for analyzing industries and competition. *New York*, *300*, 28.
- Porter, M. (1990). The Competitive Advantage of Nations. *New York: The Free Press*.
- Qaim, M., and Traxler, G. (2005). Roundup ready soybeans in Argentina: Farm level and aggregate welfare effects. *Agricultural Economics, 32*(1), 73-86.
- Regunaga, M. (2010). Implications of the organization of the commodity production and processing industry case studies in Latin America and the

Caribbean region: The soybean chain in Argentina. *Working Paper, the World Bank Latin America and the Caribbean Chief Economist Office.*

- Saghaian, S. Y. (2017). Export demand estimation for US corn and soybeans to major destinations.
- Saha, B., Sarker, R., and Mitura, V. (2014). Impact of genetically engineered varieties on the cost structure of corn and soybean production in Canada. *Canadian Journal of Agricultural Economics/Revue Canadienne D'Agroeconomie, 62*(2), 263-282.
- Sanders, D. R., Altman, I. J., and Ferraro, N. (2014). Technological advances in soybean yields: A disaggregated approach. *Agribusiness, 30*(2), 207-221.
- Sarker, R., and Ratnasena, S. (2014). Revealed comparative advantage and Half-a-Century competitiveness of Canadian agriculture: A case study of wheat, beef, and pork sectors. *Canadian Journal of Agricultural Economics/Revue Canadienne D'Agroeconomie, 62*(4), 519-544.
- Serrano, R. and Pinilla, V. (2014). Changes in the structure of world trade in the agri-food industry: The impact of the home market effect and regional liberalization from a long-term perspective, 1963-2010, *Agribusiness,* 30(2) 165-183.
- Simoes, AJG., Hidalgo, CA. (2011). The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. *Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence*.
- Tilman, D. and Clark, M. (2014). Global diets link environmental sustainability and human health, *Nature, 515*, 518-522.
- UN Comtrade Database. (2017)
- US International Trade Commission. (2012). Brazil: Competitive factors in Brazil affecting US and Brazilian agricultural sales in selected third country markets. *USITC, Washington DC.*
- van Leeuwen, M., Salamon, P., Fellmann, T., Banse, M., von Ledebur, O., Salputra, G., and M'barek, R. (2012). The agri-food sector in Ukraine: Current

situation and market outlook until 2025. *Seville, Spain: JRC Scientific and Policy Reform*

- Westcott, P. and Hansen J. (2016). *Agricultural Projections 2025.*USDA Economic Research Service.
- White, E. N., & Hewings, G. J. (1982). Space-Time Employment Modeling: Some Results Using Seemingly Unrelated Regression Estimators. *Journal of Regional Science*, *22*(3), 283-302.
- Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association, 57*(298), 348-368.
- Zhang, Q., Reed, M. R., and Saghaian, S. H. (2010). The impact of multiple volatilities on import demand for US commodities: The case of soybeans. *Agribusiness, 26*(2), 202-219.

CHAPTER 2: ANALYZING THE GROWTH OF INTERNATIONAL TRADE: LOOKING FOR A MORE COMPREHENSIVE SHIFT-SHARE

Abstract

The performance of countries in international trade has received great attention in the studies of the current world economy. The main purpose of this paper is to propose a new technique based on the traditional-shift share to decompose the growth rates of trade variables. The new technique provides similar information to that offered by the traditional shift-share, since the classical version is nested in the new version. However, the proposed technique offers an expanded capacity of analysis that includes new relevant effects, while maintaining the simplicity and ease of interpretation of the traditional one. In order to illustrate this more comprehensive shift-share data on soybean seed exports of the top exporters worldwide for the 1996-2015 period were used. The exporters analyzed are classified in terms of their performance to offer policy guidelines based on the Boudeville's Classification. The results and the subsequent classification in this scenario give helpful insights to understand export growth processes. In this way, our findings suggest there is much to benefit from adopting this technique for studying the decomposition of changes in economic variables, especially in the case of international trade performance.

Keywords: shift-share analysis, international trade, Boudeville's Classification, soybeans.

CAPÍTULO 2: ANÁLISIS DEL CRECIMIENTO DEL COMERCIO INTERNACIONAL A TRAVÉS DE UN SHIFT-SHARE MÁS COMPRENSIVO

Resumen

El desempeño de los países en el comercio internacional ha recibido gran atención en los estudios recientes de economía mundial. El principal objetivo de este capítulo es proponer una nueva técnica basada en el *shift-share* tradicional para descomponer la tasa de crecimientos de variables del comercio internacional. La nueva técnica provee información similar a la ofrecida por la descomposición tradicional, ya que la versión clásica está integrada a la versión completa. Sin embargo, la técnica propuesta ofrece una capacidad de análisis expandido que incluye efectos relevantes mientras que mantiene la simplicidad y facilidad de interpretación característicos del *shift-share* tradicional. Para ilustrar el uso de la nueva propuesta se utilizan datos de las exportaciones de granos de soja de los principales países exportadores a nivel mundial para el periodo 1996-2015. Los exportadores analizados son clasificados en términos de su desempeño para ofrecer implicaciones de políticas públicas, basadas en la Clasificación de Boudeville. Los resultados y la clasificación hecha en este escenario brindan información útil para comprender los crecimientos en los procesos de exportación. De esta manera, nuestros hallazgos sugieren que existen muchos beneficios derivados de la adopción de esta técnica para estudiar la descomposición de cambios en variables económicas, especialmente en el caso del comercio internacional

Palabras clave: análisis *shift-share*, comercio internacional, Clasificación de Boudeville, grano de soja.

2.1 Introduction

The shift-share approach has been traditionally used to analyze the growth rates of economic variables. The original technique decomposes growth in effects related to three determinant variables: geographic reference areas, industry mix or structural effect, and regional competitiveness (Dunn 1960). The widespread use of shift-share analysis has been associated with its simplicity: a minimum amount of data is required to provide reasonable and useful results. Thus, shift-share has been employed in the study of different issues such as productivity, inequality, and tourism, among others (Dinc and Haynes, 2005; Dogru and Sirakaya-Turk, 2017; Espa et al., 2016; Grossi and Mussini, 2018).

In recent decades there has been an exponential growth in the number of studies related to the theory and applications of shift-share. With regard to international trade, different papers have followed the guidelines provided by authors like, among others, Markusen et al., 1991 and Dinc and Haynes, 1998, where the focus has been on the use of international trade as a link between regional economies and the global economy. Although there have been several contributions in this line of research, the literature on shift-share including theory and methodology and incorporating comprehensive analysis of the main variables of international trade has not been sufficiently developed. However, the shift-share technique could give an overview of the factors that drive the growth of exports or imports in a certain country by making sectorial and regional comparisons. Hence, it could assess the impact of industry structure on international trade growth (industry mix or structural effect). In addition to this, it could indicate how competitive a country is in regional or international markets (regional or competitive effect). Therefore, the analysis of international trade could benefit not only from the information that the decomposition provides, but from the ease of its application, without the need to draw upon more complex techniques.

Despite the potential usefulness of shift-share for the analysis of international trade variables, most previous studies have preferred the use of other methodologies. The most common framework to study the decomposition of international trade variables has been the Constant Market Share -CMS- (among others, Chami Batista and Liu, 2017; Cheptea *et al,* 2005; Cheptea *et al*., 2014; Fagerberg, 1988; Lakkakula *et al.,* 2015). The CMS decomposes growth rates into different effects in a similar way to the traditional shift-share. But the CMS analysis incorporates export destinations within the decomposition instead of considering exports of the country studied. In consequence, the focus of the CMS method differs substantially from that of the traditional shift-share. In addition to this, the technical characteristics that the application of CMS requires subtract simplicity to the approach.

Starting from the traditional shift-share decomposition, this paper tries to obtain a wider picture of factors that affect the performance of the variable under study. The objective of this proposal is to capture new effects that could have an impact on the growth of exports. Besides, the suggested technique intends to explore hypotheses derived from the relevance of sectoral and structural characteristics of the analyzed country, that is, internal effects[25]. Even though the new decomposition has been designed for international trade, its general formulation allows its application to other contexts.

In order to illustrate the application of shift-share to international trade, the case of the soybean seed exports worldwide is studied. Soybean is one of the most traded agricultural commodities in the world and its exports grew from US$ 9.56 billion in 1996 to more than US$ 59 billion in 2015 (UN Comtrade, 2017). Soybean seed exports have been historically very concentrated in a reduced group of countries. Argentina, Brazil, and the United States have been the absolute leaders of soybean exports. To a lesser extent, Canada, Paraguay, and Ukraine have also placed their soybean production in the international market. All these countries together controlled more than 94% of global soybean exports in 2015. Thus, this study focuses on factors affecting the change in soybean export growth of the top six main exporters in the world over the 1996-2015 period, using a more comprehensive decomposition scheme than the traditional shift-share approach.

The novelty of this paper lies in the following aspects. Firstly, after an analysis of CMS, the paper describes the benefits of the traditional shift-share for studying this phenomenon. Secondly, it presents an extension of this approach. This methodological contribution is carried out through the incorporation of new effects to capture all the existing interactions among the variables considered. Thirdly, the new technique is applied to the case of soybean seed exports. Fourthly, Boudeville's (1966) method is used to propose a classification of the exporters according to their performance in terms of the traditional and new internal effects. This way, this classification allows to suggest policy

[25] In this paper, the concept of "internal effect" refers to the effects related to the country studied, which are those taking place within its territory.

guidelines for each exporter, taking into account the commercial environment in which they operate. Finally, the study shows the relevance that these effects had on the soybean exports of each country, through the estimation of regressions using data from its top six exporters and the Rest of the World (ROW).

The results suggest that a more comprehensive shift-share would be a useful tool for the analysis of changes in exports. The proposed extension complements and reinforces the findings of the traditional shift-share. From this application, it can be concluded that the traditional competitive effect and the two new internal effects (internal structure and sectoral effects) have been crucial factors for the growth of soybean seed exports worldwide during the 1996-2015 period. These results confirm that the traditional decomposition has a great explanatory power, but it omits internal effects. Consequently, the traditional decomposition is hiding relevant effects that could help to understand the change in the exports.

The remainder of this article is organized as follows. Section two provides a literature review related to shift-share analysis and its application to international trade. Section three presents the analysis and the extension of the shift-share. Section four describes the trends in soybean global exports and discusses the estimation results. Finally, section five offers final remarks and conclusions.

2.2 Literature review

The traditional shift-share assesses the growth of specific variables in particular regions by taking into account relative sectors in other regions. For this purpose, it employs three effects that measure different factors: the influence of a geographical area (national or regional), the impact of industry structure, and the competitiveness of the analyzed region.

Several improvements and extensions have been made to the original shift-share proposed by Dunn (1960). The criticism to the framework mainly attributed to the competitive effect and its inability to isolate competitiveness from the other effects, contributed to new methodological formulations (Cunningham, 1969; Houston, 1967; Rosenfeld, 1959). In this regard, one of the most popular revision was proposed by Esteban-Marquillas (1972)[26] and extended by several authors through the addition of more effects to widen the scope of this technique[27] (among others, Arcelus, 1984; Haynes and Dinc, 1987; Qiangsheng *et a*l., 1997). Notwithstanding the limitations of the traditional shift-share and of the Esteban-Marquilla's technique, they have been widely employed to study the changes of economic variables, and as a consequence, to propose policy guidelines. In this regard, Boudeville (1966) noted that the calculation of the effects related to the industry structure and competitiveness, enables an eight-fold classification of regional types. Therefore, the use of the Boudeville's regional classification have helped to find the most suitable policy guideline for each region, in order to improve their economic development (Andrikopoulos, 1980, Edwards, 1976, Stilwell, 1969).

Another body of literature has incorporated new variables into the decomposition (e.g. productivity, inequality, tourism) to adapt this technique to different fields of study. Among them, the most popular version incorporates the variable of productivity through the evaluation of the significance of regional differences in labor and capital (inputs) on

[26] This decomposition computes the competitive effect as the difference between sectoral regional and national growth rates, weighted by the national economic structure. But this correction implies the inclusion of a residual component called the "allocation component". The main criticism of this version of the shift-share has been the lack of economic interpretation of the "allocation effect". Although it has been considered a residual term, according to Artige and van Neuss (2014), its economic meaning has been evaded and often omitted in applied research.

[27] All the shift-shares that use the Esteban-Marquillas model as a baseline present the same problem. In consequence, the use of these decompositions could lead to a limited analysis of the changes in economic variables.

employment changes (Dinc and Haynes, 2005; Haynes and Dinc, 1997; Rigby and Anderson, 1993). Another popular extension of shift-share analysis has been related to the incorporation of a spatial structure within the decomposition. In this fashion, some authors have proposed a shift-share that studies changes in variables of a region as a function of their geographical neighbors (among others, Espa *et al.,* 2014; Grossi and Mussini, 2018; Nazara and Hewings, 2004).

On the other hand, international trade, a field that has played a central role in the world economy, is in need of new study techniques that are analytical yet straightforward. There is no country in the world that does not currently participate in global trade (Chiang, 2012). Although the literature has incorporated international trade within shift-share analysis, the usual practice has been to adopt this variable as part of the decomposition with the goal of analyzing changes in national employment. In this way, the effect of this phenomenon on other variables is appraised. For example, some authors introduced the value of production, exports, imports, domestic demand, and productivity to assess changes on national employment (among others, Dinc and Haynes, 1998; Fotopoulos, 2009; Markusen *et al.,* 1991). Other authors such Sihag and McDonough (1989) replaced the use of national economy with that of the world economy to reflect that international trade is also relevant in the analysis of national employment. Chiang (2012) also studied the change on employment due to exports, but separating this effect into a domestic and a foreign part. In such a manner, it can be determined whether the analyzed region has comparative advantages in international trade.

Despite the use of the traditional shift-share in a variety of areas, its direct application to international trade has been scarce. Although the few studies that used Dunn's decomposition to analyze export performances have obtained useful results (see Peh and Wong, 2009; Wilson and Mei, 1999), previous works have mostly applied a variation of shift-share analysis: the CMS (e.g., Chami Batista and Liu, 2017; Cheptea *et al*., 2005; Cheptea *et al*., 2014; Lakkakula *et al,*. 2015).

The CMS was introduced by Tyzynski (1951) to study the relation between the structural changes in world trade and the export performance of the countries. For this purpose, it decomposes the export shares in effects related to the structure of the world trade and changes in the export destinations of the country. Like the traditional shift-share, it has been subject of extensions and criticisms. Regarding its extensions, Leamer and Stern (1970) proposed a new version of this method by incorporating a new effect that study the geographical distribution of a country's export[28]. Fagerberg and Sollie (1987) presents a CMS with five effects, where the two new effects measure the country's ability to adapt their export structure to changes in the commodity and market composition of world imports, respectively. Milana (1988) reformulated the CMS using the index number theory and obtained a CMS without a residual term. Cheptea *et. al.* (2005, 2014) also presented a reformulation of the CMS that consider the geographical and sectoral dimension of countries' initial position on different import markets and of their capacity to adapt to shifts in the world economy.

In spite of the several contributions to CMS framework, it has received some objections. The incorporation of the import side in its formulation generates a residual term. Then, the criticism to the technique have been regarding to the interpretation of this residual effect (see Baldwin, 1958; Reymert and Schultz, 1985; Richardson, 1971). On the other hand, the use of imports to evaluate exports also requires more data than the traditional approach. This characteristic of CMS implies some difficulties and limitations that can be avoided by using the traditional shift-share for the analysis of international trade.

In this paper, it is claimed that the adoption of standard shift-share as an analytical technique should be more frequent in the study of international trade, since the potentialities of this method have not been exhausted in this area. In addition to this, it is argued that a shift-share to analyze international trade should incorporate the totality of the possible effects that generate changes on the variables. However, as mentioned above, while part of the literature has focused on correcting for problems detected in the original formulation, another part has developed new decompositions to capture more effects or to incorporate new variables. Thus, as it will be shown later, components related to the internal structure have generally been missing in the traditional decomposition and as a consequence, in the analysis of changes in economic variables.

In summary, this paper aims to enrich the existing literature, encouraging the use of the shift-share in the field of international trade. Hence, this work intends to cover a direct application of the shift-share to international trade which is missing in the literature.

[28]The new effect was denominated the effect of the market distribution of country's exports. Note that unlike Tyszynski (1951), this paper studied the export growth instead of export shares.

The main objectives are to provide another option besides CMS to study exports and imports, as well as to employ international trade as a variable of interest instead of considering it as an explanatory variable. Additionally, a new extension of the shift-share decomposition is presented through the introduction of new components that will try to measure all the possible factors that have an impact on the variable under study. Finally, a Boudeville's classification applied to international trade is presented. In this way, it is possible to classify the regions based on their performance in exports.

The usefulness and practicality of the comprehensive shift-share to analyze exports and imports should place this tool in a prominent position among international trade analysis techniques. With respect to the new components, special attention will be given to the so-called internal context, since it constitutes a significant source for understanding changes in exports. This improved shift-share technique would be effective not only for the analysis of international trade, but also as a relevant framework in regional and sectoral economics.

2.3 Method of analysis: shift-share applied to exports

In this paper, exports (X) at time t will be used as variable of interest. Thus, for a country j, and a product i that is included in sector m , four variables are defined:

- $g_i = (X_{i,j}^{t+1} - X_{i,j}^{t})/X_{i,j}^{t}$ denotes the annual growth rate of exports of product i for country j.
- $g = (X_j^{t+1} - X_j^{t})/X_j^{t}$ denotes the annual growth rate of exports of sector m for country j.
- $G_i = (X_i^{t+1} - X_i^{t})/X_i^{t}$ is defined similarly to g_i but at the world level, denoting the annual growth rate of world exports of product i.
- $G = (X^{t+1} - X^{t})/X^{t}$ is the equivalent to g at the world level, representing the annual growth rate of world exports of sector m.

Note that the presence of the subscript i refers to the product, while its absence represents the sector m, and that lowercase variables refer to the country j, while the uppercase variables refer to the world.

The original decomposition proposed by Dunn (1960) applied to exports is as follows:

$$g_i X_{i,j}^{t} = \sum_i G X_{i,j}^{t} + \sum_i (G_i - G) X_{i,j}^{t} + \sum_i (g_i - G_i)\, X_{i,j}^{t} = GE + IM + CE \quad (2.1)$$

where the three traditional effects have the following definitions:

- $GX_{i,j}^{t}$ is the global effect (GE) and is equivalent to the “national effect” of the traditional shift-share. GE measures the influence of world’s sector m on exports of product i. This classical component determines if the growth is motivated by the dynamism of sector m at world level.
- $(G_i - G)X_{i,j}^{t}$ is the industrial mix or structural effect (IM). It gives insights of the trends followed by the world in terms of industry structure. This effect evaluates whether product i is more or less dynamic than sector m as a whole in global markets.

- $(g_i - G_i)\, X_{i,j}^t$ is the competitive or regional effect (CE). It is the only effect within the original decomposition that compares the performance of the world and country j. The competitive effect establishes whether the exports of product i from the analyzed country have more or less dynamism than those from the entire world.
- Additionally, $(g_i - G)\, X_{i,j}^t$ is known as the net effect within the literature and it is implicitly collected in expression (2.1).

The traditional shift-share decomposition assesses the growth of exports in three ways. First, through the evaluation of the global exports of sector m. This allows for understanding how sectoral growth could favor the exports of a certain product. Second, by focusing on the structure of the world industry. Accordingly, the countries that export the products with highest growth could benefit from a favorable industry mix effect, and vice versa. Third, by comparing the performance of country j and the world in terms of the exports of product i. Through this effect, the traditional shift-share sheds light on the advantages that countries could have in the exports of a product. In summary, this framework could provide an intuitive and simple way to explore the drivers of changes in exports of a country.

In spite of the above-mentioned capabilities of the traditional shift-share, the most applied technique to international trade has been the so-called constant market share (CMS). Similarly to the shift-share, the deterministic CMS is based on the decomposition of export growths (Cheptea *et al.,* 2014). The following expression gives the identity:

$$g_i X_{i,j}^t = \sum_i G X_{i,j}^t + \sum_i (G_i - G) X_{i,j}^t + \sum_i \sum_p \left(G_{i,p} - G_i\right) X_{i,p,j}^t + \sum_i \sum_p \left[X_{i,p,j}^{t+1} - X_{i,p,j}^t \left(1 + G_{i,p}\right)\right]$$

$$= GE + IM + GEO + PERF \tag{2.2}$$

where $X_{i,p,j}^{t+1}$ and $X_{i,p,j}^t$ represent the exports of product i from country j to country $p,$ at time $t+1$ and t, respectively. G_{ip} represents the annual growth rate of global exports of product i to country p. In addition to this, GEO and $PERF$ are the geographic structure effect and export competitiveness effect, respectively.

The main novelty of CMS is the collection of effects related to export destinations. According to Cheptea *et al.* (2005), the countries with a good position in the most dynamic import countries will benefit from a favorable geographic effect. Then, this technique offers information on advantages due to the strength of relationships with importers.

Unlike traditional shift-share, the right side of expression (2.2) presents four effects instead of three. Thus, to compare the information displayed by both techniques, a parallelism between the traditional effects and those contributed by CMS is presented:

- The traditional national effect (global effect in this paper) and the industry mix effect are maintained by CMS. Hence, both techniques specify the same information in these cases.
- The third component on the right side of expression (2.2) is the geographic structure effect (GEO). It measures the importance of destination p for the exports of product i. The geographic structure effect differs from the traditional competitive effect since it evaluates the performance according to export destinations (p), instead of considering the exports of country j, as the traditional shift-share does.
- $PERF$ is defined as the export competitiveness effect. It is computed as the residual growth rate after deducing the contribution of structural effects. This effect from CMS has no equivalent in the traditional decomposition.

Although CMS and the traditional shift-share have a similar baseline, the information collected by both techniques differs in the measurement of their respective competitive effects. Specifically, the competitive effect of the traditional shift-share (CE) is focused on the exports of country j (g_i as main variable). In contrast, the geographic structure and export competitiveness effect (GEO and $PERF$, respectively) of CMS are based on export destinations, since $G_{i,p}$ is employed as main variable to evaluate export variations.

2.3.1. A critical assessment of CMS with respect to the traditional shift-share

The CMS is a useful tool to decompose changes in exports. Nevertheless, there are some difficulties in its application, especially if the original proposal by Dunn is considered as a valid approach to study the growth of international trade.

First, CMS replaces the traditional competitive effect with the geographical structure and export competitiveness effects, eliminating an important source of information. In this way, CMS approach unnecessarily forsakes the study of the comparative advantage of countries, one of the most valuable components in terms of trade. It is noteworthy that calculating this effect is extremely simple and does not require additional data. Therefore, a framework for analyzing international trade should maintain the traditional competitive effect.

Second, CMS incorporates export destinations within the decomposition, which generates two disadvantages. On the one hand, the use of data referring to exports toward specific markets requires the assumption of stability in export destinations over time. Nevertheless, such stability is atypical in international trade. To overcome this situation, the average of $X_{i,p,j}$ has been used in the literature[29]. However, this solution could generate a limited view of the phenomenon under study. To illustrate this problem, Table 2.8 displays the existence of important changes in destinations of soybean exports during the time period under study. Thus, the use of CMS could bias the result and, consequently, it could lead to inaccurate explanations of changes occurred in soybean exports. On the other hand, the use of export destinations requires more data availability, whereas one of the most valuable features of shift-share analysis has always been its minimum data requirement (Dinc and Hayness, 2005).

Third, CMS focuses on global performance and export destinations (see that G_i and $G_{i,p}$ are the variables involved in expression (2.2). While this technique considers foreign markets and world performance, it ignores effects that the internal structure of industry might have on exports. Yet there is no immediate reason to prefer studying the effects of destination markets and global exports instead of internal conditions. Furthermore, there is no evidence to affirm that internal characteristics of the countries do not affect export activity.

[29] For example, Lakkakula *et al.* (2015) calculated the average of $X_{i,p,j}$ every five years.

Fourth, there has not been a consensus on the interpretation of the residual term ($PERF$). While some authors argued that it is a genuine measure of competitiveness (Richardson, 1971a), other claimed that it has not an economic meaning (among others, Reymertt and Schultz, 1985).

Table 2.8: Changes in destinations* of soybean exports, 1996, 2005, and 2015 (% of total soybean exports in millions of dollars)

	ARG			BRA			CAN		
	YEAR			YEAR			YEAR		
Importer	**96**	**05**	**15**	**96**	**05**	**15**	**96**	**05**	**15**
China	11.58	75.23	82.92	0.42	32.12	75.24	0.55	1.06	25.16
Germany	7.91	0.02	0.00	5.65	4.20	0.84	1.64	0.13	1.66
Indonesia	0.00	1.68	0.00	0.24	0.00	0.01	0.45	3.00	1.15
Japan	0.07	0.00	0.00	8.54	1.81	0.88	12.14	31.30	13.89
Mexico	0.00	0.32	0.00	0.00	0.17	0.00	0.05	1.78	0.00
Netherlands	32.58	0.00	0.00	57.22	22.70	2.77	10.56	5.40	7.36
Russia	0.00	0.00	0.00	0.00	0.02	1.10	0.00	0.39	0.07
Spain	19.42	0.08	0.00	8.46	9.25	4.33	7.26	0.94	0.10
Thailand	0.00	5.36	1.16	0.24	2.74	3.21	0.26	0.33	1.84
Turkey	0.30	2.07	0.00	0.09	0.58	0.24	0.00	0.51	2.80
	PRY			**UKR**			**USA**		
	YEAR			**YEAR**			**YEAR**		
Importer	**96**	**05**	**15**	**96**	**05**	**15**	**96**	**05**	**15**
China	0.00	0.00	0.00	0.00	0.00	0.06	5.56	35.56	55.59
Germany	0.02	0.08	12.63	0.00	0.00	0.20	5.22	3.14	4.28
Indonesia	0.00	0.00	0.00	0.00	0.00	0.00	2.86	4.78	4.09
Japan	0.00	0.00	0.01	0.00	0.00	0.02	15.35	12.76	5.57
Mexico	0.00	0.00	5.49	0.00	0.00	0.00	11.52	13.52	7.59
Netherlands	45.53	5.62	2.27	0.00	0.02	0.38	12.02	1.84	2.41
Russia	0.00	0.00	24.10	0.00	0.53	0.00	0.00	0.00	1.00
Spain	0.00	0.00	6.98	0.00	0.00	2.92	4.73	1.09	2.06
Thailand	0.00	0.00	0.04	0.00	0.00	0.00	1.69	1.32	1.21
Turkey	0.00	0.00	6.77	0.00	25.07	47.44	0.55	1.77	0.97

Notes: *The destinations selected for this table correspond to the top importers of soybean at world level. These countries represent more than 80% of soybean global imports (UN Comtrade, 2017).
Millions of dollars, 2010=100
Source: Author's elaboration with data from UN Comtrade.

All this does not mean that CMS is incorrect or that it does not provide useful insights on the changes of exports. In fact, despite the drawbacks generated by the consideration of export destinations, CMS establishes a relationship between the role of importers and export growth. That is, CMS expands the vision of the shift-share to analyze the export activity. Therefore, in this paper, it is claimed that although the use of CMS is appropriate to understand this variable, the traditional shift-share approach should be used before to analyze the export destinations, this is, before to apply CMS.

However, it is important to note that the traditional shift-share (see expression (2.1)) places more emphasis on variables related to world performance. In fact, as previously mentioned, only the competitive effect includes a variable related to the country analyzed (g_i). Nevertheless, exports might depend not only on effects that other geographical areas have on the country, but also on internal conditions. Therefore, there is another missing step between the use of the traditional shift-share and the adoption of CMS (see Figure 2.1). This missing step is related to the examination of effects that contemplate the internal performance of the economy under study that has not been completely explored in the literature.

Figure 2.1: Explanatory scheme of the missing step between the traditional shift-share and CMS

Source: Author's elaboration

Previous research has not analyzed all the possible effects derived from the interactions among product i, sector m, country j, and the world. In this way, if all the possibilities derived from the differences among the variables (g_i, G_i, g and G) were contemplated, there would be 12 combinations (see Table 2.9). Note that there are symmetrical effects, for example $(g_i - G_i)$ and $(G_i - g_i)$; so, it would be sufficient to take only one of each pair to capture the interaction. Consequently, there are six interactions to consider. This proposal selects the interactions that appear in the original decomposition and adds the missing effects.

According to Table 2.9, the traditional shift-share considers three of the six interactions shown. The industrial mix effect $(G_i - G)$, the competitive effect $(g_i - G_i)$, and the net effect $(g_i - G)$ are included. Nevertheless, the other three possibilities are omitted in this approach. Therefore, to cover the need to analyze the internal structure of the industry of each country, a comprehensive shift-share is built. This version expands the scope of the traditional shift-share, including new effects that allow a comprehensive understanding of the export activity, both globally and internally.

Table 2.9: Possible interactions between the analyzed variables: effects contemplated and not contemplated by the traditional shift-share decomposition.

Possible Effects		Symmetric Effects
No contemplated effect	$g_i - g$	$g - g_i$
Competitive effect	$g_i - G_i$	$G_i - g_i$
Net effect	$g_i - G$	$G - g_i$
No contemplated effect	$g - G_i$	$G_i - g$
No contemplated effect	$g - G$	$G - g$
Industrial mix effect	$G_i - G$	$G - G_i$

Source: Author's elaboration

The comprehensive shift-share is constructed starting from Dunn's framework and including in the technique the rest of possible effects shown in Table 2.9 (effects that traditional shift-share does not contemplate). The new expression is as follows:

$$g_i X_{i,j}^t = \sum_i G X_{i,j}^t + \sum_i (G_i - G) X_{i,j}^t + \sum_i (g_i - G_i)\, X_{i,j}^t + \sum_i (g_i - g)\, X_{i,j}^t + \sum_i (g - G)\, X_{i,j}^t + \sum_i (g - G_i) X_{i,j}^t + \sum_i [(G + G_i) - (g + g_i)] X_{i,j}^t \quad (2.3)$$

In expression (2.3), besides the original effects previously discussed, four new components are proposed:

- $(g_i - g)X_{i,j}^t$ is the internal industrial effect (IIE). This effect represents the structure of the industry of country j. IIE complements the traditional industrial mix, giving an internal point of view.
- $(g - G)X_{i,j}^t$ is the internal sectoral effect (ISE). It allows to understand changes promoted by the greater (or lesser) dynamism of sector m in country j. In other words, it helps to define those changes in exports due to the growth of sector m.
- $(g - G_i)X_{i,j}^t$ is the contextual effect (CTE). It evaluates whether internal sector

m is more (or less) dynamic than world exports of product i, and if internal context boosts the exports of country j.

- $[(G + G_i) - (g + g_i)]\, X_{i,j}^t$ is the residual term. This level difference effect (LDE) measures the effect of the difference between the growth rates of world variables and those of country j. It represents a competitive effect that operates through a comparison between the general performances of the two levels considered: the world and the country.

This new decomposition not only captures all the interactions among the considered variables, but it also determines whether country j has a relative strength or weakness in the exports of product i compared to the rest of products included in m. The proposal presented in this paper also identifies whether this situation is reinforced or diminished by the strength or weakness of sector m in country j. Furthermore, the traditional method of shift-share to analyze exports overcomes the aforementioned problems shown by CMS. First, the comprehensive shift-share decomposition includes the traditional competitive effect. In this way, the explanatory power of this effect is maintained. Second, by using only export data, the problems generated by the assumption of stability in export destinations do not appear. Third, in addition to the traditional ones, the extended version incorporates effects that capture the influence of internal structure. That is, instead of considering export destinations (like the CMS) or only global effects (like traditional shift-share), internal effects are used. As a consequence, a residual term without economic meaning is avoided (like $PERF$ of the CMS).

Finally, the comprehensive version of shift-share takes into account the complete set of effects that could have an impact on export growth. Unlike the traditional decomposition, this technique collects effects related to the world and also incorporates internal conditions, capturing characteristics of the productive structure of countries in the process.

2.3.2. Boudeville's classification for international trade

Along with the calculation of each effect, a classification of the exporters in terms of their performance and based on Boudeville's technique (1966) is proposed. In its original form, Boudeville suggested that eight types of regions can be detected through the evaluation of the industry mix (IM) and the competitive effect (CE) of the traditional shift-share. Thus, a region may grow slowly in relation to other regions as a result of the industry mix or locational disadvantages. As a consequence, each situation can be rectified by different policy guidelines. According to Stilwell (1969), the deficiencies attributed to the competitiveness of one region (CE) can be corrected making general improvements in infrastructure. On the other hand, the regions that present an unfavorable industry mix simply need injections of growth industries in other regions.

As with the traditional shift-share, Boudeville's classification has been usually applied to the study of employment. By adapting it to the field of international trade, the classification reveals the types of environments where the exports of product i is made (see Table 2.10). In general terms, regions T1-T4 types represent those countries where the exports of product i are growing faster than the average. On the contrary, types T5-T8 characterize those with a slow growth or experiencing decreases in exports (Edwards, 1976). Nevertheless, the cause of the slow growth in region T5 is due to the unfavourable industry mix effect, whereas the one experienced by type T6 is a consequence of other disadvantageous factors, more linked to the competitive economic advantages of the country studied (Andrikopoulos, 1980; Stilwell, 1969).

In addition to the Boudeville's technique based on the traditional effects, a new classification in terms of the new internal effects (I1-I8) is offered in Table 2.10. For this purpose, the internal industrial effect (IIE) and the internal sectoral effect (ISE) are evaluated[30].

Similarly to the traditional classification, regions I1-I4 types represent those countries where the exports of product i are growing faster than the average, while I5-I8 regions show a slow growth or decreases in exports. In the cases of I5 and I6 regions, the analysis of the internal effects provides new insights into the domestic potential drivers of export growth. Thus, the slow export of type I5 is also a consequence of an unfavorable internal

[30] These effects are selected because they are analogous (in a local way) to the traditional ones of the original classification.

structure. Similarly, the slow growth of exports in countries described as type I6 could also be explained by a weak sector m, in contrast to the world version of it. A complete description of every export environment detected through this technique is shown in Table 2.10. Also, the suggested policies guidelines for each case is presented.

Table 2.10: Boudeville's classification for the traditional and new internal effects*

<table>
<tr><th>Type</th><th>g_i</th><th>IM and IIE</th><th>CE and ISE</th><th>Relation between IM and CE, IIE and ISE</th><th>Global Environment</th><th>Internal environment</th><th>Policy implication</th></tr>
<tr><td>T1-I1</td><td>+</td><td>+</td><td>+</td><td>$|IM| > |CE|$
$|IIE| > |ISE|$</td><td rowspan="2">The exporters performed well within an global structure that encourage the exports of product i</td><td rowspan="2">The product i has an advantageous position within a national sector m that is also competitive at the world level.</td><td rowspan="2">The country should continue to strengthen its comparative advantages in the exports of the product i.</td></tr>
<tr><td>T2-I2</td><td>+</td><td>+</td><td>+</td><td>$|CE| > |IM|$
$|ISE| > |IIE|$</td></tr>
<tr><td>T3-I3</td><td>+</td><td>+</td><td>-</td><td>$|IM| > |CE|$
$|IIE| > |ISE|$</td><td>The country shows comparative disadvantage in the exports of product i in a global market that favors the exports of this product.</td><td>The product i has an advantageous position in a national sector m that is not competitive at the world level</td><td>The country would benefited from a specialization strategy in product i to improve its competitiveness and take advantage of the global trends.</td></tr>
<tr><td>T4-I4</td><td>+</td><td>-</td><td>+</td><td>$|CE| > |IM|$
$|ISE| > |IIE|$</td><td>The country presents comparative advantage in the exports of the product i in a global market that disfavors the exports of this product.</td><td>The product i has a disadvantageous position in a national sector m that is competitive at the world level.</td><td>Although the country experiences growth in the exports of product i, it would benefited from a small diversification to other products of the sector m, due to the trends followed by the global and national industries.</td></tr>
<tr><td>T5-I5</td><td>-</td><td>-</td><td>+</td><td>$|IM| > |CE|$
$|IIE| > |ISE|$</td><td>The country presents comparative advantage in the exports of the product i in a global market that disfavors the exports of this product</td><td>The product i has a disadvantageous position in a national sector m that is competitive at the world level.</td><td>Since the growth of the exports of the product i is negative and the global and national context does not favor these exports, the country should follow a diversification strategy.</td></tr>
<tr><td>T6-I6</td><td>-</td><td>+</td><td>-</td><td>$|CE| > |IM|$
$|ISE| > |IIE|$</td><td>The country shows comparative disadvantage in the exports of product i in a global market that favors the exports of this product.</td><td>The product i has an advantageous position in an sector that is not competitive at the world level</td><td>The country should follow a specialization strategy in product i to improve its competitiveness and overcome the negative growth rate experienced.</td></tr>
<tr><td>T7-I7</td><td>-</td><td>-</td><td>-</td><td>$|IM| > |CE|$
$|IIE| > |ISE|$</td><td rowspan="2">The country have comparative disadvantages in a global market that disfavor the export of the product i</td><td rowspan="2">The product i has a disadvantageous position in a national sector m that is not competitive at the world level.</td><td rowspan="2">Diversification of the exports to other products from other sectors.</td></tr>
<tr><td>T8-I8</td><td>-</td><td>-</td><td>-</td><td>$|CE| > |IM|$
$|ISE| > |IIE|$</td></tr>
</table>

***Note:** This table presents eight possible scenarios. However, the results obtained from the calculation of the effects could generate more environments. In those cases, the policy guideline should be adapted to the scenario detected.
Source: Author's elaboration

In summary, the new shift-share proposal ensures the consideration of all the interactions among variables, exhausting all the existing effects. This allows an expanded view of the export activity by giving us an internal and a global scope. Furthermore, the classification of the exporters based on Boudeville's method, provides an integral way to assess the performance of the countries and hence to better develop policy guidelines for each case studied. In the following section, the comprehensive shift-share of expression (2.3) and the above-mentioned classification of the countries will be illustrated through an application to the case of the soybean seed exports worldwide.

2.4 Case of study and estimation results

After an overview of trends in world soybean market is presented, the effects proposed in the comprehensive shift-share (see expression 2.3) are calculated for the case of world soybean seed exports. Then, the exporters are classified according to the typology indicated above. The relevance of each effect of the comprehensive shift-share is shown. This is done by estimating regressions between the variable under study for each exporter country and the detected effects. These results are then discussed, highlighting the contribution and usefulness of the comprehensive shift-share.

2.4.1 Trends in soybean world markets

This study examines the growth of exports of all major soybean exporting countries. During the period under study, the United States (USA), Brazil (BRA), Argentina (ARG), Paraguay (PAR), Canada (CAN), and Ukraine (UKR) have been the leaders of the soybean seed market, covering more than 94% of the world exports (FAO, 2017). The volume of soybean exports from the remaining countries, grouped as a residual unit called Rest of the World (ROW).

Soybean has been the most traded crop of the last two decades. In 2015, world soybean trade accounted for 38% of global soybean production, while other important crops such as rice, wheat, and corn introduced less than 20% of their productions to international markets (Lakkakula *et al,.* 2015).

The accelerated growth of international soybean trade has occurred in response to the large increase in both demand and production. In the last two decades, the world has doubled its consumption and production of soybeans, a process motivated mainly by the different uses of this crop (FAO, 2017). Soybean is cultivated for human consumption and industrial processing (soybean meal and oil), as well as for the production of animal feed and biodiesel (Goldsmith and Hirsch, 2006; Goldsmith, 2008; US International Trade Commission, 2012).

The world exports of soybean seed have increased threefold, reaching growth rates higher than the average of agricultural products during the 1996-2015 period. In fact, over the last twenty years, soybean exports have experienced a cumulative growth rate of 10.09%, while agricultural trade has grown at 3.79% (FAOSTAT, 2017). This difference becomes more relevant considering that the agricultural sector has played a key role in the international trade of the analyzed countries. Particularly in the South American countries, agricultural trade has represented more than 50% of total exports in the period under study. Ukraine has also followed this path, doubling the share of agricultural trade within its total exports. However, in Canada and the United States, the shares of agricultural products in total exports have been modest (see Table 2.11). Within the exports of agricultural products, soybean has been an essential product for the analyzed economies. Table 2.11 indicates that soybean seeds accounted for more than 10% of agricultural trade in Argentina, Brazil, Paraguay, and the United States in 2015. Although Canada and Ukraine presented lower values, they have also followed a similar trend.

Table 2.11: Exports of soybean seed and agricultural products*, 1996 and 2015

	Agricultural trade share in total exports (%)				Soybean share in agricultural exports (%)			
	1996	**2015**	**Mean**	**Std. Dev.**	**1996**	**2015**	**Mean**	**Std. Dev.**
ARG	72.44	85.71	61.32	13.82	4.41	12.07	8.59	3.35
BRA	31.85	56.63	39.27	9.09	5.30	20.91	12.96	3.62
CAN	11.04	12.19	9.23	6.40	0.40	3.11	1.23	0.89
PRY	67.54	76.93	60.11	15.73	37.74	29.76	39.95	7.10
UKR	19.59	42.84	22.13	10.66	0.03	4.33	1.09	1.36
USA	9.27	13.20	10.74	1.73	8.48	10.21	8.66	1.93
ROW	11.61	9.01	10.19	0.83	0.06	0.19	0.13	0.05
WORLD	11.88	10.50	10.82	0.50	1.13	3.46	1.97	0.64

Notes: *Millions of dollars, 2010=100
Source: Author's elaboration with data from UN Comtrade Database 2017.

During this period, no other significant competitor[31] has appeared on the global soybean market. The cumulative growth rates displayed in Table 2.12 show that the main exporters have in fact increased their volume of exports. These increases have been greater during the first half of the period under study, but in general, there is evidence of a sustained growth. The main exporters have also secured their positions in international markets, as shown by their market shares (Table 2.12). Despite this consolidation, several changes have taken place within soybean market during these years. The most important shift relates to the positioning of Brazil as the market leader. According to Table 2.12, in 1996, the United States dominated the world market with nearly 68% of global exports, while Brazil and Argentina accounted only for 14% and 8%, respectively. However, in 2015, Brazilian soybean exports exceeded those of the United States. In this way, Brazil has become the absolute leader of the market, reaching 49% of the exports. On the

[31] Significant competitors are those exporters which have export shares equal or greater than 1%.

contrary, the United States and Argentina decreased their participation, resulting in a noticeable shift in the main historical exporters of soybeans[32]. With respect to those traditionally categorized as minor exporters, whereas Canada and Ukraine have solidified their positions in the market, Paraguay and ROW have shown a decline in their shares of soybean exports.

To better understand the factors behind the performance of these countries and the changes registered in the market, the traditional and the comprehensive shift-share are used. As shift-share analysis requires both sectoral and geographical references, in this paper, agricultural trade is taken as a sectoral reference for two main reasons. First, because the soybean industry is part of the agricultural sector. Second, as mentioned before, agriculture has been an important contributor to the economy of these countries. On the other hand, the world exports of soybean seed are used in order to carry out the decomposition. As a result, the whole world is considered as the geographical reference.

Table 2.12: Soybean market share and growth rate of exports*, 1996-2015

	Cumulative Average Growth Rate (%)			**Soybean Market Share** (%)**			
	96-15	**96-05**	**06-15**	**1996**	**2015**	**Mean**	**Std. Dev.**
ARG	9,20	17,77	4,16	8.23	7.71	10.57	4.27
BRA	16,65	22,21	11,93	14.05	49.28	36.33	8.08
CAN	12,92	8,98	14,91	1.65	3.02	1.74	1.34
PRY	7,93	10,14	10,38	4.03	2.99	4.40	1.16
UKR	37,36	39,20	29,27	0.02	1.59	0.43	0.55
USA	5,43	0,56	8,81	67.59	31.36	41.20	9.95
ROW	9,07	10,09	7,30	4.43	4.05	5.33	1.05
WORLD	9,56	9,36	10,00	100	100		

Notes: *Millions of dollars, 2010=100
**The soybean market share was calculated as quotient of soybean export of each country and the soybean exports at world level.
Source: Author’s elaboration with data from UN Comtrade Database

All the data related to the soybean seed and agricultural exports[33] were obtained from the UN (United Nations) Comtrade Database that uses the Standard International Trade of the United Nations (SITC, REV 3) to classify goods. The annual values of soybean

[32]Argentina, Brazil and the United States have been the leaders of unprocessed soybean market, accounting around 80 percent of the global exports of this product, during 1996-2015 (UN Comtrade 2017).

[33] For the agricultural exports, the following sectors corresponding to SITC were considered: a) food and live animals, b) beverages and tobacco, c) crude materials, inedible except fuels and, d) animal and vegetal oils, fats and waxes.

exports were deflated by the Agriculture Value Added deflator (2010=100), which is calculated using data from the World Development Indicators Database. The values for the ROW were calculated as the difference between the world exports of soybean seeds (or agricultural products) and the sum of the values corresponding to the main exporters.

2.4.2 Estimation results

This section presents the results of the application of the traditional shift-share and those of the comprehensive shift-share proposed in this paper (see expression 2.3). In order to avoid the dependency of results on the periods used, the dynamic version of the shift-share is adopted (Barff and Knight 1988). Therefore, the components of expression (2.3) were calculated for each year in the 1996-2015 period.

The analysis is divided into two subsections. First, a summary of the calculated effects and the classification of the exporters according to these results are presented. This contextualizes the performance of the main exporters in this market. Second, the results of the regressions are discussed, with the aim of analyzing the relevance of each effect on the changes of soybean exports.

Description of the effects calculated

Table 2.13 reveals that, on average[34], the growth rate of soybean exports was positive for the main exporters and the rest of the world (ROW). In particular, Brazil presented the highest growth, followed by the United States and Argentina. This clearly reflects the market dominance of these countries.

With regard to the traditional effects, the global effect (GE) was positive for all the countries, but with considerable differences among them. The GE dislplayed high values for the United States, Brazil, and Argentina, while it was relatively lower in other countries. A similar result is observed for the industrial mix or structural effect (IM). Since the calculation of both effects are the same for all the exporters, these differences are explained by the volume of their exports (higher values correspond to the main exporting countries). The positive sign of these effects indicates that global context facilitated the acceleration of their soybean exports.

The competitive or regional effect (CE) indicate divergences among the exporters. Brazil, Canada, and Ukraine obtained positive values. On the contrary, the rest of exporters presented negative values. The countries with positive CE values are the same ones that displayed the highest growth rates of their exports and improved their participation in global soybean markets (see Table 2.12). In contrast, negative values in

[34]Go to Appendix 2 to see the results for each year and each country.

CE are associated with lower growth rates, as well as with losses in their soybean market share (the case of the USA, Argentina, ROW, and Paraguay). Therefore, it can be concluded that a greater export growth is associated with positive competitive effects in the case of study. It is important to emphasize that CE makes a big difference among the three main exporters. While the CE is negative for the United States and Argentina, it is positive for Brazil. Accordingly, the results suggest that the CE is also associated to the consolidation of Brazil as the market leader.

Now, the effects proposed in the complete shift-share that are not contemplated by the traditional shift-share are analyzed. The results are displayed in Table 2.13.

Table 2.13: Summary of the effects calculated* from expression (2.3)

			Traditional effects					
	$giX_{i,j}^{t}$		GE		IM		CE	
	AVG	**Std.Dev.**	**AVG**	**Std. Dev.**	**AVG**	**Std. Dev.**	**AVG**	**Std.Dev.**
ARG	199.51	1315.00	103.55	214.17	191.14	511.20	-95.18	1368.74
BRA	1469.43	2049.13	304.21	642.45	681.13	1513.95	484.09	1706.15
CAN	86.17	190.24	11.77	42.67	45.02	107.33	29.38	170.12
PRY	73.04	387.04	35.86	71.84	72.29	178.43	-35.11	412.66
UKR	49.47	82.92	0.78	10.11	16.21	35.21	32.49	73.95
USA	639.89	2641.70	317.66	667.52	700.50	1580.32	-378.26	2154.24
ROW	104.25	329.80	41.23	83.29	100.42	206.26	-37.40	334.84

					Internal effects			
	IIE		ISE		CTE		LDE	
	AVG	**Std. Dev.**	**AVG**	**Std. Dev.**	**AVG**	**Std. Dev.**	**AVG**	**Std.Dev.**
ARG	117.73	1191.30	-21.77	252.56	-212.91	560.76	116.94	1479.76
BRA	622.79	1966.04	542.43	1347.84	-138.71	1569.13	-1026.51	2572.33
CAN	75.93	212.59	-1.53	105.41	-46.55	147.12	-27.85	225.82
PRY	-14.05	236.21	51.23	200.91	-21.06	215.18	-16.12	554.00
UKR	37.43	79.29	11.26	30.96	-4.95	35.03	-43.75	87.96
USA	197.51	2302.51	124.72	1162.66	-575.77	1196.79	253.54	2954.63
ROW	73.21	345.62	-10.19	26.34	-110.61	222.55	47.60	348.44

Note: *Millions of dollars, 2010=100
Source: Author's elaboration

The internal industrial effect (IIE) shows a positive average for all the countries, except for Paraguay. Hence, these exporters are characterized by an internal industry structure where soybean exports are relatively stronger, and consequently their economies exhibit a high specialization in the product.

The internal sectoral effect (ISE) reveals disparities between the countries. The positive and highest average corresponded to Brazil. The USA, Paraguay, and Ukraine also obtained positive values. In contrast, the ISE was negative for the rest of exporters. In general terms, these countries have had a good position within the global agricultural sector. Then, the results indicate that a strong agricultural sector may be necessary to play an important role in the soybean global market.

The average of the contextual effect (CTE) was negative for all countries. This evidence is supported by the outstanding growth of global soybean exports in comparison with the global agricultural sector previously mentioned.

In evaluating the level difference effect (LDE), two different groups of exporters can be distinguished. The first group comprises those exporters with a positive average LDE. The USA, Argentina and ROW belong to this group. On the other hand, the LDE attained negative values for Brazil, Ukraine, Canada, and Paraguay. These results are referred to the advantages (disadvantages) that the agricultural and soybean sectors of these countries offer with respect to the world. Those exporters with a positive sign have been at a disadvantage with respect to global growth rates. In contrast, negative signs imply a greater dynamism of the main exporters.

Therefore, while the traditional shift-share remarks that Brazil had a clear competitive advantage over the rest of exporters, the study of the new effects reveals that the internal structure of its industry (IIE and ISE) also boosted its positioning in the soybean market. These results, along with the CE values obtained by Argentina and the United States reinforce the consolidation of Brazil as the market leader. This evidence suggests that a high level of soybean specialization, as well as a strong agricultural sector are important factors determining the role of each country in the soybean global market[35].

[35] In fact, the exporters have taken advantage of the acceleration of the demand that has occurred in the last twenty years by improving their soybean production volume. For example, Argentina, Brazil, Paraguay, and Ukraine have expanded their soybean harvested areas to increase their production. This has been done by replacing areas previously destined to livestock and other crops to currently harvest soybeans (Arima *et al.,* 2011; Chekhov, 2015; Regunaga, 2010). Another strategy has been the adoption of Genetic Modified Soybeans (GMS), which allows for the cultivation of soybeans in any type of soil (Goldsmith & Hirsch, 2006; Hausmann and Klinger, 2007). On the other hand, Canada and the United States have invested in technology to reduce production costs and to improve the efficiency per hectare of soybean cultivation (Masuda and Goldsmith, 2009; Saha *et al*., 2014). In such a way, it can be seen that main soybean exporting countries have made efforts to improve their production levels.

The Boudeville's classification in terms of the traditional and new internal effects for the case of soybean exports is shown in Table 2.14. In general terms, since all the countries presented positive growth rates, they were classified as T1-T4 and I1-I4 types. However, the environment where they operated nationally and globally were different. Thus, Table 2.14 describes every environment and suggests policy guidelines according to each situation.

Table 2.14: Boudeville's classification for the traditional and new internal effects of each country analyzed (1996-2015)

Country	Type	Global Environment	Internal environment	Policy implication
ARG	T3-I3	Argentina shows comparative disadvantage in the exports soybeans in a global market that favors the exports of this product.	Soybeans export has an advantageous position in a national agricultural sector that is not competitive at the world level	Specialization in soybean exports to take advantage of the national and global trends: subsidies for the production of soybeans, export linked incentives and/or investment in infrastructure.
BRA	T1-I1	Brazil performed well within an global structure that encourage the exports of soybeans	Soybeans export has an advantageous position within a national agricultural secctor that is also competitive at the world level.	Brazil should continue to strengthen its comparative advantages in the exports of soybeans.
CAN	T1-I3	Canada performed well within an global structure that encourage the exports of soybeans	Soybeans export has an advantageous position in a national agricultural sector that is not competitive at the world level	Specialization in soybean exports to improve the position of soybeans within the internal industry: subsidies for the production of soybeans, export linked incentives and/or investment in infrastructure.
PAR	T3-I4	Paraguay shows comparative disadvantage in the exports soybeans in a global market that favors the exports of this product.	Soybean exports has a disadvantageous position in a national agricultural sector that is competitive at the world level.	Diversification of exports to other products of agricultural sector
UKR	T1-I1	Ukraine performed well within an global structure that encourage the exports of soybeans	Soybeans export has an advantageous position within a national agricultural secctor that is also competitive at the world level.	Ukraine should continue to strengthen its comparative advantages in the exports of soybeans.
USA	T3-I1	USA shows comparative disadvantage in the exports soybeans in a global market that favors the exports of this product.	Soybeans export has an advantageous position within a national agricultural secctor that is also competitive at the world level.	Specialization in soybean exports to take advantage of the global trends: subsidies for the production of soybeans, export linked incentives and/or investment in infrastructure.

Source: Author's elaboration

The analysis of the so-called internal effects provides complementary information on the changes occurred in soybean market. While the traditional shift-share analyzes the global context, the complete version focuses on internal conditions which favor or disfavor soybean exports. The results reveal that soybean exports from these countries have been more dynamic than global exports. Since these countries have dominated the market during 1996-2015, it can be claimed that this condition is one of the most important requirements for the entry and performance in the soybean seed market. Furthermore, the new internal effects demonstrate the relevance of soybeans within the agricultural sector in most of these countries, providing relevant insights about the structure of their industries.

Regression results

In the following subsection, the estimates of different regressions are shown to complement the description presented in the subsection above. The objective is to reflect the relevance of each effect explaining the changes observed in soybean exports. These regressions have only exploratory purposes, and they do not intend to specify an econometric model with explanatory objectives. Thus, the dependent variables considered are the annual growth rate of soybean exports for the main exporters and ROW. This analysis considers the traditional effects, as well as the effects introduced in this paper. Seven regressions were run for each country (one for each effect). The regressions were carried out using Ordinary Least Squares (OLS)[36].

Table 2.15: Summary of the significance of each effect for each country (1996-2015)

	Traditional shift-share			Comprehensive shift-share			
	GE	IM	CE	IIE	ISE	CTE	LDE
ARG			+ ***	+ ***			-***
BRA		+ **	+ ***	+ ***	+ **		- ***
CAN	- **	+ **	+ ***	+ ***			- ***
PRY			+ ***	+ ***	+ ***	+ ***	- ***
UKR		+ **	+ ***	+ ***	+ *		- ***
USA	- **	+ ***	+ ***	+ ***	+ ***		- ***
ROW			+ ***	+ ***			- ***

Note: *, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively.
Source: Author's elaboration

[36] It is important to note that in regressions with only one explanatory variable, the coefficient of determination (R^2) is equal to the correlation coefficient of Spearman squared. Therefore, in explanatory terms, it is the same to evaluate the correlation between two variables through simple regressions or through Spearman Test.

Table 2.15 displays that the most explanatory effects are the classical competitive effect (CE), internal industrial effect (IIE) and level difference effect (LDE). To a lesser extent, internal sectorial effect (ISE) and global effect (GE) are also correlated with the growth of soybean exports. Finally, the lower explanatory capacity corresponds to traditional industry mix and contextual effect (IM and CTE, respectively). In conclusion, the growth of soybean exports has been mainly based on the advantage that this product (countries) has presented over other agricultural products (world exports).

The disaggregated results for each country are presented in Table 2.16. From the regressions made between growth rates and traditional effects, it can be observed that the competitive effect (CE) is the most statistically significant effect for main exporters. It has a significance at the 1% level in all cases, with positive coefficients for all of them. The next most explanatory effect is the industry mix effect (IM). The coefficients are well adjusted in terms of significance: 1% for Brazil and USA, and 5% for Canada and Ukraine. For the rest of exporters and ROW, this effect is not statistically significant. The effect with the least explanatory power within this group is the global effect (GE). It is statistically significant only for Canada and the United States, at the 5% level in both cases. Therefore, it can be concluded that the growth in soybean exports has mostly experienced a positive influence from the differential performance that these countries have had in this product in comparison with the world.

The results derived from the new effects included in the comprehensive version of shift-share are quite revealing (see Table 2.16). The internal industrial effect (IIE) is one the most relevant effects in this group, with positive and highly significant coefficients for all countries at the 1% level. Similar to the IIE, the level difference effect (LDE) is strongly correlated with the growth of soybean seed exports. This result is significant and negative for all countries at the 1% level.

To a lesser extent, the internal sectoral effect (ISE) has also contributed to explaining changes in soybean exports. The results are statistically significant at the 10% level for Ukraine, at the 5% level for Brazil, and at the 1% level for Paraguay and USA. For Argentina, Canada, and ROW, the ISE is not statistically significant. The contextual effect (CTE) is the least explanatory effect in this group. It is statistically significant only for Paraguay. Thus, the influence of the internal industry has been very important for the performance of these countries in soybean markets. This result establishes that the internal industry situation has an impact on exports. In fact, in the case of soybeans, it has been one of the factors that has most promoted the consolidation of main exporters in international markets.

Table 2.16: Results of the regressions between the annual growth rates of soybean exports and each analyzed effect (1996-2015).

		Original effects			**New effects**			
		GE	IM	CE	IIE	ISE	CTE	LDE
		G	$Gi-G$	$gi-Gi$	$gi-g$	$g-G$	$g-Gi$	$(Gi+G)-(gi+g)$
ARG	$\boldsymbol{\beta_1}$	1.707	-0.216	0.911	1.075	1.958	0.577	-0.837
	p-val (F test)	0.249	0.732	0.000***	0.000***	0.113	0.310	0.000***
	$\boldsymbol{R^2}$	0.077	0.007	0.900	0.949	0.141	0.061	0.887
BRA	$\boldsymbol{\beta_1}$	-1.178	0.777	0.998	0.836	0.800	-0.132	-0.659
	p-val (F test)	0.120	0.010*	0.000***	0.000***	0.021**	0.680	0.000***
	$\boldsymbol{R^2}$	0.137	0.329	0.691	0.643	0.277	0.010	0.684
CAN	$\boldsymbol{\beta_1}$	-2.197	1.000	0.991	0.757	0.537	-0.256	-0.679
	p-val (F test)	0.032**	0.012**	0.000***	0.000***	0.216	0.416	0.000***
	$\boldsymbol{R^2}$	0.243	0.318	0.785	0.716	0.089	0.039	0.651
PRY	$\boldsymbol{\beta_1}$	1.682	-0.301	0.885	1.483	1.446	1.468	-0.681
	p-val (F test)	0.193	0.570	0.000***	0.000***	0.000***	0.000***	0.000***
	$\boldsymbol{R^2}$	0.098	0.019	0.891	0.819	0.564	0.666	0.951
UKR	$\boldsymbol{\beta_1}$	-3.098	1.184	1.047	0.973	1.120	-0.322	-0.878
	p-val (F test)	0.111	0.028**	0.000***	0.000***	0.075*	0.578	0.000***
	$\boldsymbol{R^2}$	0.143	0.253	0.871	0.866	0.175	0.019	0.868
USA	$\boldsymbol{\beta_1}$	-1.885	1.092	1.097	1.073	1.575	-0.418	-0.827
	p-val (F test)	0.039**	0.002***	0.000***	0.000***	0.001***	0.438	0.000***
	$\boldsymbol{R^2}$	0.227	0.427	0.800	0.875	0.481	0.036	0.856
ROW	$\boldsymbol{\beta_1}$	-0.386	0.258	0.842	0.915	3.078	-0.179	-0.795
	p-val (F test)	0.691	0.503	0.000***	0.000***	0.310	0.617	0.000***
	$\boldsymbol{R^2}$	0.009	0.026	0.775	0.919	0.064	0.015	0.748

Note: *, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively.
Source: Author's elaboration

In summary, the estimates indicate that both the traditional effects and those introduced in this paper, taken together, capture every potential driver of the soybean export growth for each country. Moreover, one of the most important finding is that the IIE has played a fundamental role on the growth of soybean exports. This result proves that the performance of countries in international trade depends not only on the context in which exports move and the influence of other regional areas on the market. Instead, the growth of exports is also highly determined by the structure of the internal industry, as well as for the strength of sectors at the national level, as occurred in the soybean case.

Finally, it is important to emphasize that these estimation results have confirmed the usefulness of shift-share for the analysis of exports. Particularly, in this case study, both the traditional effects and the new effects presented high levels of significance. Furthermore, the calculation of effects contributed to recognizing factors that have motivated the unprecedented growth recorded in soybean trade. This approach and the subsequent classification of the exporters prove to be very useful tools to analyze exports, delivering interesting information on export processes and the industrial structure of countries. Consequently, it should be applied more frequently to determine the drivers of export growth from a regional and a sectoral point of view, as well as to propose policy guidelines to maintain or improve the performance of the countries in international trade.

2.5 Final remarks and conclusions

The main contributions of this paper are both methodological and empirical. First, a comprehensive version of shift-share decomposition to study exports was proposed. Second, an illustration of the use of the new comprehensive shift-share for international trade was presented. In particular, the exports of soybean seed corresponding to the main world exporters were studied.

Shift-share analysis has been applied to a variety of fields in regional economics. However, its use in the study of international trade has been limited. For this reason, one of the purposes of this work has been to encourage the adoption of shift-share analysis in the study of exports, through the description of benefits that it can provide to the understanding of international trade. The main strengths of the shift-share are the simplicity of its application and the usefulness of its results to understand changes in international trade. On the other hand, shift-share allows for comparisons between geographical units (with a regional scope) by contributing sectoral information on the growth of exports or imports.

In order to improve the quantity and quality of information that shift-share analysis can address in issues of international trade, an extension of the decomposition has been proposed. The proposal is based on the traditional shift-share proposed by Dunn (1960) and incorporates all the possible interactions between the variables under study. In this way, it is guaranteed that all the effects resulting from the interactions between geographical and sectoral references are taken into account within the decomposition. Furthermore, the proposed extension emphasizes the relevance of internal effects or the idiosyncratic characteristics when studying changes in exports. Thus, the internal industrial effect (IIE), internal sectoral effect (ISE), contextual effect (CTE), and level difference effect (LDE) appear within the deterministic decomposition to determine the role of internal factors in export growth. In addition, a classification of the exporters based on Bourdeville's approach (1969) was presented. This way, each country was classified according to their performance, allowing the identification of possible policy guidelines to improve the competitiveness of the countries in international trade. The contribution is not only useful in the field of international trade, but can also be applied in all areas where the traditional shift-share is commonly used[37].

The application to the case of study reveals several findings. First, it confirms the usefulness of shift-share analysis for the study of international trade. The regressions carried out demonstrate the existence of significant correlations between changes in exports and the traditional effects of shift-share, particularly for the traditional competitive effect. Second, the use of the comprehensive shift-share provides information that cannot be obtained by applying previous techniques such as the traditional shift-share and CMS. The internal effects introduced in this paper were quite explanatory in the soybean case. This way, the internal industrial effect (IIE) has been one of the most important drivers of the outstanding growth of soybean exports. Similarly, the LDE showed high explanatory power. To a lesser extent, the ISE and CTE have also contributed to understanding the performance of the main exporters during the 1996-2015 period. Also, the classification proposed allows to have an integral picture of the situation of each country, identifying the main drivers of their privileged position and the necessary actions to continue their dominance in this market.

Therefore, it is advisable to use the traditional shift-share and its proposed extension for an intuitive analysis of changes in international trade variables. Both techniques explain exports in regional and sectoral terms, allowing for interesting insights into the factors explaining the growth of variables. In addition to this, the comprehensive shift-share presented in this paper complements the perspective given by traditional shift-share, adding an internal perspective. Future international trade research would benefit from the use of the shift-share, as well as from the addition of the proposed internal effects within the decompositions applied to any field.

[37]Other types of analysis could be addressed. For example, in the general formulation of comprehensive shift-share shown in expression (3), the presence of subscript i could denote the employment in sector i, while its absence could represent the total employment. In the same way, the use of lowercase could denote a region integrated to a country, while the use of capitals could denote the country.

Appendix

Table 2.17: Results of the effects calculated* for Argentina (1997-2015)

ARG	$giX_{i,j}^{t}$	GE	IM	CE	IIE	ISE	CTE	LDE
		G	$Gi - G$	$gi - Gi$	$gi - g$	$g - G$	$g - Gi$	$G + Gi - (g + gi)$
1997	-592.59	4.06	196.90	-793.55	-618.31	21.66	-175.24	771.89
1998	729.38	0.85	-28.70	757.23	707.55	20.97	49.67	-778.20
1999	0.03	38.66	-24.99	-13.65	-92.88	54.24	79.23	-40.59
2000	390.87	45.79	181.02	164.06	463.11	-118.03	-299.05	-46.03
2001	986.50	53.23	282.72	650.55	823.07	110.20	-172.52	-760.75
2002	186.80	198.12	133.51	-144.83	-302.44	291.13	157.61	-146.30
2003	822.67	164.86	503.03	154.79	842.77	-184.95	-687.98	30.17
2004	-358.53	402.81	-509.50	-251.84	-646.89	-114.44	395.06	366.28
2005	1085.48	323.91	-263.60	1025.17	643.24	118.33	381.93	-1143.50
2006	-992.87	419.53	-504.81	-907.60	-1429.53	17.13	521.93	890.47
2007	1758.02	69.74	372.09	1316.18	1495.46	192.82	-179.28	-1509.00
2008	272.78	300.36	1419.35	-1446.92	199.86	-227.44	-1646.79	1674.36
2009	-3009.16	-447.84	751.63	-3312.95	-2230.35	-330.97	-1082.60	3643.92
2010	2920.06	152.16	-43.57	2811.47	2911.19	-143.29	-99.71	-2668.19
2011	-808.61	382.25	-707.11	-483.76	-838.66	-352.20	354.91	835.96
2012	-1580.84	-142.81	884.60	-2322.63	-1531.01	92.98	-791.62	2229.65
2013	908.09	77.43	193.49	637.17	843.67	-13.00	-206.50	-624.17
2014	-349.47	59.87	267.23	-676.57	70.70	-480.04	-747.27	1156.61
2015	1422.10	-135.59	528.36	1029.33	926.31	631.38	103.02	-1660.71

Source: Author's elaboration
Note: *Millions of dollars, 2010=100

Table 2.18: Results of the effects calculated* for Brazil (1997-2015)

BRA	$giX_{i,j}^{t}$	GE	IM	CE	IIE	ISE	CTE	LDE
		G	$Gi-G$	$gi-Gi$	$gi-g$	$g-G$	$g-Gi$	$G+Gi-(g+gi)$
1997	1854.85	6.94	336.25	1511.66	1701.86	146.05	-190.20	-1657.71
1998	-239.50	14.05	-472.58	219.02	-261.52	7.97	480.54	-226.99
1999	442.32	123.87	-80.05	398.50	-900.06	1218.51	1298.56	-1617.01
2000	885.99	168.62	666.60	50.77	1178.43	-461.06	-1127.66	410.29
2001	2226.85	173.61	922.08	1131.16	522.14	1531.10	609.02	-2662.26
2002	1044.51	560.87	377.97	105.67	516.42	-32.78	-410.75	-72.89
2003	1798.10	500.89	1528.34	-231.13	1081.79	215.42	-1312.92	15.71
2004	1540.60	1138.50	-1440.05	1842.15	-318.64	720.74	2160.79	-2562.89
2005	-915.13	1195.73	-973.08	-1137.77	-2042.83	-68.03	905.05	1205.81
2006	-500.12	1037.26	-1248.09	-289.29	-875.67	-661.71	586.38	951.00
2007	-384.21	217.21	1158.86	-1760.28	-278.63	-322.79	-1481.65	2083.07
2008	3415.31	568.99	2688.79	157.53	2386.65	459.67	-2229.12	-617.19
2009	529.90	-1104.15	1853.13	-219.07	1819.30	-185.24	-2038.37	404.31
2010	-2000.16	960.52	-275.07	-2685.61	-4725.35	1764.67	2039.74	920.94
2011	2760.49	846.57	-1566.01	3479.94	1557.28	356.65	1922.66	-3836.59
2012	1819.89	-471.86	2922.83	-631.07	2062.45	229.31	-2693.52	401.77
2013	5019.67	465.83	1164.11	3389.73	4300.32	253.51	-910.60	-3643.24
2014	2072.65	352.60	1573.91	146.14	2010.51	-290.46	-1864.37	144.32
2015	6547.08	-976.10	3803.59	3719.59	2098.63	5424.55	1620.97	-9144.15

Source: Author's elaboration
Note: *Millions of dollars, 2010=100

Table 2.19: Results of the effects calculated* for Canada (1997-2015)

CAN	$giX_{i,j}^{t}$	*GE*	*IM*	*CE*	*IIE*	*ISE*	*CTE*	*LDE*
		G	$Gi-G$	$gi-Gi$	$gi-g$	$g-G$	$g-Gi$	$G+Gi-(g+gi)$
1997	-135.59	0.82	39.52	-175.93	3.80	-140.20	-179.73	316.13
1998	7.31	0.10	-3.30	10.51	8.11	-0.90	2.40	-9.61
1999	-5.05	1.24	-0.80	-5.49	-7.09	0.80	1.61	4.68
2000	-1.28	1.22	4.82	-7.32	-2.38	-0.12	-4.94	7.44
2001	-6.62	0.94	5.02	-12.59	-4.17	-3.40	-8.41	15.98
2002	2.30	1.44	0.97	-0.11	3.56	-2.70	-3.67	2.81
2003	7.47	1.26	3.84	2.36	7.19	-0.98	-4.82	-1.38
2004	277.06	3.22	-4.08	277.92	8.22	265.62	269.70	-543.54
2005	69.53	33.31	-27.11	63.33	32.16	4.06	31.17	-67.39
2006	74.01	38.77	-46.65	81.89	34.63	0.61	47.26	-82.50
2007	203.06	10.24	54.64	138.18	164.97	27.84	-26.80	-166.02
2008	141.93	40.66	192.14	-90.87	138.17	-36.89	-229.04	127.76
2009	294.75	-69.89	117.30	247.34	345.87	18.77	-98.53	-266.11
2010	281.52	80.04	-22.92	224.41	182.88	18.61	41.53	-243.01
2011	-243.22	104.90	-194.05	-154.07	-150.86	-197.25	-3.21	351.32
2012	507.89	-38.46	238.24	308.11	529.99	16.36	-221.88	-324.47
2013	49.14	48.69	121.68	-121.23	-174.57	175.02	53.34	-53.79
2014	-201.84	28.73	128.26	-358.83	-248.23	17.66	-110.60	341.17
2015	314.85	-63.61	247.87	130.59	570.43	-191.97	-439.84	61.38

Source: Author's elaboration
Note: *Millions of dollars, 2010=100

Table 2.20: Results of the effects calculated* for Paraguay (1997-2015)

PAR	$giX_{i,j}^{t}$	GE G	IM $Gi - G$	CE $gi - Gi$	IIE $gi - g$	ISE $g - G$	CTE $g - Gi$	LDE $G + Gi - (g + gi)$
1997	303.57	1.99	96.54	205.03	179.60	121.97	25.43	-327.00
1998	42.73	3.03	-101.85	141.56	-11.10	50.80	152.65	-192.36
1999	-170.71	30.65	-19.80	-181.55	-14.68	-186.67	-166.86	368.22
2000	-43.28	27.83	110.02	-181.13	-104.97	33.86	-76.16	147.27
2001	308.49	20.98	111.43	176.08	44.33	243.18	131.75	-419.26
2002	149.82	71.17	47.96	30.69	-15.87	94.53	46.56	-125.22
2003	390.50	64.70	197.43	128.37	188.76	137.04	-60.39	-265.41
2004	-285.27	166.32	-210.37	-241.22	-178.15	-273.44	-63.07	514.66
2005	-68.42	118.68	-96.59	-90.52	-70.60	-116.51	-19.92	207.03
2006	-352.54	105.28	-126.68	-331.14	-300.56	-157.27	-30.58	488.41
2007	416.29	15.13	80.75	320.41	245.74	155.42	74.67	-475.83
2008	293.79	67.35	318.29	-91.85	60.26	166.18	-152.11	-74.33
2009	-506.53	-120.95	203.00	-588.58	-280.77	-104.80	-307.80	693.38
2010	726.35	63.64	-18.23	680.94	469.42	193.29	211.51	-874.22
2011	334.64	121.94	-225.56	438.26	317.27	-104.57	121.00	-333.70
2012	-588.57	-65.81	407.66	-930.42	-388.44	-134.32	-541.98	1064.74
2013	786.73	39.85	99.60	647.29	150.37	596.51	496.91	-1243.79
2014	-104.14	36.27	161.90	-302.31	-220.55	80.14	-81.75	222.16
2015	-245.69	-86.77	338.11	-497.03	-336.98	178.06	-160.05	318.97

Source: Author's elaboration
Note: *Millions of dollars, 2010=100

Table 2.21: Results of the effects calculated* for Ukraine (1997-2015)

UKR	$giX_{i,j}^{t}$	GE	IM	CE	IIE	ISE	CTE	LDE
		G	$Gi - G$	$gi - Gi$	$gi - g$	$g - G$	$g - Gi$	$G + Gi - (g + gi)$
1997	-1.32	0.01	0.41	-1.74	-0.83	-0.50	-0.91	2.24
1998	1.42	0.00	-0.05	1.47	1.43	-0.01	0.04	-1.46
1999	-0.03	0.07	-0.05	-0.05	-0.42	0.32	0.37	-0.27
2000	0.37	0.09	0.34	-0.05	0.26	0.03	-0.31	0.02
2001	-1.45	0.09	0.45	-1.99	-1.32	-0.21	-0.66	2.20
2002	0.49	0.06	0.04	0.40	0.34	0.09	0.05	-0.48
2003	13.34	0.08	0.23	13.04	13.31	-0.04	-0.27	-12.99
2004	-1.93	1.76	-2.23	-1.46	-5.02	1.33	3.56	0.13
2005	32.47	1.38	-1.12	32.21	31.56	-0.47	0.65	-31.74
2006	27.25	4.68	-5.63	28.20	25.39	-2.82	2.81	-25.39
2007	21.99	1.66	8.83	11.50	16.43	3.91	-4.93	-15.41
2008	-32.62	5.89	27.86	-66.38	-76.13	37.62	9.76	28.76
2009	39.45	-5.44	9.13	35.76	28.85	16.04	6.91	-51.80
2010	73.15	7.44	-2.13	67.84	78.01	-12.30	-10.17	-55.53
2011	249.72	13.36	-24.71	261.07	213.49	22.87	47.58	-283.94
2012	169.33	-14.49	89.77	94.05	107.80	76.02	-13.75	-170.06
2013	11.28	17.69	44.21	-50.61	36.30	-42.71	-86.91	93.32
2014	91.55	10.33	46.09	35.13	-15.51	96.74	50.64	-131.87
2015	245.54	-29.91	116.56	158.90	257.32	18.14	-98.42	-177.03

Source: Author's elaboration
Note: *Millions of dollars, 2010=100

Table 2.22: Results of the effects calculated* for the United States (1997-2015)

USA	$giX_{i,j}^{t}$	GE	IM	CE	IIE	ISE	CTE	LDE
		G	$Gi-G$	$gi-Gi$	$gi-g$	$g-G$	$g-Gi$	$G+Gi-(g+gi)$
1997	714.75	33.38	1617.68	-936.32	383.84	297.52	-1320.16	638.79
1998	-2384.79	31.54	-1060.70	-1355.63	-1817.42	-598.92	461.79	1954.55
1999	66.60	200.69	-129.70	-4.39	-67.22	-66.87	62.83	71.27
2000	1266.27	240.98	952.65	72.64	395.60	629.69	-322.96	-702.33
2001	-243.95	248.12	1317.79	-1809.86	243.89	-735.96	-2053.75	2545.82
2002	946.41	506.55	341.37	98.49	319.33	120.53	-220.84	-219.02
2003	1852.73	452.58	1380.94	19.21	1823.49	-423.34	-1804.27	404.12
2004	-2225.39	1056.45	-1336.26	-1945.58	-1718.93	-1562.90	-226.65	3508.48
2005	379.30	708.50	-576.58	247.37	-923.31	594.10	1170.68	-841.47
2006	1168.27	710.36	-854.75	1312.65	-513.51	971.42	1826.17	-2284.07
2007	1161.23	183.37	978.28	-0.41	1271.77	-293.90	-1272.18	294.31
2008	4859.56	573.23	2708.85	1577.48	2814.37	1471.96	-1236.89	-3049.44
2009	4707.84	-1237.58	2077.06	3868.36	4205.32	1740.10	-336.96	-5608.46
2010	-94.97	1379.55	-395.07	-1079.45	-1541.70	67.18	462.25	1012.26
2011	-4830.77	1428.82	-2643.10	-3616.50	-3375.56	-2884.04	-240.94	6500.53
2012	5098.57	-472.00	2923.67	2646.89	5547.52	23.04	-2900.63	-2669.94
2013	-2331.03	563.71	1408.70	-4303.44	-2570.22	-324.51	-1733.22	4627.95
2014	3341.23	283.11	1263.75	1794.36	1421.40	1636.72	372.97	-3431.08
2015	-1293.83	-855.81	3334.84	-3772.86	-2145.97	1707.94	-1626.89	2064.92

Source: Author’s elaboration
Note: *Millions of dollars, 2010=100

Table 2.23: Results of the effects calculated* for the Rest of the World (ROW) (1997-2015)

ROW	$giX_{i,j}^{t}$	GE	IM	CE	IIE	ISE	CTE	LDE
		G	$Gi-G$	$gi-Gi$	$gi-g$	$g-G$	$g-Gi$	$G+Gi-(g+gi)$
1997	298.96	2.19	105.93	190.84	278.10	18.67	-87.26	-209.51
1998	122.31	3.17	-106.71	225.85	114.27	4.87	111.58	-230.72
1999	-180.86	35.35	-22.85	-193.37	-201.76	-14.46	8.39	207.83
2000	64.01	32.90	130.07	-98.96	32.42	-1.31	-131.38	100.27
2001	52.62	29.47	156.51	-133.36	26.77	-3.62	-160.13	136.98
2002	22.15	67.19	45.28	-90.31	-40.64	-4.40	-49.68	94.71
2003	128.80	53.18	162.26	-86.64	69.84	5.78	-156.48	80.86
2004	290.01	113.32	-143.33	320.02	206.52	-29.83	113.50	-290.19
2005	-114.83	134.01	-109.06	-139.78	-238.27	-10.57	98.48	150.36
2006	81.92	114.97	-138.34	105.29	-24.54	-8.51	129.83	-96.78
2007	-6669.31	27.22	145.24	-25.58	119.14	0.52	-144.72	25.06
2008	439.14	83.51	394.62	-38.99	380.22	-24.59	-419.22	63.59
2009	75.34	-156.57	262.78	-30.86	258.59	-26.68	-289.45	57.54
2010	77.62	136.22	-39.01	-19.59	-43.73	-14.87	24.14	34.46
2011	-50.52	147.75	-273.32	75.05	-250.68	52.40	325.73	-127.45
2012	1168.33	-64.16	397.42	835.08	1241.54	-9.05	-406.46	-826.03
2013	118.79	90.80	226.90	-198.91	40.83	-12.83	-239.73	211.74
2014	-342.65	54.04	241.23	-637.93	-367.18	-29.51	-270.74	667.43
2015	-417.34	-121.23	472.41	-768.52	-210.46	-85.65	-558.06	854.16

Source: Author's elaboration
Note: *Millions of dollars, 2010=100

References

- Andrikopoulos, Andreas A. "Industrial structure and regional change: The case of Greek economy, 1963-1969." *Επιθεώρηση Κοινωνικών Ερευνών* 32, no. 32 (1978): 106-116.
- Andrikopoulos, A. A. (1980). A synthesis of the production function and the shift-share model: a new regional modelling approach. *Regional Science and Urban Economics*, *10*(4), 539-560.
- Arcelus, F. J. (1984). An Extension of Shift-Share Analysis. *Growth and Change*, 15(1), 3-8.
- Arima, E. Y., Richards, P., Walker, R. and Caldas, M. M. (2011). Statistical confirmation of indirect land use change in the Brazilian Amazon. *Environmental Research Letters*, 6(2), 024010.
- Artige, L., & Neuss, L. (2014). A new shift-share method. *Growth and Change*, 45(4), 667-683.
- Baldwin, R. E. (1958). The commodity composition of trade: selected industrial countries, 1900-1954. *The Review of Economics and Statistics*, 50-68.
- Barff, R. A., & III, P. L. K. (1988). Dynamic shift-share analysis. *Growth and change*, 19(2), 1-10.
- Batista, J. C. (2008). Competition between Brazil and other exporting countries in the US import market: a new extension of constant-market-shares analysis. *Applied Economics*, 40(19), 2477-2487.
- Boudeville, J. R. (1966). *Problems of regional economic planning*. Edinburgh: Edinburgh UP.
- Chekhov, S. (2015). Functioning of the market of soybean in Ukraine. *ЕкономікаIРегіон*, (4), 61-66.
- Cheptea, A., Gaulier, G., & Zignago, S. (2005). World trade competitiveness: A disaggregated view by shift-share Analysis. *CEPII Working Paper 2005-23.*
- Cheptea, A., Fontagné, L., & Zignago, S. (2014). European export performance. *Review of World Economics*, 150(1), 25-58.

- Chiang, S. H. (2012). Shift-share analysis and international trade. *The Annals of Regional Science*, *49*(3), 571-588.
- Cunningham, N.J. 1969. A note on the "proper distribution of industry". *Oxford Economic Papers* 21(1): 122–127.
- Dinc, M., and K. Haynes. 2005. Productivity, international trade and reference area interactions in shift-share analysis: Some operational notes. *Growth and Change* 36(3): 374–394.
- Dinc, M., & Haynes, K. E. (1998). International trade and shift-share analysis: A specification note. *Economic Development Quarterly*, *12*(4), 337-343.
- Dunn, E. S. (1960). A statistical and analytical technique for regional analysis. *Papers in Regional Science*, *6*(1), 97-112.
- Dogru, T., & Sirakaya-Turk, E. (2017). Engines of tourism's growth: An examination of efficacy of shift-share regression analysis in South Carolina. *Tourism Management*, *58*, 205-214.
- Edwards, J. Arwel. Industrial structure and regional change: A shift-share analysis of the British Columbia economy 1961–1970. *Regional Studies* 10, no. 3 (1976): 307-317.
- Espa, G., Filipponi, D., Giuliani, D., & Piacentino, D. (2014). Decomposing regional business change at plant level in Italy: A novel spatial shift-share approach. *Papers in Regional Science*, *93*(S1).
- Esteban-Marquillas, J. M. (1972). I. A reinterpretation of shift-share analysis. *Regional and Urban Economics*, *2*(3), 249-255.
- Fagerberg, J., & Sollie, G. (1987). The method of constant market shares analysis reconsidered. *Applied Economics*, *19*(12), 1571-1583.
- Fagerberg, J. (1988). International competitiveness. *The economic journal*, *98*(391), 355-374.
- Food and Agriculture Organization of the United Nations. (2017).
- Fotopoulos G., Kallioras D., and Petrakos G. (2010). Spatial variations of Greek manufacturing employment growth: The effects of specialization and international trade. *Papers in Regional Science*, 89(1): 109-132.
- Goldsmith, P., and Hirsch, R. (2006). The Brazilian soybean complex. *Choices, 21*(2), 97-103.

- Grossi, L., & Mussini, M. (2018). A spatial shift-share decomposition of electricity consumption changes across Italian regions. *Energy Policy*, 113, 278-293.
- Hausmann, R., and Klinger, B. (2007). Growth diagnostic: Paraguay. *Centre for International Development. Harvard University.*
- Haynes, K.E., and Z.B. Machunda. 1987. Considerations in extending shift-share analysis: A note. *Growth and Change* 18: 69–78.
- Haynes, K. E., & Dinc, M. (1997). Productivity Change in Manufacturing Regions: A Multifactor/Shift-Share Approach. *Growth and Change*, *28*(2), 201-221.
- Houston, D.B. 1967. The shift and share analysis of regional growth: A critique. *Southern Economic Journal*. 33(4): 577–581.
- Lakkakula, P., Dixon, B. L., Thomsen, M. R., Wailes, E. J., & Danforth, D. M. (2015). Global rice trade competitiveness: a shift-share analysis. *Agricultural economics*, 46(5), 667-676.
- Leamer E. E., and Stern R. M. (1970). Quantitative international economics. *Boston: Allyn and Bacon.*
- Markusen, A. R., Noponen, H., & Driessen, K. (1991). International trade, productivity, and US regional job growth: A shift-share interpretation. *International Regional Science Review*, *14*(1), 15-39.
- Masuda, T., and Goldsmith, P. D. (2009). World soybean production: Area harvested, yield, and long-term projections. *International Food and Agribusiness Management Review, 12*(4), 143-162
- Milana C. (1988), Constant-Market-Shares analysis and index number theory. *European Journal of Political Economy*, 4: 453-478.
- Nazara, S., & Hewings, G. J. (2004). Spatial Structure and Taxonomy of Decomposition in Shift-Share Analysis. *Growth and Change*, *35*(4), 476-490.
- Peh K, Wong F (1999) Growth in Singapore's export markets. *Asian Economic Journal* 13: 321-344.
- Qiangsheng, L., Haynes, K. E., & Dinc, M. (1997). An extended and integrated approach to shift-share: Decomposition analyses of the Washington metropolitan economy. *Applied Geographic Studies*, *1*(4), 233-252.

- Regunaga, M. (2010). Implications of the organization of the commodity production and processing industry case studies in Latin America and the Caribbean region: The soybean chain in Argentina. Working Paper, *the World Bank Latin America and the Caribbean Chief Economist Office*.
- Reymert, R., & Schultz, C. E. (1985). Eksport og markedsstruktur. In *Rapporter 85/5*. *Central Bureau of Statistics Oslo.*
- Rigby, D. L., & Anderson, W. P. (1993). Employment change, growth and productivity in Canadian manufacturing: An extension and application of shift-share analysis. *Canadian Journal of Regional Science*, *16*(1), 69-88.
- Rosenfeld, F. 1959. Commentaire à l'exposé de M. Dunn. *Economie Appliquée* 4: 531–534.
- Richardson, J. D. (1971a). Constant-market-shares analysis of export growth. *Journal of international economics*, 1(2), 227-239
- Richardson J. D. (1971b). Some sensitivity tests for a constant market shares analysis of export growth. *Review of Economics and Statistics*, 53: 300-304.
- Saha, B., Sarker, R., and Mitura, V. (2014). Impact of genetically engineered varieties on the cost structure of corn and soybean production in Canada. *Canadian Journal of Agricultural Economics/Revue Canadienne D'Agroeconomie, 62*(2), 263-282.
- Sihag, B. S., & McDonough, C. C. (1989). Shift-Share Analysis: The International Dimension. *Growth and Change*, *20*(3), 80-88.
- Stilwell F. J. B. (1969). Regional growth and statistical adaptation. *Urban Studies*, 6: 162-178.
- UN Comtrade Database. (2017)
- US International Trade Commission. (2012). Brazil: Competitive factors in Brazil affecting US and Brazilian agricultural sales in selected third country markets. *USITC, Washington DC.*
- Tyszynski, H. (1951). World Trade in Manufactured Commodities, 1899-1950. *The Manchester School*, *19*(3), 272-304.
- Wilson, P. (2000). The export competitiveness of dynamic Asian economies 1983-1995. *Journal of Economic Studies*, *27*(6), 541-565.

CHAPTER 3: SPATIAL SHIF-SHARE ANALYSIS: COULD WE KNOW MORE NOW?

Abstract

Since Nazara and Hewings (2004) incorporated the influence of spatial interaction within shift-share analysis, several alternative formulations have appeared in the literature. This paper discusses the major research contributions to this field, highlighting their strengths and limitations. After providing an exhaustive overview of the literature, a further step is carried out and a new spatial shift-share methodology is proposed. The main objective of this new methodology is to overcome the problems detected in the previous frameworks. However, this new proposed method also has the capability of providing with further information about the influence that spatial interactions could have on the growth rate of economic variables. This is done by considering effects that have not been previously analyzed in the literature. In this way, it is offered as a complementary tool to the traditional non-spatial shift-share for the study of the drivers of changes in economic variables. To illustrate this extension of the shift–share method, the new technique is applied to the analysis of the evolution of the Agricultural Gross Value Added (AGVA) in 47 Spanish economies at the NUTS 3 level. The results highlight the relevant role played by spatial interactions in the variations of the AGVA in Spain. Furthermore, evidence of the dependency between the local, regional and national comparative advantages of these 47 NUTS 3 regions was found. Consequently, this new approach can shed new insights into the analysis of the changes of AGVA in Spain, from a broader point of view.

Keywords: spatial shift-share, Agricultural Gross Value Added, NUTS 3 regions, regional and local comparative advantages, Spain.

CAPÍTULO 3: ANÁLISIS SHIFT-SHARE CON COMPONENTES ESPACIALES: ¿ES POSIBLE CONOCER MÁS?

Resumen

Desde que Nazara y Hewings (2004) incorporaron las influencias de las interacciones espaciales dentro del análisis *shift-share*, una amplia variedad de versiones alternativas han aparecido en la literatura. Este capítulo estudia las principales contribuciones a esta área de estudio, remarcando las fortalezas y debilidades de cada una de ellas. Luego de una revisión exhaustiva de la literatura, una nueva versión del *shift-share* espacial es propuesta. El principal objetivo de esta nueva metodología es solucionar algunos de los problemas detectados en las contribuciones encontradas previamente en la literatura. Sin embargo, este método también tiene la capacidad de proveer mayor información sobre la influencia que las interacciones espaciales pueden tener en el crecimiento de variables económicas. Esto se lleva a cabo mediante la consideración de efectos que no han sido analizados previamente en la literatura. De esta manera, se ofrece una herramienta complementaria al *shift-share* tradicional y no espacial, para el estudio de los factores que impulsan los cambios en las variables económicas. Para ilustrar la metodología propuesta, la misma es aplicada al análisis de la evolución del Valor Añadido Bruto Agrícola en 47 provincias españolas a nivel NUTS 3. Los resultados resaltan el papel relevante de las interacciones espaciales en las variaciones del Valor Añadido Bruto Agrícola en España. Además, evidencia de dependencia entre la competitividad a nivel local, regional y nacional es ofrecida. Como consecuencia, esta nueva propuesta puede ofrecer nueva información en el análisis del Valor Añadido Bruto Agrícola en España, con un punto de vista más amplio

Palabras clave: *shift-share* espacial, Valor Añadido Bruto Agrícola, regiones NUTS 3, ventajas comparativas locales y regionales, España.

3.1 Introduction

Shift-share analysis is a statistical technique that has traditionally been used to study changes in economic variables. It decomposes the growth rates of these variables in three components: national effect, structural effect and regional competitive effect. This method was first proposed by Dunn (1960) and its main objective was to uncover interregional comparisons, using geographical and sectoral benchmarks. In this sense, it implicitly takes into account the geographical aspect, because it compares the growth rates of economic variables using different benchmarks, most typically comparing regional changes with national ones. However, the original decomposition does not explicitly consider the spatial interactions between the regions under study. In other words, when analyzing the growth of a variable of sector i in region r, it is assumed that this variable is independent of the growth of the same sector in neighboring regions. This assumption is however only valid if region r is an isolated and self-sufficient economy, which is not a common characteristic of actual connected regions or countries (Hewings, 1976; Isard 1960; Mayor and López, 2009). In strict terms, the traditional shift-share analysis therefore ignores those spatial interactions between regions and, hence, a further step is required.

The importance of including spatial dependences in shift-share was firstly recognized by Hewings (1976), whereas Nazara and Hewings (2004) subsequently proposed the first spatial shift-share. This framework incorporates neighborhood influences by comparing the growth rates of economic variables for a specific region with those of its neighbors. Notwithstanding the simplicity of its formulation, the approach has been criticized mainly for two reasons. First, this decomposition includes both “simple” and “combined” effects. According to these authors, the main difference between them is that while “simple effects” analyze the same geographical areas or the same industrial sectors, the “combined” effects compare different geographical and industrial levels. Consequently, this creates some difficulties in the interpretation of these so-called “combined effects”. Secondly, these authors did not present a unique decomposition of the shift-share analysis. Instead, twenty-six decompositions were proposed, leaving the analysts to make the choice of an appropriate decomposition.

Several extensions have been developed since the first *spatial* decomposition was presented by Nazara and Hewings (see among others, Ramajo and Márquez, 2008; Mayor and López, 2008; Espa *et al.*, 2013; Hareth *et al,* 2013; Matlaba *et al.*, 2014). Their main contributions were related to the solution of the drawbacks previously mentioned. Thus, these new extensions have mainly focused on the development of a unique decomposition that contemplates only “simple” effects. Although, in general, all these proposals have overcome the problems generated by the “combined” effects, the lack of a unique or preferred choice has only been partially addressed.

Regardless of the problems detected in the framework, spatial shift-share has been considered an effective tool for regional analysis. This is because both the traditional shift-share and the spatial version of it are very intuitive to use. Furthermore, the traditional shift-share studies the changes of economic variables from a national point of view, whereas the spatial shift-share analyzes the same changes with a regional (neighboring) scope. Thus, these two techniques together offer complementary information by disaggregating the drivers of the growth rate of an economic variable. It is also relevant to mention that the greater availability of data makes the application of the spatial version of the shift-share analysis easier in recent times[38]. Finally, the information obtained through this spatial method affords the opportunity to deepen the understanding of the various geographical influences, taking each region analyzed as a part of an integrated and interrelated system.

In this paper, a literature review about the main methodological and empirical contributions to the field is shown. The objective of this review is to present a detailed assessment of the main strengths and limitations of each of those contributions. In addition, an extension of the spatial shift-share decomposition is proposed. This new methodology presents an integral solution for some of the drawbacks presented by the decomposition of Nazara and Hewings (2004) and its subsequent extensions. Therefore, following the practice of previous researchers, the focus is on the decomposition of the growth rate of a regional socio-economic variable into only simple effects. Nevertheless, this proposal not only offers a unique decomposition constituted by simple effects, but it also considers all the effects that could affect the variable under study. This extended spatial shift-share provides a framework that contemplates new effects that have not been included before, introducing a new perspective within the spatial shift-share literature. Hence, it complements and reinforces the information provided by both the non-spatial

[1]The theoretical and empirical foundations about the need to explicitly consider spatial interactions in socio-economic studies, together with the increase in the use of softwares related to the Geographical Information Systems, have produced an increase in the demand for analysis tools that incorporate spatial dimension in the field of social science.

and the spatial shift-share literature in uncovering the sources for the growth of economic variables. To illustrate the use of this proposal, the changes in the agricultural Gross Value Added (AGVA) at the NUTS 3[39] level regions in Spain are studied during the period 2000-2014.

This paper contributes to the literature in the following aspects. First, it provides a comprehensive review of the extensions and applications of spatial shift-share. Secondly, a new extension of the methodology is presented. Thirdly, the changes of AGVA at the Spanish NUTS 3 level are analyzed by decomposing their growth rates using both the non-spatial and the spatial shift-share. The application suggests the relevant role played by the spatial effects on the changes observed in the case study. Finally, a classification of the NUTS 3 regions according to their results is displayed in order to identify the characteristics of each type of region.

The remainder of this article is organized as follows. Section 2 provides a literature review, in which the major contributions to spatial shift-share are discussed in detail. Section 3 presents the extension of the spatial shift-share methodology proposed in this paper. This methodology will be illustrated in Section 4 by means of an application to the Spanish AGVA, highlighting the new information learned about the performance of this sector. Finally, section 5 offers some final remarks and conclusions.

[1]The NUTS classification (Nomenclature of Territorial Units for Statistics) is a hierarchical system for dividing up the economic territory of the EU. The NUTS 3 nomenclature is defined to make socio-economic analyses of small regions, such as the so-called provinces in the case of Spain.

3.2 Literature review

The traditional shift-share assesses the growth of specific economic variables in particular regions by taking into account the relative sectors at the national level. For this purpose, it decomposes the growth into three components: the national growth effect, the industry mix effect and the regional shifts or competitive effect.

Let $x_{i,r}^{t}$ the value of the economic magnitude x of the sector i for the region r at time t. Then, for a regional economic system composed of several regions and a total aggregate known as the nation, four variables are defined:

- $g_i = (x_{i,r}^{t+1} - x_{i,r}^{t})/x_{i,r}^{t}$ denotes the annual growth rate of x in sector i for the region r.
- $g = (x_{r}^{t+1} - x_{r}^{t})/x_{r}^{t}$ denotes the annual growth rate of x in all sectors for the region r.
- $G_i = (x_{i}^{t+1} - x_{i}^{t})/x_{i}^{t}$ is defined similarly to g_i but at the national level, expressing the annual growth rate of x in sector i for the nation.
- $G = (x^{t+1} - x^{t})/x^{t}$ is the equivalent to g at the national level, representing the annual growth rate of x in all sectors for the nation.

Note that the presence of the subscript i refers to a specific sector, while its absence represents all the sectors, and that lowercase variables refer to the region r, while the uppercase variables refer to the nation.

The expression of the shift-share method proposed by Dunn (1960) is as follows:

$$g_i x_{i,r}^{t} = G x_{i,r}^{t} + (G_i - G) x_{i,r}^{t} + (g_i - G_i)\, x_{i,r}^{t} = NE + IM + CE \quad (3.1)$$

where:

- NE is the **national effect**. It represents the change in the regional variable x in sector i that may be attributed to changes in the national one.
- IM is the **industrial mix effect** or **structural effect**. It represents the impact of the national structure of the industry analyzed on the regional growth of the x in sector i.
- CE is the **competitive** or **regional shift effect**. It measures the part of the regional growth of x in sector i that is explained by the specialization in sector i .

The traditional shift-share analysis compares the growth rates of variables from different geographical areas (national and regional) that belong to an economic system.

Although it has been always considered as a tool to make comparisons between economic performances across regions, Dunn's proposal did not take into account the interactions that these geographical areas may have with each other. The literature however has recognized the importance of these territorial influences. For example, Isard (1960) claimed that any spatial unit of an economic system is affected positively or negatively by its neighboring regions. A step further was given by Hewings (1976), who expressed the need to incorporate spatial variables within the shift-share decomposition, in order to improve the quality of the comparisons made by using this technique.

Although the importance of spatial components in the shift-share analysis was acknowledged, it was not until Nazara and Hewings (2004) that a new *spatial* modification of this method emerged. These authors introduced spatial components to the traditional shift-share decomposition to represent interactions between the regions under evaluation. In order to measure these interactions, they proposed the use of a weight matrix, denominated as W.

The matrix W, is an $R \times R$ matrix, where R is the number of regions in the considered system. The rth row shows the structure of the region r's interactions with other regions. Denoting s as a neighboring region of r, the intensity of the interaction between regions r and s is expressed by $w_{r,s}$. This way, $w_{r,s} = 0$ if regions r and s have no interaction and $0 < w_{r,s} \leq 1$ otherwise[40].

Before integrating this matrix into the traditional shift-share, W is standardized by rows and therefore the sum of each row in the matrix is equal to unity.

The spatial shift-share method proposed by these authors is as follows:

$$g_i x_{i,r}^t = G x_{i,r}^t + (wg_i - G) x_{i,r}^t + (g_i - wg_i) x_{i,r}^t = NE + NNIM + RNRS \quad (3.2)$$

[40] At this point, it is important to mention that there are several ways to build a spatial weight matrix based on geographical criteria. One of the most popular options is the contiguity-based matrix, which considers two regions as neighbors whether they share a common border. Another common criteria is the distance-based neighborhood definition, which considers two regions as neighbors if their distance is equal, or less than equal, to a certain fixed distance, the so-called "critical cut-off". The concept of the "nearest neighbor" is another popular option and establishes as neighboring regions the set of k regions closest to the region under study (for example, with $k = 5$). Other common criteria is the inverse of the distance squared. Thus, the selection of the strategy is based on the availability of data and the interest of the researchers.

where:

$$wg_i = \frac{\sum_{s=1}^{R} w_{r,s} x_{i,s}^{t+1} - \sum_{s=1}^{R} w_{r,s} x_{i,s}^{t}}{\sum_{s=1}^{R} w_{r,s} x_{i,s}^{t}} \qquad (3.3)$$

$x_{i,s}^{t}$ and $x_{i,s}^{t+1}$ represents the value of the economic magnitude x of the sector i for the region s at time t and $t+1$. Besides the national effect (NE), two new effects were added:

- $(wg_i - G)x_{i,r}^{t}$ is the **neighbor-nation industry mix effect** ($NNIM$). It compares the sectoral growth rates of the neighbors of region r and the national growth of all sectors.
- $(g_i - wg_i)x_{i,r}^{t}$ is the **region neighbor regional-shift effect** ($RNRS$). It compares the dynamism of x in sector i of region r with that registered in neighboring regions.

Expression (3.2) modifies the initial shift-share decomposition by highlighting the importance of the spatial components within the decomposition. However, the approach has received some criticism. In the first place, while expression (3.1) is only composed by "simple" effects, the spatial shift-share includes both "simple" and "combined" effects. The main difference between them is that the so-called "combined" effects compare more than one aspect at the same time.[41] This fact could lead to difficulties in the interpretation of these effects. To overcome this problem, the authors showed that the combined effects can be decomposed as a sum of "simple" effects[42]. Notwithstanding this suggestion, this process can become complex and difficult if the correct combinations are not found (Espa *et. al*, 2013; Ramajo and Márquez, 2008).

Secondly, Nazara and Hewings proposed the so-called "taxonomy of shift-share." In this taxonomy, they displayed twenty-six different decompositions obtained through all the possible combinations of "simple" and "combined" effects. They classified them into two different types. On the one hand, six diverse decompositions that include only non-

[41] $(G_i - G)$ analyzes the same geographical area, meanwhile $(g_i - G_i)$ compares the same sector. But the spatial effect $(wg_i - G)$ compares different geographical units and sectors.
[42]For example, $(wg_i - G) = (wg_i - wg) + (wg - g) + (g - g_i) + (g_i - G_i) + (G_i - G)$. In this way, the neighbor-nation industry mix effect is expressed in terms of a sequence of only "simple" effects.

spatial effects[43] and twenty possibilities incorporating a combination of non-spatial and spatial effects. Therefore, the selection of the appropriate decomposition depends on the researcher, making its application very subjective.

Inspired by this pioneering study, several authors have contributed to the spatial shift-share literature. The contributions have been both methodological and empirical. Regarding the methodological contributions, Ramajo and Márquez (2008) proposed a “pure spatial shift-share” with equation (3.2) as a baseline but with the following reworking:

$$g_i x_{i,r}^t = wg x_{i,r}^t + (wg_i - wg) x_{i,r}^t + (g_i - wg_i) x_{i,r}^t =$$

$$g_i x_{i,r}^t - wg x_{i,r}^t = (wg_i - wg) x_{i,r}^t + (g_i - wg_i) x_{i,r}^t =$$

$$NLC = NIM + RNRS \quad (3.4)$$

where wg is defined analogously to wg_i. In addition, NLC and NIM are the **net local change** and the **neighborhood industrial mix**, respectively.

Expression (3.4) replaced the national scope with one for the neighborhood. For this reason, it is considered a “pure spatial shift-share.” This approach modified the three effects of the traditional shift-share by adding spatial components. Hence, expression (3.4) has primarily focused on solving the problem generated by the “combined” effects. In other words, this proposal is a “pure spatial version” of the traditional shift-share and, as a consequence, it only contains “simple” effects. On the other hand, it does not contemplate all the possible effects that result from the combination of the different growth rates studied. Expression (3.4) is only one of the several combinations that could be obtained in this way.

Along the same lines, Espa *et al.* (2013), Hareth *et al.* (2013) and Matlaba *et al.* (2014) developed an extension of the spatial shift share specified in expression (3.2). These authors worked on another task: the information presented by the neighborhood effects. In fact, they stated that the insights provided by the $RNRS$ can sometimes hide

[43] Nazara and Hewings (2004) showed that the traditional shift-share proposed by Dunn (1960) is only one of the twenty six combinations of their proposed “taxonomy of the shift-share”.

information.[44] Although these studies named the effects differently, the decomposition presented by these three methodologies is the same:[45]

$$\begin{aligned} g_i x_{i,r}^t &= G x_{i,r}^t + (G_i - G) x_{i,r}^t + (g_i - wg_i) x_{i,r}^t + (wg_i - G_i) x_{i,r}^t \\ &= NE + IM + RNRS + NNRS \quad (3.5) \end{aligned}$$

where all variables are as previously defined and $NNRS$ is **the neighbor-nation regional shift effect.**[46] This effect compares the neighbors of region r and the nation in terms of the growth of the variable x in sector i.

This decomposition differs from expression (3.2) in three ways. First, in addition to the national effect, this version also maintains the industry mix effect (IM) of the traditional shift-share proposed by Dunn (1960). Secondly, the decomposition presents “simple” effects only. Thirdly, the right-hand side of the expression presents four effects instead of three. In fact, there are two types of competitive effects in this version: the region neighbor regional-shift effect ($RNRS$) of Nazara and Hewings (2004) and the so-called neighbor-nation regional shift effect ($NNRS$). Thus, although these decompositions incorporate more effects, as in expression (3.4), the authors do not explore all the effects that can be obtained when considering all the selected variables.

On the other hand, instead of starting from equation (3.2) as the previous approaches described, Mayor and López (2009) focused on the incorporation of spatial components to Esteban-Marquillas’s (1972) modification. For this purpose, they used the “homothetic spatially influenced employment” $\left(x_i^{t^*}\right)$.[47] Thus, by adding this component to the decomposition of Esteban-Marquillas, the expression becomes the following:

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[44]For example, if the neighborhood effect shows a positive value but the difference in performance between neighbors and nation is negative, the competitive effect of the region is mainly due to individual factors, rather than to neighborhood advantages (Espa *et al.*, 2013).

[45]In order to maintain a standard notation, the names of the effects were unified.

[46] The neighbor-nation regional shift effect ($NNRS$) of Espa *et al.* (2013) is denominated as state competitive effect (SCE) by Hareth *et al.* (2013) and as potential spatial spillover effect (PSE) by Matlaba *et al.* (2014).

[47]The “homothetic spatially influenced” employment is defined as

$$x_{i,r}^{t\ *} = x_r^{t+1} \left(\frac{\sum_{s=1}^{R} x_{i,s}}{\sum_{i=1}^{k} \sum_{r=1}^{R} x_{i,s}} \right)$$

where all variables are as previously defined, s is a neighbor of r, R is the number of regions, and k is the number of sectors within the system.

$$g_i x_{i,r}^t = G x_{i,r}^t + (G_i - G) x_{i,r}^t + (g_i - G_i)\, x_{i,r}^{t\;*} + (g_i - G_i)\big(x_{i,r}^t - x_{i,r}^{t\;*}\big) =$$

$$NE + IM + SNCE + SLE \qquad (3.7)$$

where the third component is the so-called **spatial net competitive effect** ($SNCE$) and the last effect is the **spatial locational effect** (SLE). Notice that the first and the second terms are the national and the industry mix effect of the Dunn's version. The spatial locational effect (SLE) is the equivalent to the allocation effect of Esteban Marquilla's decomposition. Consequently, it has the same problem as the non-spatial version: the lack of an economic interpretation of this effect (see Artige and van Neuss, 2014). This work also compared the version obtained through the spatial filtering approach in order to investigate the change of the regional employment in Spain. The spatial filtering is an alternative way to deal with spatial autocorrelation in regression analysis and involves the filtering of variables allowing the elimination of the spatial effects (Mayor and López, 2008). The procedure is based on the decomposition of a variable into two components (spatial and non-spatial) through the use of a filter which removes the spatial component of each of the considered variables[48]. Finally, their contribution also relied on the sensitivity analysis of the results with respect to the spatial weight matrix used.

Regarding the empirical applications of spatial shift share, Shi *et al.* (2007) studied the performance of Jiangsu Province in China based on international tourism receipts from 1995 to 2004 using the decomposition proposed by Nazara and Hewings (2004). Zaccomer and Mason (2011) analyzed the employment change in a single Italian NUTS 2 region, adding new effects to adapt the model to their case of study. Flores *et al.* (2018) investigated the interregional interaction in regional employment growth, analyzing the impact of neighboring regions in Mexico. For this purpose, they employed the spatial

[48] In this paper, the screening procedure was used as a decomposition technique. This method is based on the consideration of a spatial vector S:

$$S \approx \rho W x$$

where W and $x$were previously defined and ρ is the auto-regressive coefficient. The S vector must be designed to capture the spatial dependence in the considered data. Its construction is based on data points, but in dealing with surface partitions, points could be considered as the references of different spatial areas. This vector allows the conversion of the dependent variable into its non-spatial equivalence:

$$x^* = x - S$$

Once the model includes all the non-spatial variables, it can be specified and estimated by the OLS method, leading to an unbiased estimation. After the filtering process is finished, a traditional shift-share analysis and the Esteban-Marquillas's version were carried out considering both the spatial and non-spatial (filtered) component of the variables (Mayor and López, 2008).

shift-share proposed by Matlaba *et al.* (2014). Grossi and Mussini (2018) applied a spatial shift-share decomposition to regional electricity consumption at the NUTS 3 level in Italy from 2000 to 2013 by using the specification presented by Espa *et al.* (2013). As those previously discussed methodological research contributions, in general, all these studies found out that the spatial interactions among regions played a key role in the growth of the variables under study. Therefore, there is accumulating evidence that supports the need and importance of considering spatial interdependence among the socio-economic variables of the regions analyzed.

In summary, the different extensions developed from the initial spatial shift-share analysis have attempted to offer a unique decomposition and avoid the subjectivity in the selection of one decomposition from the wide variety of taxonomies proposed by Nazara and Hewings (2004). The difficulties for the economic interpretation of the combined effects have also inspired these extensions. However, in this paper it is claimed that the previous research has not exhaustively addressed all the problems described before. In fact, many of these contributions have solved the problems of interpretation by proposing analyses composed of "simple" effects only. Although all of them have developed unique spatial decompositions, they have not clearly explained why the effects introduced in their versions are sufficient to analyze the complete set of drivers of changes in variable x. In this sense, it could be said that all the decompositions presented are mainly a variation developed on the basis of the Nazara and Hewings taxonomy. That is, the authors' work reviewed thus far have essentially selected one of the taxonomies to present it as a unique approach and illustrated it with an empirical application.

For all these reasons, a new extension of the spatial shift–share methodology is proposed in this paper. The new approach seeks to provide an efficient solution to the drawbacks of the traditional spatial shift-share and its subsequent extensions. This paper presents a unique method that is not one more of the different decompositions listed in the taxonomy created by Nazara and Hewings (2004) since it explores a new set of effects, never explored in the literature before. These effects are used to deepen in the analysis of the impact that spatial interactions among regions could have on the growth rate of economic variables. Subsequently, it attempts to expand the quantity of information that the literature about the spatial shift-share provides to the understanding of the changes in these variables. The next section will present the proposed decomposition methodology.

3.3 An extension to the spatial shift-share

In this section, a new spatial decomposition is presented. The main idea of this approach is to obtain an expression that contemplates all the possible interactions among the variables analyzed through "simple" effects only.

As mentioned before, a similar idea was introduced by Nazara and Hewings (2004), in their so-called "taxonomy of the shift-share." However, rather than proposing a single preferred version, they presented twenty six decomposition alternatives. Although these alternatives were also built by combining the variables studied, each decomposition obtained is strictly expressed as a set of three effects. In order to elaborate the analysis built on these three effects, every decomposition ignores three of the six variables studied. For example, by selecting the national effect (G) as the first term of the formulation, four decompositions could be ultimately obtained (see Table 3.24). Nonetheless, these four decompositions ignore three of the six growth rates studied. As a consequence, the researchers primarily need to analyze their case study and evaluate which one of the different alternatives offered is the most appropriate one in view of their purposes. In summary, none of the twenty-six decompositions, if applied separately, offers a compact solution in the case that the study would need an exploratory and comprehensive analysis of all the possible effects affecting the growth of a sector in a certain region.

Table 3.24: Taxonomy of the shift-share proposed by Nazara and Hewings (2004), isolating the variable (G) as the first effect of the shift-share decomposition.

Decomposition	Ignored variables in the decomposition
$g_i = G + (G_i - G) + (g_i - G_i)$	g, wg_i, and wg
$g_i = G + (g - G) + (g_i - g)$	G_i, wg_i, and wg
$g_i = G + (wg_i - G) + (g_i - wg_i,)$	G_i, g, and wg
$g_i = G + (wg - G) + (g_i - wg)$	G_i, g, and wg_i

Source: Author's elaboration

With the objective of providing one suitable framework to examine every possible effect, a new decomposition is proposed. This extension intends to complement the information given by the traditional shift-share (Dunn, 1960) and the spatial-shift share proposed by Nazara and Hewings (2004). Therefore, it considers the neighboring regions as a geographical benchmark, instead of the nation as the traditional shift-share does. Thus, following the methodology proposed by Ramajo and Márquez (2008), this new spatial proposal aims to replace the national point of view with one based on the definition of the neighborhood. Then, the growth rate of variables related to the nation are replaced for variables related to the growth rates of the neighboring regions. So, G_i and G are replaced by wg_i and wg. Note that unlike expression (3.4) the new proposal also introduces the variable g. Although the previous extensions have omitted this growth rate, it could provide useful information about the productive structure of the region. Moreover, its incorporation into the decomposition would permit deeper insights, since in addition to the analysis of sector i, the economic performance of all the sectors could also be evaluated. Consequently, the whole variables set to be considered in this new decomposition are g_i, wg_i, g, and wg.

The economic arguments underlying this proposal is connected with a bottom-up approach linked to the literature of interregional interaction stimulated by the pioneer contributions of Myrdal (1957) and Hirschman (1958). Following this perspective, the existence of important effects from the region to the nation is related to the generation of combined aggregate regional effects (Duranton and Puga, 2004; Márquez *et al.*, 2015). These effects could have different sources (for a review, see Ramajo *et al.*, 2017). In any case, the recognition of interregional effects among regional sectors (and so among regional economies) justifies the need to consider the important feedback effects from the regions to the nation that is adopted in the new decomposition.

Bearing in mind the objective of providing a unique option, the new proposal must take into account all the possibilities derived from the differences among g_i, wg_i, g and wg. If every combination among these four variables is considered, twelve effects could be obtained. However, due to the existence of symmetrical effects like, for example $(g_i - wg_i)$ and $(wg_i - g_i)$, it is sufficient to have only one of each pair to capture the interaction. Consequently, there are six total interactions to be considered, three of which were already included in previous extensions (see Table 3.25). This new proposed formulation not only keeps those former effects, but it further incorporates the other three missing ones. These new effects offer a characterization of the internal structure of a regional sector i and compare it with respect to that of the neighboring regions.

Table 3.25: Contemplated and not contemplated effects in the previously discussed spatial shift-share decompositions.

Possible Effects	Contemplated by	Symmetric Effects
Net local change: NLC $(g_i - wg)$	Ramajo and Márquez (2008)	$wg - g_i$
Not contemplated effect: IIE $(g_i - g)$	-	$g - g_i$
$RNRS$ $(g_i - wg_i)$	Nazara and Hewings (2004), Ramajo and Márquez (2008), Espa *et al.* (2013), Hareth *et al.* (2013) and Matlaba *et al.* (2014)	$wg_i - g_i$
Not contemplated effect: NSE $(g - wg)$		$wg - g$
Not contemplated effect: NCE $(g - wg_i)$		$wg_i - g$
Contemplated: NIM $(wg_i - wg)$	Ramajo and Márquez (2008)	$wg - wg_i$

Source: Author's elaboration

In this way, a new shift-share decomposition is formulated by using all the components described in Table 3.25. The expression is as follows:

$$\begin{aligned} g_i x_{i,r}^t = & \sum_i wg x_{i,r}^t + \sum_i (wg_i - wg) x_{i,r}^t + \sum_i (g_i - wg_i) x_{i,r}^t \\ & + \sum_i (g_i - g) x_{i,r}^t + \sum_i (g - wg) x_{i,r}^t + \sum_i (g - wg_i) x_{i,r}^t \\ & + \sum_i [(wg + wg_i) - (g + g_i)] x_{i,r}^t \end{aligned}$$

$$g_i x_{i,r}^t = NTE + NIM + RNRS + IIE + NSE + SCE + SLDE \qquad (3.8)$$

where the effects have the following definitions:

- $wgx_{i,r}^t$ is the **neighborhood total effect** (NTE). It measures the effect of change observed in the economic variable x that can be attributed to the performance of the neighbors of region r (Ramajo and Márquez, 2008).
- $(wg_i - wg)x_{i,r}^t$ is the **neighborhood industrial mix** (NIM) . It is the part of change explained by the industry mix of the neighbors of region r (Ramajo and Márquez, 2008).
- $(g_i - wg_i)x_{i,r}^t$ is the **region neighbor regional-shift effect** $(RNRS)$ of the original proposal by Nazara and Hewings (2004).
- $(g_i - g)x_{i,r}^t$ is the **internal industrial effect** (IIE). This effect represents the structure of the industry of region j. IIE complements the traditional industrial mix by giving an internal point of view.

- $(g - wg)x_{i,r}^{t}$ is the **neighborhood sectoral effect** (NSE). It compares the regional growth rate of x in all sectors, with respect to the one from its neighbors.
- $(g - wg_i)x_{i,r}^{t}$ is the **neighborhood contextual effect** (NCE). It evaluates whether all the sectors of region r are more (or less) dynamic than the neighbors' sector i.
- $[(wg + wg_i) - (g + g_i)]x_{i,r}^{t}$ is the **neighborhood level difference effect** $(NLDE)$, obtained as a residual term derived from the expression that specifies all the possible effects. It measures the effect of the difference between the growth rates of the variables of the neighbors and those of region r.

This new spatial shift-share decomposition overcomes the problems of choice caused by the several taxonomies previously described. Thus, if a researcher intends to explore the impacts of the spatial interactions among regions on the growth rate of a given variable, this version provides all the possible effects. Then, there is no longer need to select a one of the previous taxonomies.

In addition, and not less relevant, the proposed methodology contains "simple" effects only. That is to say, these effects always measure either the same sector or the same region in different combinations. Therefore, their economic interpretation is intuitive and an additional decomposition to facilitate this task becomes unnecessary.

Finally, this new formulation offers information about the local conditions of region r and its competitiveness within the neighborhood in which it operates. Furthermore, all the effects include a variable associated with region r. So, all the comparisons now inform about the comparative advantages (or disadvantages) for sector i with respect to the neighboring regional sector. As previous contributions have not studied the variable g, the assessment of the growth of all the sectors of the region studied has been ignored until now. Nevertheless, the expression (3.8) not only provides information on sector i, but also on all the sectors (or the sectoral benchmark). As a result, combined with the traditional shift-share, this approach is able to provide complete information of the comparative advantages or disadvantages of sector i in region r

In order to illustrate and discuss the utility of the new proposed extension of the spatial shift-share analysis, both the traditional version of the method and the extended one specified in expression (3.8) are subsequently applied to the case of the changes in the Agricultural Gross Valued Added (AGVA) of the 47 Spanish NUTS 3 regions during the period 2000-2014.

3.4 Illustration for 47 Spanish NUTS 3 regions

In this section, the approach proposed in expression (3.8) is illustrated. The main purpose is analyzing the drivers of the changes on the AGVA in 47 Spanish NUTS 3 regions (namely provinces in Spain). The application is organized as follows. First, the data used are described. Secondly, the results obtained with the non-spatial shift-share are presented. Thirdly, the application of the extension specified in expression (3.8) is examined. Finally, as an exploratory analysis, the correlations between the variable under study for each region and the effects detected are calculated.

3.4.1 Data

Cambridge Econometrics' European Regional Database (ERD) is used to analyze the changes in the AGVA of 47 Spanish –NUTS 3 regions belonging to 15 Spanish peninsular regions across the period from 2000 to 2014. The NUTS 3 regions without direct geographical connection with the peninsula have not been taking into account (provinces belonging to Ceuta and Melilla, Islas Baleares and Islas Canarias). Table 3.26 shows the NUTS classification system of Spain. From that table, it is possible to see the correspondence between each NUTS 3 region and the 15 Spanish peninsular regions (NUTS 2 regions), which are considered in this study.

To carry out the decompositions, the AGVA and the total GVA data at the Spanish NUTS 3 level are used. Thus, the total GVA is used as sectoral reference in this paper. On the other hand, there are two geographical references considered in this study. The values of both the agricultural and the total GVA of Spain are employed as reference in the application of the traditional shift-share. In the case of the proposed new spatial shift-share, the neighboring regions are used as a geographical benchmark. The weight matrix was built using the the $k = 5$ nearest neighbor's strategy, since some regions have more neighbors than others (e.g. Madrid in contrast to Galicia).

Table 3.26: Regions considered at NUT 1, NUTS 2 and NUTS 3 levels.

NUTS-1: Spain			
	NUTS-2		**NUTS-3**
1	**Andalucía (AND)**	1	Almería
		2	Cádiz
		3	Córdoba
		4	Granada
		5	Huelva
		6	Jaén
		7	Málaga
		8	Sevilla
2	**Aragón (ARA)**	9	Huesca
		10	Teruel
		11	Zaragoza
3	**Cantabria (CAN)**	12	Cantabria
4	**Castilla-La Mancha (CLM)**	13	Albacete
		14	Ciudad Real
		15	Cuenca
		16	Guadalajara
		17	Toledo
5	**Castilla y León (CTL)**	18	Ávila
		19	Burgos
		20	León
		21	Palencia
		22	Salamanca
		23	Segovia
		24	Soria
		25	Valladolid
		26	Zamora
6	**Cataluña (CAT)**	27	Barcelona
		28	Girona
		29	Lleida
		30	Tarragona
7	**Comunidad de Madrid (MA)**	31	Madrid
8	**Comunidad Foral de Navarra (NA)**	32	Navarra
9	**Comunidad Valenciana (VAL)**	33	Alicante
		34	Castellón
		35	Valencia
10	**Extremadura (EXT)**	36	Badajoz
		37	Cáceres
11	**Galicia (GAL)**	38	A Coruña
		39	Lugo
		40	Ourense
		41	Pontevedra
12	**La Rioja (RI)**	42	La Rioja

13	**País Vasco (VAS)**	43	Álava
		44	Guipúzcoa
		45	Vizcaya
14	**Principado de Asturias (PAS)**	46	Asturias
15	**Región de Murcia (MUR)**	47	Murcia

Source: Author's elaboration based on the NUTS classification system of Spain.

3.4.2 A brief overview of the trends in AGVA in the Spanish NUTS 3 regions

AGVA in Spain increased at a modest rate across the period 2000-2014. Table 3.27 exposes that it experienced a positive growth of 0.35% in average during those years, being this growth below the rate of the total GVA over the period of analysis (1.45%). However, it is important to point out that the agricultural activities had not a large participation in the total economy, since AGVA only represents 3% of the total GVA in Spain.

In regional terms, Table 3.27 shows differences in the dynamism of the agricultural sector. The NUTS 3 regions that displayed the highest positive growth[49] rates in the AGVA were Jaén and Sevilla (corresponding to the NUTS 2 region of Andalucía), Huesca, Teruel and Zaragoza (Aragón), Castellón (Comunidad Valenciana), Lugo and Ourense (Galicia). In most of the remaining NUTS 3 regions, the total GVA increased faster than the AGVA, following the same pattern as the whole country. These regional disparities were related to the different level of participation of the agricultural sector in the total GVA of the NUTS 3 regions. Table 3.27 displays that Almería and Jaén (Andalucía), Huesca (Aragón), Albacete, Ciudad Real and Cuenca (Castilla-La Mancha), Palencia, Soria and Zamora (Castilla León), Badajoz (Extremadura) and Lugo (Galicia) exhibited the highest shares, where agricultural activities accounted for more than 10% in the total GVA of these NUTS 3 regions. In contrast, NUTS 3 regions like Córdoba, Granada, Sevilla, Barcelona, Valencia, A Coruña, Pontevedra, and Murcia displayed lower participation of their agricultural industry in the total GVA. This suggests that not all of the regions have the same degree of agriculture dependence.

[49] A high positive growth is defined as a growth rate greater than 3%.

Table 3.27: Growth rate of the AGVA, the total GVA, and shares of the AGVA* (average 2000-2014)

		Growth Rate of AGVA (%)		Growth Rate of Total GVA (%)		Share of AGVA in Total GVA (%)		Share of each region in the Spanish AGVA (%)	
	Region	**AVG**	**STD. DEV**	**AVG**	**STD. DEV**	**AVG**	**STD. DEV**	**AVG**	**STD. DEV**
Andalucía	Almería	2.34	9.04	1.20	4.00	15.97	1.16	6.53	0.66
	Cádiz	0.25	13.84	0.62	3.04	3.64	0.54	2.40	0.27
	Córdoba	1.81	20.12	1.32	3.34	8.36	1.00	3.49	0.33
	Granada	3.68	6.63	1.97	3.16	6.72	0.96	3.14	0.44
	Huelva	0.23	7.47	0.58	3.92	8.17	0.48	2.37	0.28
	Jaén	10.00	70.08	0.97	5.50	11.43	2.80	3.87	0.86
	Málaga	2.17	11.79	2.12	3.57	2.99	0.36	2.50	0.17
	Sevilla	4.18	10.65	1.81	3.11	4.65	0.38	5.21	0.60
Aragón	Huesca	3.10	13.36	2.00	4.11	14.69	1.67	2.65	0.37
	Teruel	3.84	17.69	1.03	2.95	6.09	0.68	0.69	0.09
	Zaragoza	3.46	9.62	1.57	3.09	3.80	0.43	2.89	0.36
Cantabria	Cantabria	-4.55	7.62	0.84	2.84	2.77	0.82	1.09	0.25
Castilla -La Mancha	Albacete	-0.67	10.92	1.50	2.87	10.61	1.49	2.38	0.22
	Ciudad Real	-2.06	16.59	1.04	3.51	11.07	2.51	3.37	0.51
	Cuenca	0.98	15.28	1.72	3.57	16.77	2.63	2.12	0.15
	Guadalajara	2.68	24.52	2.91	4.69	4.12	0.80	0.59	0.09
	Toledo	-1.74	12.28	1.85	4.47	7.51	1.76	2.74	0.28
Castilla León	Ávila	-2.85	14.54	0.53	3.03	6.67	1.67	0.65	0.13
	Burgos	-0.67	12.61	0.87	2.88	5.98	0.65	1.81	0.20
	León	-2.61	5.71	0.52	2.60	5.15	0.89	1.61	0.21
	Palencia	-2.20	13.28	0.91	3.73	10.16	1.39	1.32	0.16
	Salamanca	-0.75	9.36	0.54	2.86	6.24	0.59	1.36	0.13
	Segovia	-4.30	12.46	0.29	3.18	9.62	2.48	1.07	0.25
	Soria	0.63	38.14	0.84	3.62	10.79	2.84	0.74	0.18
	Valladolid	-0.95	14.08	0.83	2.56	5.15	0.55	2.00	0.17
	Zamora	-1.39	10.04	0.94	3.03	10.88	1.48	1.21	0.13
Cataluña	Barcelona	1.12	7.49	1.17	2.63	0.70	0.04	3.26	0.17
	Girona	2.29	7.26	2.05	3.43	3.30	0.29	2.00	0.16
	Lleida	-1.43	12.11	1.90	2.88	7.85	1.48	2.85	0.36
	Tarragona	-0.88	9.77	1.86	3.53	2.52	0.42	1.65	0.18
Comunidad de Madrid	Madrid	-5.35	15.87	1.75	2.34	0.14	0.06	0.80	0.24
Comunidad Foral de Navarra	Navarra	2.63	4.78	1.33	2.43	3.97	0.32	2.25	0.26
Comunidad Valenciana	Alicante	1.55	9.32	1.37	3.58	2.27	0.29	2.41	0.16
	Castellón	3.78	12.54	0.53	3.40	3.71	0.39	1.57	0.20
	Valencia	2.24	9.66	1.18	3.28	2.78	0.37	4.74	0.46
Extremadura	Badajoz	-3.01	6.48	1.24	3.25	11.08	2.73	3.72	0.60

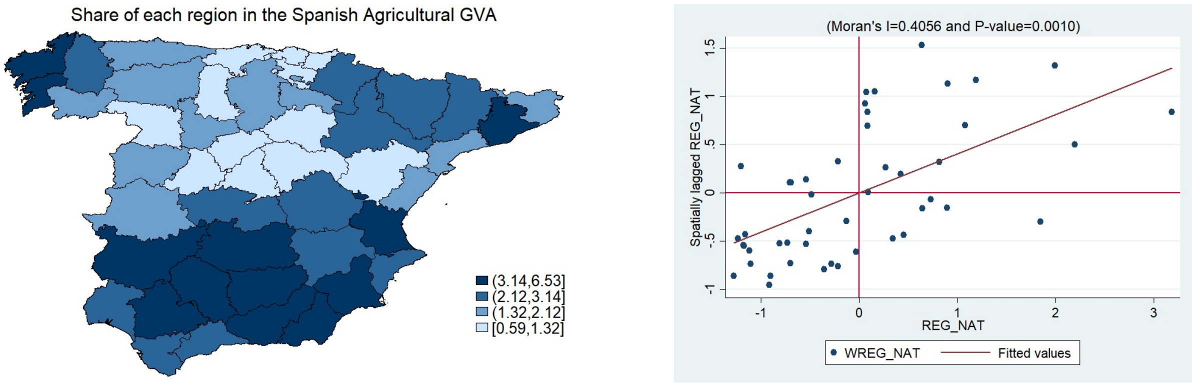
	Cáceres	2.02	8.62	1.19	2.50	6.52	0.74	1.35	0.12
Galicia	A Coruña	1.56	5.18	1.68	2.92	4.68	0.35	3.48	0.19
	Lugo	3.95	10.69	1.54	2.84	11.19	1.05	2.41	0.28
	Ourense	5.06	11.29	1.36	2.77	6.93	1.08	1.37	0.25
	Pontevedra	2.34	10.52	1.26	3.37	5.42	0.78	3.15	0.37
La Rioja	La Rioja	-0.48	8.20	1.26	2.84	7.79	1.22	1.91	0.15
País Vasco	Álava	2.34	12.66	1.96	3.78	2.19	0.36	0.73	0.10
	Guipúzcoa	-1.61	9.94	1.16	3.18	1.09	0.30	0.72	0.15
	Vizcaya	-4.68	10.76	0.93	2.22	0.82	0.33	0.82	0.27
Principado Asturias	Asturias	-1.52	5.82	0.57	3.30	2.23	0.33	1.57	0.18
Región de Murcia	Murcia	0.18	9.37	1.83	3.26	5.89	1.06	4.94	0.37
	Spain	**0.35**	**6.15**	**1.38**	**2.67**	**3.23**	**0.31**	**0.00**	**0.00**

Note: *Millions of euros (current values)
Source: Author's elaboration

However, it is important to emphasize that not all the regions under analysis had the same importance for the Spanish AGVA. Table 3.27 shows that those NUTS 3 regions with the highest shares in the national agricultural AGVA from 2000 to 2014, were Almería, Córdoba, Granada, Jaén, and Sevilla (Andalucía), Ciudad Real (Castilla- La Mancha), Barcelona (Cataluña), Valencia (Comunidad Valenciana), Badajoz (Extremadura), A Coruña, Pontevedra (Galicia) and Murcia (Región de Murcia).

Furthermore, these NUTS 3 regions not only played an important role in the national AGVA, but they also showed a positive growth over the period of analysis (with the exception of Ciudad Real and Badajoz that experienced a decline in their AGVA). Figure 3.2 shows the spatial distribution of the share that each region represents in the national AGVA. This map reveals that the regions with the highest contribution to the Spanish GVA are mainly located in the south of Spain. In fact, the value obtained for Moran's *I* (Cliff and Ord, 1981) was positive and significant at the 1% level under the null hypothesis of the non-existence of spatial autocorrelation (see Figure 3.2). Therefore, there are spatial factors affecting this sector in the regions analyzed, which indicate the need to consider the spatial effects to study the changes on the agricultural sector in the Spanish regions.

Figure 3.2: Spatial distribution and Moran's I diagram of dispersion of the importance of each NUTS 3 region in the national AGVA* (average in the period of 2000-2014)



Note: *Millions of euros (current values)
Source: Author's elaboration based on data from Cambridge Econometrics' European Regional Database (ERD).

In summary, the agricultural sector has decreased its contribution to the total GVA in Spain, but not all the NUTS 3 regions have followed this same pattern. An initial examination of the data reveals that not all these regional economies showed the same relative contribution to the national AGVA, and that the most important regions to the national AGVA are spatially grouped. This point out the existence of spatial influences and the relevance of performing an analysis that include spatial interactions. In addition, our descriptive analysis suggests different behaviors in the agriculture sector of the Spanish regions (the regions with positive growth rates seem to perform differently). Thereby, in order to better understand these differences, the traditional shift-share and the new spatial shift-share are next applied.

3.4.3 Results of the traditional shift-share

Table 3.28 displays the results for the 47 NUTS 3 regions obtained in the application of the traditional shift-share specified in expression (3.8).

Table 3.28: Summary of the effects calculated with the traditional shift-share analysis* (average in the period 2000-2014)

NUTS-2	NUTS-3	Traditional effects**			
		Growth rate $g_i x_{i,r}^t$	NE G	IM $(G_i - G)$	CE $(g_i - G_i)$
		AVG	AVG	AVG	AVG
Andalucía	Almería	32.30	19.87	-13.19	25.63
	Cádiz	-4.40	7.49	-7.49	-4.39
	Córdoba	0.63	12.69	-13.69	1.63
	Granada	30.48	9.13	-6.56	27.91
	Huelva	-0.11	8.26	-6.22	-2.15
	Jaén	-36.27	15.07	-21.95	-29.39
	Málaga	10.48	7.96	-7.09	9.61
	Sevilla	47.07	15.62	-13.89	45.34
Aragón	Huesca	15.30	7.29	-6.69	14.69
	Teruel	3.98	2.05	-2.07	4.00
	Zaragoza	22.20	8.38	-6.75	20.57
Cantabria	Cantabria	-14.36	4.84	-4.90	-14.30
Castilla -La Mancha	Albacete	-6.68	8.89	-7.64	-7.94
	Ciudad Real	-29.23	13.28	-10.03	-32.47
	Cuenca	-0.60	7.35	-7.78	-0.18
	Guadalajara	-0.35	1.53	-1.75	-0.13
	Toledo	-17.38	10.68	-10.42	-17.65
Castilla León	Ávila	-6.14	2.79	-3.03	-5.90
	Burgos	-6.53	5.40	-4.80	-7.13
	León	-11.48	6.42	-5.77	-12.14
	Palencia	-9.24	4.72	-5.09	-8.87
	Salamanca	-3.77	4.86	-4.33	-4.29
	Segovia	-13.28	4.92	-4.96	-13.24
	Soria	-9.85	3.30	-4.12	-9.03
	Valladolid	-9.21	6.55	-6.78	-8.98
	Zamora	-5.39	4.61	-4.19	-5.80
Cataluña	Barcelona	6.98	10.44	-9.47	6.01
	Girona	10.08	6.77	-5.27	8.58
	Lleida	-13.83	11.29	-11.39	-13.73
	Tarragona	-5.37	5.87	-5.40	-5.84
Comunidad de Madrid	Madrid	-14.38	3.97	-3.96	-14.39
Comunidad Foral de Navarra	Navarra	14.37	6.38	-4.70	12.69
Comunidad Valenciana	Alicante	7.57	8.63	-7.68	6.62

	Castellón	12.04	5.24	-4.07	10.88
	Valencia	23.54	13.91	-13.11	22.74
Extremadura	Badajoz	-32.65	15.40	-15.43	-32.62
	Cáceres	6.24	4.30	-3.54	5.48
Galicia	A Coruña	12.87	11.45	-9.60	11.01
	Lugo	20.62	6.89	-6.02	19.75
	Ourense	15.55	3.75	-2.61	14.41
	Pontevedra	16.53	9.56	-7.89	14.86
La Rioja	La Rioja	-4.26	7.28	-6.96	-4.57
País Vasco	Alava	3.10	2.01	-1.65	2.74
	Guipúzcoa	-4.37	3.19	-3.08	-4.48
	Vizcaya	-14.24	4.19	-4.35	-14.08
Principado de Asturias	Asturias	-6.59	6.20	-5.82	-6.97
Región de Murcia	Murcia	-2.75	18.40	-17.35	-3.80

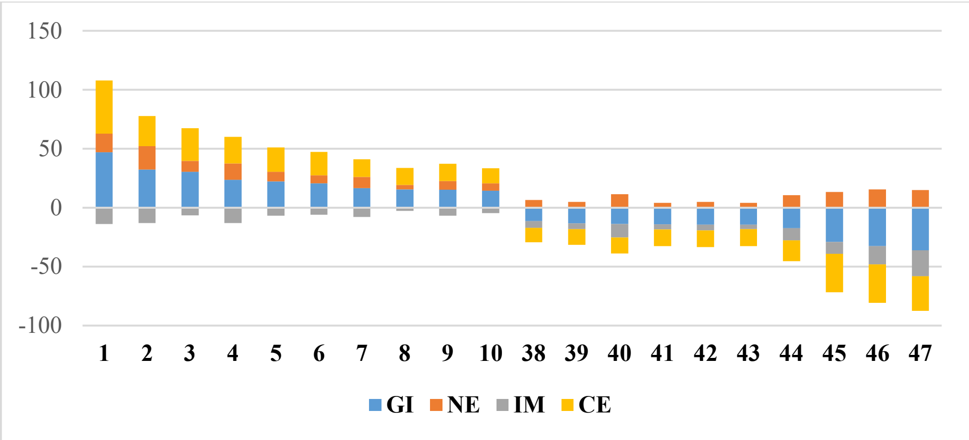
Notes: *Millions of euros (current values)
**$g_i x_{i.r}^t$= growth rate of AGVA, NE= National Effect, IM= Industry Mix Effect, CE= Competitive Effect.
Source: Author's elaboration

From column 3 in Table 3.28, on average, all the NUTS 3 regions of Aragón, Galicia, Comunidad Foral de Navarra and Comunidad Valenciana exhibited a positive change in the AGVA. Likewise, most of the NUTS 3 regions of Andalucía (Almería, Córdoba, Granada, Sevilla, Málaga) also experienced a positive value. To a lesser extent, two NUTS 3 regions in Cataluña, Barcelona and Girona, and one in Extremadura (Cáceres) also had a positive result. The rest of the NUTS 3 regions attained a negative value during the period of analysis.

From a general analysis of the effects proposed by Dunn (1960), it can be concluded that the agricultural sector experienced disadvantages in comparison with the total aggregate of all the sectors. This is evidenced by the positive sign of the national effect (NE) and the negative sign of the industry mix (IM) in all the NUTS 3 regions. In addition, this national trend also influenced the competitive effect (CE). Thus, the majority of the NUTS 3 regions recorded a negative CE over the period of study. Those regions displaying a positive CE were the same ones that attained a positive change in the AGVA. Therefore, these results imply that a positive growth rate of this variable was associated with a positive competitive effect (CE).

Figure 3.3 compares the contribution of each effect of the traditional shift-share to those results that report the most positive and negative changes at the AGVA. This illustration reveals that the different performance outcomes of the NUTS 3 regions are mainly attributable to the competitive effect. Hence, the greater the competitive effect, the greater the growth of the agricultural GVA. In other words, the growth (decline) of the agricultural GVA is explained by the advantages (disadvantages) displayed for that sector in the NUTS 3 regions with respect to the national agricultural GVA. This also implies the importance of being competitive in the national context.

Figure 3.3: Comparison among the ten regions* displaying the most positive and negative changes in the AGVA, and the contribution of each effect of the traditional shift-share** (average in the period 2000-2014)

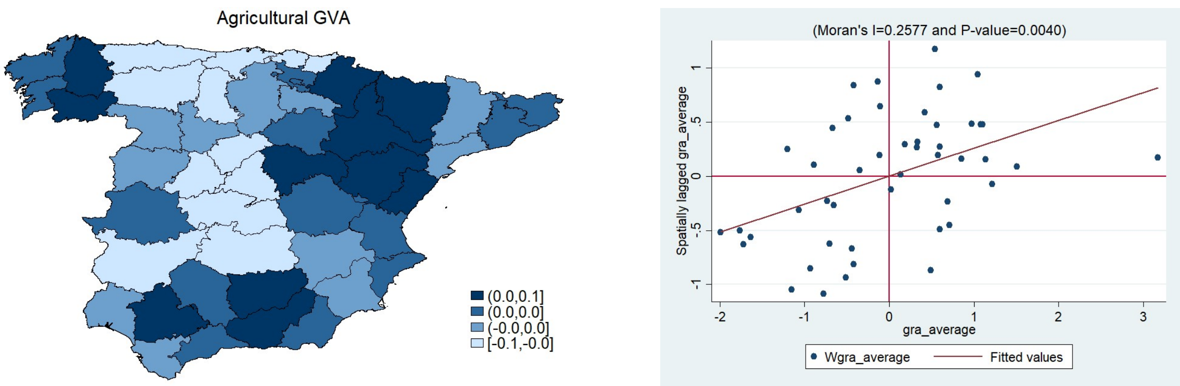


Notes: *1= Sevilla, 2= Almería, 3= Granada, 4=Valencia, 5=Zaragoza, 6=Lugo, 7=Pontevedra, 8=Ourense, 9=Huesca, 10=Navarra, 38= León, 39=Segovia, 40=Lleida, 41=Vizcaya, 42=Cantabria, 43=Madrid, 44=Toledo, 45=Ciudad Real, 46=Badajoz, 47= Jaén.
**Millions of euros (current values)
Source: Author's elaboration

Next, the existence of significant spatial interactions in the growth rate of the AGVA will be empirically verified, highlighting the need to use a spatial shift-share analysis. Figure 3.4 shows the spatial distribution of the growth rate of the AGVA for the NUTS 3 regions during the period 2001-2014. This illustration suggests a strong geographic pattern in the distribution of changes in the AGVA, thus revealing the presence of clusters in the regional growth rates. Additionally, the homogenous nature of these clusters implies that the Spanish NUTS 3 regions tends to be surrounded by regions displaying similar values, demonstrating the existence of positive spatial autocorrelation.

Moran's *I* was calculated to verify the existence of spatial autocorrelation. The value obtained was 0.257 under the null hypothesis of the non-existence of spatial autocorrelation. The *p-value* associated with this test was significant at the 1% level (see Figure 3.4). This result confirms the existence of a strong positive and statistically significant degree of spatial dependence in the growth rates of the AGVA among the Spanish NUTS 3 regions. This outcome also supports the prior confirmation of the spatial aggrupation of the most (less) important regions to the national AGVA (Figure 3.2). Consequently, the application of the spatial shift-share decomposition proposed in expression (8) is justified, since it would capture the different spatial effects that were operating within this Spanish regional system, providing the underlying information about the influences of the spatial interactions.

Figure 3.4: Spatial distribution and Moran's I diagram of dispersion of the growth rate of the AGVA* (average in the period 2000-2014)



Note: *Millions of euros (current values)
Source: Author's elaboration

3.4.4 Results of the spatial shift-share

Table 3.29 presents the results obtained after applying expression (3.8). In general, these effects evidence the low dynamism of the agricultural sector in the regions analyzed, as well as in their neighbors.

Table 3.29: Summary of the effects derived from the spatial shift-share analysis* (average in the period 2000-2014)

NUTS-2	NUTS-3	Growth rate	New effects**						
			NTE	NIM	$RNRS$	IIE	NSE	NCE	$NLDE$
		$g_i x^t_{i.r}$	wg	$wg_i - wg$	$g_i - wg_i$	$g_i - g$	$g - wg$	$g - wg_i$	$(wg + wg_i) - (g + g_i)$
		AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG
Andalucía	Almería	32.30	22.05	-7.45	17.70	17.30	-7.05	0.40	-10.65
	Cádiz	-4.40	9.54	3.21	-17.15	-7.22	-6.72	-9.93	23.87
	Córdoba	0.63	14.74	-24.11	9.99	-10.82	-3.30	20.81	-6.69
	Granada	30.48	10.86	-5.53	25.15	16.68	2.95	8.47	-28.10
	Huelva	-0.11	8.90	-4.63	-4.38	-3.28	-5.73	-1.11	10.12
	Jaén	-36.27	14.77	-15.37	-35.66	-39.02	-12.01	3.36	47.68
	Málaga	10.48	7.91	0.55	2.02	-1.90	4.47	3.92	-6.49
	Sevilla	47.07	14.38	-21.82	54.51	26.22	6.47	28.28	-60.97
Aragón	Huesca	15.30	7.14	-3.35	11.51	5.13	3.03	6.39	-14.55
	Teruel	3.98	1.89	0.76	1.33	2.47	-0.38	-1.15	-0.94
	Zaragoza	22.20	8.38	0.27	13.54	12.69	1.13	0.86	-14.67
Cantabria	Cantabria	-14.36	3.85	-10.54	-7.66	-17.70	-0.50	10.04	8.16
Castilla-La Mancha	Albacete	-6.68	8.83	-5.42	-10.10	-15.93	0.41	5.83	9.68
	Ciudad Real	-29.23	15.61	-13.01	-31.83	-38.45	-6.38	6.62	38.21
	Cuenca	-0.60	8.71	-8.11	-1.20	-8.87	-0.45	7.66	1.65
	Guadalajara	-0.35	2.09	-6.10	3.65	-3.90	1.45	7.55	-5.10
	Toledo	-17.38	12.54	-34.51	4.59	-31.51	1.58	36.09	-6.16
Castilla León	Ávila	-6.14	3.24	-7.96	-1.41	-7.34	-2.04	5.92	3.45
	Burgos	-6.53	4.22	-14.98	4.23	-9.54	-1.21	13.77	-3.03
	León	-11.48	4.11	-4.65	-10.94	-14.21	-1.38	3.27	12.32
	Palencia	-9.24	2.78	-10.87	-1.15	-12.30	0.27	11.15	0.88
	Salamanca	-3.77	2.79	-8.14	1.57	-5.85	-0.72	7.42	-0.85
	Segovia	-13.28	5.70	-13.03	-5.96	-15.02	-3.96	9.06	9.92
	Soria	-9.85	3.34	-4.54	-8.64	-11.32	-1.86	2.68	10.51
	Valladolid	-9.21	3.24	-17.69	5.25	-12.89	0.44	18.13	-5.69
	Zamora	-5.39	2.74	-4.99	-3.14	-8.42	0.30	5.28	2.84
Cataluña	Barcelona	6.98	12.48	-6.43	0.94	-1.81	-3.68	2.75	2.75
	Girona	10.08	6.58	-1.53	5.04	0.20	3.30	4.83	-8.33
	Lleida	-13.83	11.16	-0.22	-24.77	-28.15	3.17	3.39	21.59
	Tarragona	-5.37	5.00	-0.48	-9.90	-13.58	3.20	3.68	6.70

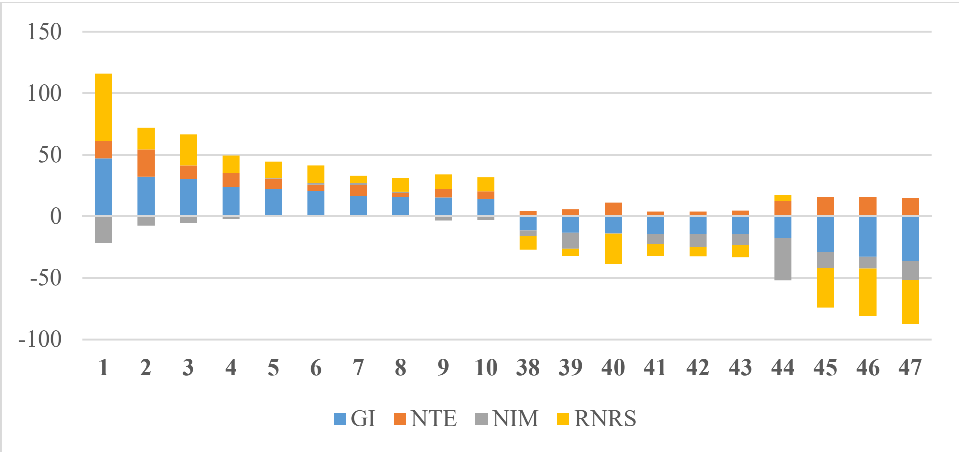
Comunidad de Madrid	Madrid	-14.38	4.59	-9.00	-9.97	-18.99	0.02	9.01	9.96
Comunidad Foral de Navarra	Navarra	14.37	5.91	-2.87	11.33	8.02	0.43	3.30	-11.76
Valencia	Alicante	7.57	8.12	-3.60	3.06	-1.09	0.54	4.14	-3.60
	Castellón	12.04	5.31	1.55	5.18	10.11	-3.38	-4.93	-1.80
	Valencia	23.54	11.73	-2.34	14.16	12.42	-0.60	1.74	-13.56
Extremadura	Badajoz	-32.65	15.91	-9.84	-38.73	-46.08	-2.48	7.36	41.20
	Cáceres	6.24	3.44	-11.89	14.69	2.57	0.23	12.12	-14.92
Galicia	A Coruña	12.87	7.67	5.04	0.15	-0.88	6.07	1.03	-6.22
	Lugo	20.62	5.16	1.46	13.99	12.36	3.10	1.64	-17.09
	Ourense	15.55	3.42	1.05	11.09	11.71	0.42	-0.62	-11.51
	Pontevedra	16.53	8.90	1.81	5.82	8.05	-0.41	-2.22	-5.41
La Rioja	La Rioja	-4.26	6.69	-7.57	-3.38	-10.85	-0.10	7.47	3.48
	Alava	3.10	1.53	-2.59	4.16	0.21	1.36	3.95	-5.52
	Guipúzcoa	-4.37	2.68	-3.93	-3.12	-6.94	-0.12	3.81	3.24
País Vasco	Vizcaya	-14.24	3.77	-8.18	-9.83	-16.85	-1.16	7.02	10.99
Principado de Asturias	Asturias	-6.59	4.18	-7.70	-3.07	-9.65	-1.12	6.58	4.19
Región de Murcia	Murcia	-2.75	16.85	-9.22	-10.39	-26.93	7.32	16.54	3.07

*Notes: Millions of euros (current values)
** $g_i x_{i.r}^t$= Growth rate of AGVA, NTE =Neighborhood Total Effect, NIM= Neighborhood Industry Mix Effect, $RNRS$ = Region Neighbor Regional-Shift Effect, IIE= Industrial Internal Effect, NSE= Neighborhood Sectoral Effect, NCE= Neighborhood Contextual Effect, $NLDE$= Neighborhood Level Difference Effect.
Source: Author's elaboration

From Table 3.29, it is possible to corroborate that the neighborhood total effect (NTE) was positive in the 47 Spanish NUTS 3 regions, whereas the neighborhood industry mix (NIM) was negative in most of them, except for Málaga and Cádiz (Andalucía), Teruel and Zaragoza (Aragón), Castellón (Comunidad Valenciana) and all the NUTS 3 regions in Galicia. These results expose that the AGVA displays a slower growth with respect to the total GVA of the neighbors of each region analyzed. Moreover, these neighboring regions have followed the same trend as the nation. On the other hand, those NUTS 3 regions that recorded the highest positive region neighbor regional-shift effects ($RNRS$) were the same ones that also attained a positive change. Therefore, the presence of comparative advantages of these regions with respect to their neighbors explained their better performance in the agricultural sector. Figure 3.5 compares the changes on the agricultural GVA and the different contribution of each one of the three effects analyzed above (NTE, NIM and $RNRS$). In this case, it can be concluded that the higher $RNRS$, the higher the AGVA growth rate.

Regarding the new effects proposed in this paper, the internal industry effect (IIE) provides information about the internal structure of each region analyzed. The majority of the NUTS 3 regions obtained a negative internal industry effect (IIE), suggesting that most of these economies showed a lack of dynamism in agriculture with respect to the total regional economy. On the contrary, according to Table 3.29, positive values correspond to those NUTS 3 regions displaying the highest agricultural GVA growth rates.

Figure 3.5: Comparison among the ten regions* displaying the most positive and negative changes in the AGVA, and the contribution of each effect derived from the traditional shift-share ** (average in the period 2000-2014)

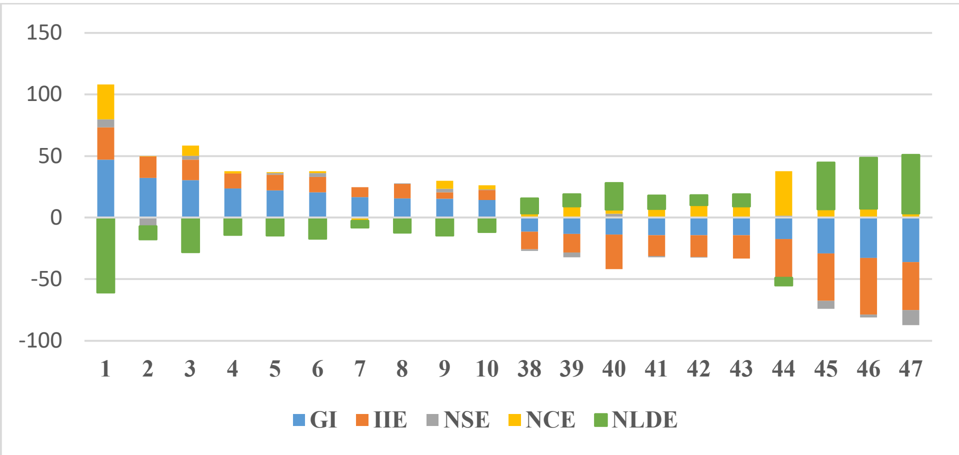


Notes: *1= Sevilla, 2= Almería, 3= Granada, 4=Valencia, 5=Zaragoza, 6=Lugo, 7=Pontevedra, 8=Ourense, 9=Huesca, 10=Navarra, 38= León, 39=Segovia, 40=Lleida, 41=Vizcaya, 42=Cantabria, 43=Madrid, 44=Toledo, 45=Ciudad Real, 46=Badajoz, 47= Jaén.
**Millions of euros (current values)
Source: Author's elaboration

The neighborhood sectoral effect (NSE) was also negative in most of the NUTS 3 regions analyzed. This implies a lower dynamism of their total GVA compared to the total GVA of their neighboring regions. The slower growth of AGVA of the neighbors is also reflected by the positive results of the neighborhood contextual effect (NCE) in most of the NUTS 3 regions. In other words, the growth of total GVA of each region was greater than the weighted average of the growth of AGVA of their neighbors. Finally, the neighborhood level difference effect ($NLDE$) was negative only in those regions that experienced a positive change in the AGVA. This outcome reinforces the important role played by the comparative advantages characterizing these regions with respect to their neighbors. Therefore, the internal structure of the NUTS 3 regions and the lack of comparative advantages relative to their neighbors limited the extent to which the AGVA could change positively.

The growth rate of the AGVA is compared with those new spatial internal effects in Figure 3.6. Thus, the linkage between a high positive change and high internal dynamism in the region studied (IIE) is shown. Also, it can be seen that higher comparative disadvantages of these regions over their neighbors negatively impacted on the growth rate of their AGVA (NSE, NCE and $NLDE$).

Figure 3.6: Comparison among the ten regions* displaying the most positive and negative changes in the AGVA, and the contribution of each effect derived from the traditional shift-share ** (average in the period 2000-2014)



Notes: *1= Sevilla, 2= Almería, 3= Granada, 4=Valencia, 5=Zaragoza, 6=Lugo, 7=Pontevedra, 8=Ourense, 9=Huesca, 10=Navarra, 38= León, 39=Segovia, 40=Lleida, 41=Vizcaya, 42=Cantabria, 43=Madrid, 44=Toledo, 45=Ciudad Real, 46=Badajoz, 47= Jaén.
**Millions of euros (current values)
Source: Author's elaboration

In summary, the estimation of these new effects clearly supports the outcomes previously obtained. That is, the decline in the AGVA has been related to a low dynamism in agriculture within the analyzed regions. The application of the traditional shift-share, as well as of the spatial shift-share proposed in this paper, offer some new interesting insights. First, after applying the traditional effects of Dunn (1960), it can be concluded that the dynamism of the country in agriculture has decreased. Secondly, the internal effect (IIE) incorporated in the new proposal highlights that most of the regions also experienced a low internal dynamism in agriculture with respect to the rest of sectors in the regional economy. Thirdly, the spatial effects reveal that the neighboring regions also exhibited a higher growth rates in their GVA compared to the AGVA. Consequently, the AGVA followed the same decreasing trend in the three geographical levels analyzed: national, regional and local.

3.4.5 Exploratory analysis of the effects

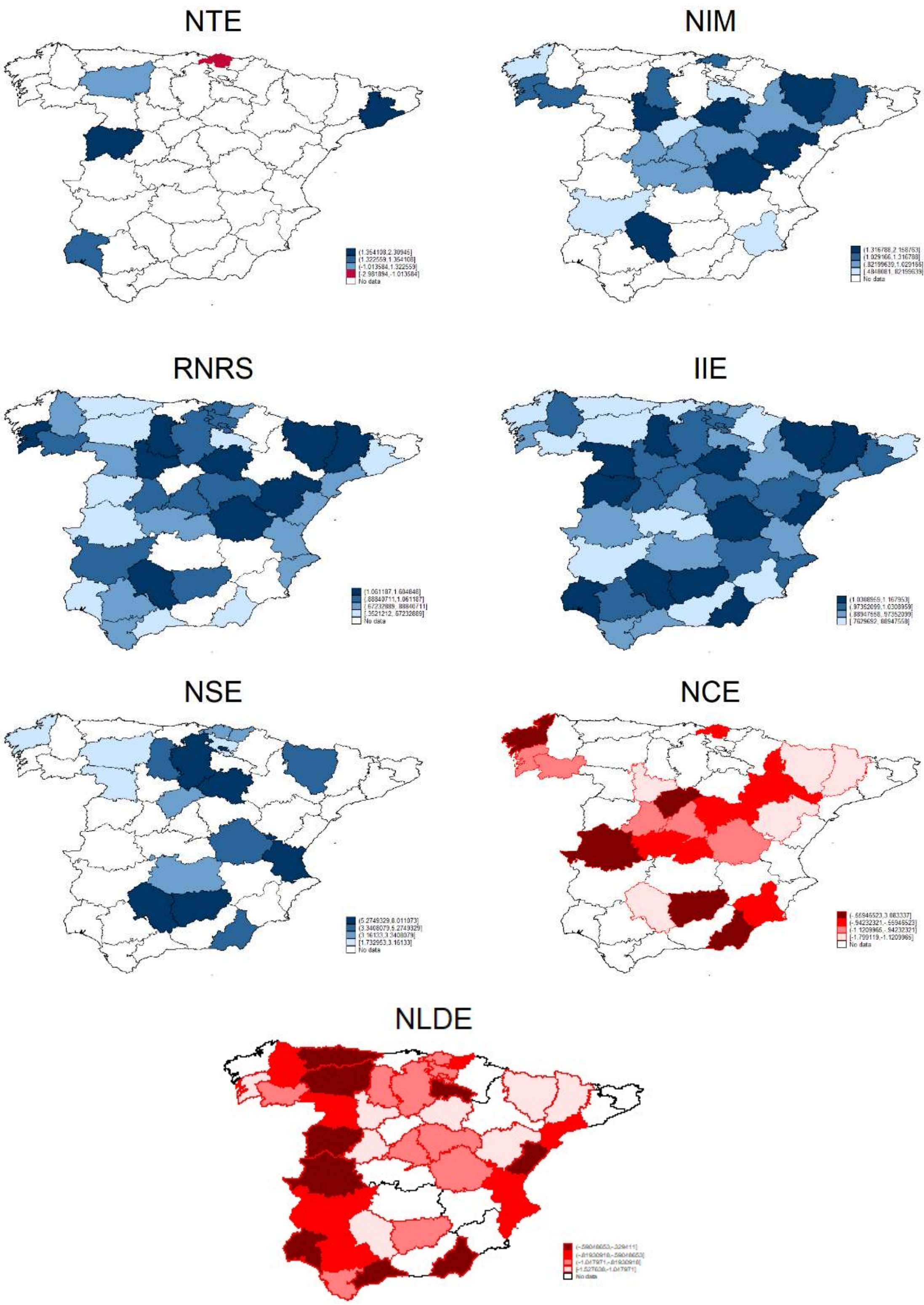
The following estimates of different regressions give a complementary perspective to the analysis previously presented. The aim of this section is to measure the correlation between each effect and the changes in the AGVA. Thus, it is important to highlight that the regressions have only exploratory purposes, that is, they do not have confirmatory purposes (they are not causal relationships). The dependent variable considered is the annual growth rate of the AGVA for each one of the 47 Spanish NUTS 3 regions. The independent variables are the different effects derived from the spatial shift-share analysis proposed in this paper. A total of 47 regressions were run for each region (one for each effect). The regressions were carried out using Ordinary Least Squares (OLS)[50].

In general terms, all the results were well adjusted in terms of statistical significance, but not all the effects seem to have the same influence on the change of the variable under study. Figure 3.7 exhibits the geographical distribution of the significant results obtained for each effect. In this way, it is possible to see the effects with the highest correlations (positive or negative) with the growth rate in each corresponding NUTS 3 region. The disaggregated results for each region are presented in the Appendix (Table 3.31).

The highest correlations correspond to the internal industry effect (IIE), showing significant results for all the regions analyzed. This effect has a positive impact on the growth of the AGVA, confirming the importance of the dynamism of the local agricultural sector. The region neighbor regional-shift effect ($RNRS$) and the neighborhood industry mix effect (NIM) also presented a positive correlation on the majority of the NUTS 3 regions. Therefore, the competitiveness in the agricultural sector of the studied regions in comparison with their neighbors, as well as the dynamism in agriculture of these neighboring regions, also seem to be drivers of the change of the variable under study. On the other hand, the level difference effect ($NLDE$) is also correlated with the studied variable in most of the regions, but in this case, the relationship between them is negative. In other words, a positive $NLDE$ could generate the decrease of the AGVA.

[50] It is important to note that in regressions with only one explanatory variable, the coefficient of determination (R^2) is equal to the Spearman squared correlation coefficient. Therefore, in explanatory terms, it is the same to evaluate the correlation between two variables through simple regressions or by performing the Spearman Test. Nevertheless, the advantage is that the regressions provide more information, since they show the statistical significance.

Figure 3.7: Significant results of the correlations carried out between each effect ($NTE, NIM, RNRS, IIE, NSE, NCE$ and $NLDE$) and the growth rate of the AGVA for the 47 Spanish NUTS 3 regions analyzed.



Source: Author's elaboration

To a lesser extent, the neighborhood contextual effect (NCE) and the neighbor sectoral effect (NSE) are also correlated with the growth of the AGVA in some NUTS 3 regions. Since the NSE had a positive correlation, it could be claimed that if the region performs better in the total GVA than its neighboring regions, their AGVA tends to experience positive growth. On the other hand, the NCE showed a negative relationship with the growth of the AGVA, suggesting that the dynamism of the neighboring regions had a key on the local growth of the agricultural GVA. Finally, the lowest correlation corresponded to the neighborhood total effect (NTE).

From these exploratory results, it would be possible to claim that the decline observed in the AGVA of NUTS 3 regions has being associated to, not only the disadvantages accruing to this sector within its own region, but also to the low dynamism of the agricultural sector of its neighbors. These results also point out that is not only important to analyze the structure of the national industry to understand the changes in economic variables, but also to explore the internal structure of the region analyzed, as well as the internal structures of the neighbors. In fact, in the particular case of the AGVA, the trends followed by the internal industry and the neighboring regions have been correlated to the decline of the agricultural activities in most of the 47 Spanish NUTS 3 regions.

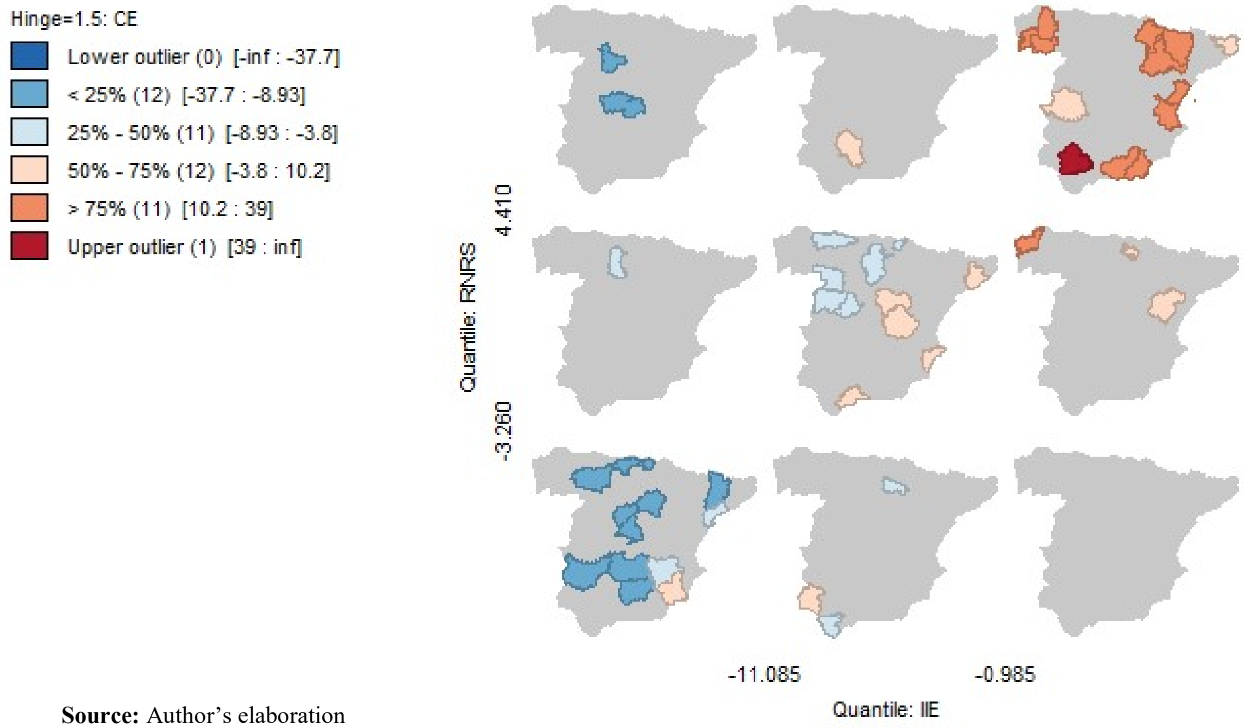
3.4.6 A classification of the 47 Spanish regions

In order to promote the usefulness of applying both the non-spatial and the spatial shift-share, Figure 3.8 displays a conditional plot that illustrates the interplay between the three types of competitiveness that the agricultural sector could develop. The main objective is to reflect the importance of the local and regional competitiveness to achieve a better performance at the national level. This way, the regions could be classified according to their competitive position.

Three types of competitiveness can be identified through the combined use of the traditional shift-share and the new proposed extension of the spatial shift-share. The traditional competitive effect (CE) accounts for those advantages/disadvantages that the agriculture sector of the NUTS 3 regions could have relative to that of the nation. The region neighbor regional shift ($RNRS$) exhibits the competitiveness of the agricultural sector of the regions with respect to their neighbors. The internal industry effect (IIE) captures the advantages/disadvantages that the agricultural sector could present because of the internal industry structure of the regions analyzed. A comparison among these three effects becomes especially relevant in this study, due to the fact that the decline in the AGVA in most of the Spanish regions was mainly related to the disadvantageous position of this sector compared to the remaining ones in the three levels analyzed: region, neighborhood and country.

In order to perform the analysis, the regions are ordered in a tridimensional space (see Figure 3.8). In an imaginary X axes (horizontal plane), the average of the internal industry effect (IIE) during the period 2001-2014 is located. In an imaginary Y axes (vertical plane), the average of the region neighbor regional-shift effect ($RNRS$) is located. Finally, the imaginary Z axes is displayed by different colors, that represent quantiles group distribution of the average of the competitive effect (CE). This way it is possible to evaluate whether the combination of the local and the regional competitiveness, could improve the competitiveness at the national level, generating thus positive changes on the agricultural sector of the studied regions.

Figure 3.8: Conditional Plot of the internal industry effect (IIE), the region neighbor regional-shift effect $(RNRS)$ and the competitive effect (CE) (average in the period 2001-2014)



Source: Author's elaboration

Through the comparison of these three variables, nine maps are generated in an array of 3 rows by 3 columns. From this conditional map, it is possible to see the differences in competitiveness at the national level as a function of their competitiveness at the local and regional levels. In general, Figure 3.8 shows that the competitiveness at the national level is dependent both the internal and the regional competitiveness. In other words, the disadvantageous position of one region in agriculture at the national level is due to the lack of local agricultural dynamism and its subsequent low competitiveness with respect to its neighboring regions. Therefore, it is difficult to occupy an advantageous position within the national economic system if there is a low degree of competitiveness at lower geographical levels.

The conditional plot also allows to classify the regions analyzed according to their competitiveness at the local and regional levels. Table 3.30 presents the classification of the NUTS 3 regions. It describes the characteristics associated to each type of region in terms of the dynamism of the agricultural sector at the local, regional and national levels. This categorization also offers a diagnosis of the situation of each region, which could be very helpful to formulate hypothesis and perform further analyses on the drivers of the decline of AGVA in Spain. Also, it provides a general idea about the advantages or disadvantages of the nine type of regions, marking the direction through the most appropriate strategy to improve the performance of the regions.

As it can be seen, in all these cases there was a clear influence of both the internal and the neighboring-regions competitiveness trends on the position of the regions at the national level. In order to be competitive in the national agricultural sector, the regions should first improve the growth of their local AGVA, as well as their competitiveness at the regional level. This information could be useful in terms of policy implications. Thereby, the actions designed to improve the performance of the regions should be focused on these three levels. In other words, it is necessary to adopt an integral solution instead of applying different strategies at each of the analyzed levels.

In summary, these results indicate that by only using “simple” effects, this new spatial shift-share analysis is able to capture every potential driver of the growth of the AGVA in a Spanish case. This way, it was not necessary to resort to another extra decomposition for studying all the possible interactions among the total GVA, the AGVA, the region analyzed and its neighbors. Furthermore, one of the most important findings is that the local internal industry structure and the comparative advantages over the neighboring regions played a fundamental role on the decline of the AGVA. This outcome suggests that the growth of economic variables in a region not only depends on the national economic context, but it is also influenced by the structure of the local industry, as well as by the economic structure of the neighboring regions.

Table 3.30: Classification of the NUTS 3 regions according to the results of their competitive effects

Cell	*IIE*	*RNRS*	*CE*	Type of region	Regions
(1,1)	Low	Low	Medium- High (negative)	This region presents a low dynamism in agriculture and has no advantage in comparison with its neighborhood or the country.	Murcia
			Medium-Low (negative)		Albacete
			Medium-Low (negative)		Tarragona
			Low		Badajoz
			Low		Cantabria
			Low		Jaén
			Low		León
			Low		Lleida
			Low		Madrid
			Low		Segovia
			Low		Soria
			Low		Vizcaya
(2,1)	Medium	Low	Medium-High (negative)	Although the region is moderately dynamic in the agricultural sector, it is not yet competitive at regional and national level.	Huelva
			Medium-Low		Cádiz
			Medium-Low		La Rioja
(3,1)	High	Low	Low	The region has a high dynamism in the agricultural sector, but it is not competitive within the neighborhood and the country. This suggests that the high dynamism at the local level is more related to the poor performance of the other sectors than to advantages of the agricultural sector.	--
(1,2)	Low	Medium	Medium-Low	Even with a low dynamism in agriculture, this region has a medium level of competitiveness compared to its neighbors and the country.	Palencia
(2,2)	Medium	Medium	Medium-High (negative)	The region exhibits moderate dynamism in agriculture, and a medium level of regional competitiveness. However, although it performs better than its neighbors, it is not competitive at the national level.	Alicante
			Medium-High (positive)		Barcelona
			Medium-High (negative)		Cuenca
			Medium High (negative)		Guadalajara
			Medium High (positive)		Málaga
			Medium-Low (negative)		Asturias
			Medium- Low		Ávila
			Medium- Low		Burgos
			Medium- Low		Guipúzcoa
			Medium- Low		Salamanca
			Medium- Low		Zamora
(2,3)	High	Medium	Medium High (positive)	The region exhibits high dynamism in agriculture, but only reaches a moderate level of regional and national competitiveness.	A Coruña
			Medium-Low (positive)		Álava
			Medium-Low (positive)		Teruel
(1,3)	Low	High	Low	The region exhibits a low dynamism in agriculture, but it is competitive at the regional level. In addition, it has a low national competitiveness, which suggests that the high competitiveness in the neighborhood is more related to the poor performance of the neighbors than to the comparative advantages of the region analyzed.	Toledo
			Low		Valladolid
(2,3)	Medium	High	Medium-High (positive)	The region has a moderate level of dynamism in agriculture, but it is still competitive at regional and national level.	Córdoba
(3,3)	High	High	High outlier	The region is highly dynamic in agriculture and presents high levels of regional and national competitiveness.	Sevilla
			High		Almería
			High		Castellón
			High		Granada
			High		Huesca
			High		Lugo
			High		Navarra
			High		Ourense
			High		Pontevedra
			High		Valencia
			Medium-High (positive)		Cáceres
			Medium-High (positive)		Gerona

Source: Author's elaboration

3.5 Final remarks

The main contribution of this paper is twofold. First, an exhaustive literature review of the spatial shift-share decomposition and its extensions were presented. Second, a new spatial shift-share analysis was proposed and an application of this framework to the changes on the AGVA of 47 Spanish NUTS 3 regions was developed to illustrate the utility of this new method.

The shift-share has been a useful tool to assess the performance of regional economic variables by traditionally taking into account two types of benchmarks: sectoral and geographical. Although the idea of a geographical dimension has been always present in the shift-share analysis, the original formulation proposed by Dunn (2004) did not contemplate the spatial interactions among the territories. In other words, the original shift-share and its consequent extensions considered every region as an isolated unit within the economic system. Consequently, the influence that the neighboring regions could have on the region studied has been omitted for a long period in the literature.

Nazara and Hewings (2004) introduced a spatial shift-share, using a weight matrix to measure the geographical interactions among the regions. Several extensions have been based on this decomposition. Most of them aimed to tackle the main problems arising of this proposal referring to the need of providing a standard decomposition, as well as elucidating the economic meaning of the "combined" effects proposed in the so-called taxonomy of the shift-share by Nazara and Hewings. However, the existing versions have only partially solved these problems until now.

In this sense, the spatial shift-share analysis proposed in this paper offers a unique decomposition based on only "simple" effects. In other words, given a certain variable of a specific region, this method allows to make comparisons with the neighboring economies of the region studied, taking thus account of all the possible interactions among the variables involved. Moreover, since this approach only uses "simple" effects, the economic interpretation of the results becomes easier. Therefore, the new proposal analyzes not only the performance of a region with respect to their neighbors, but also the impact of the internal industry structure of the neighboring regions. As a consequence, the two sources of criticism of the spatial shift-share by Nazara and Hewings (2004) are addressed.

From the illustration previously presented, the decomposition showed that the decline observed in the AGVA in Spain was related to the lower dynamism of the agriculture compared to other sectors. Furthermore, through the application of both the non-spatial and the spatial shift-share, it could be seen that this trend has influenced the three levels analyzed: the national, regional (neighboring regions) and internal. Therefore, the application of the decomposition proposed in this paper gave insights on these three levels, allowing to better evaluate the sources of the changes registered on the AGVA. In addition, the regressions carried out showed the need to consider the spatial interactions within an economic system. In particular, for the case of study, almost all of the effects presented in this decomposition displayed significant correlation with the AGVA growth rates. As a result, the proposed decomposition provides a deep exploratory analysis in order to formulate hypotheses that explain the decreases in the agricultural GVA growth rates of the Spanish regions.

Finally, this methodological contribution opens a new perspective through the study of the impact of the internal industry structure of the regions and their competitiveness compared to their neighboring regions on the growth of an economic variable. Besides, the proposal offers a unique and simple solution, making its application very intuitive. As a consequence, this technique could be adopted as a tool to make regional and internal comparisons, taking into account the geographical location of the regions, as well as their industry structure.

Appendix

Table 3.31: Results of the regressions between the annual growth rates of the AGVA and each effect derived of the spatial comprehensive shift-share (2000-2014).

NUTS-3		NTE	NIM	$RNRS$	IIE	NSE	NCE	$NLDE$
	β_1	0.303	-0.268	0.352	1.080	3.341	0.306	-0.336
Almería	R^2	0.011	0.165	0.556	0.798	0.755	0.257	0.607
	p-val (F test)	0.726	0.150	0.002***	0.000***	0.000***	0.064*	0.001***
	β_1	0.033	0.639	0.888	0.946	-0.501	-0.644	-0.880
Cádiz	R^2	0.000	0.086	0.767	0.950	0.003	0.090	0.755
	p-val (F test)	0.980	0.309	0.000***	0.000***	0.862	0.297	0.000***
	β_1	1.653	1.558	1.605	1.072	5.594	-1.678	-1.528
Córdoba	R^2	0.088	0.675	0.824	0.963	0.271	0.645	0.859
	p-val (F test)	0.304	0.000***	0.000***	0.000***	0.056*	0.001***	0.000***
	β_1	-0.387	0.160	0.159	0.847	1.161	-0.123	-0.154
Granada	R^2	0.030	0.081	0.091	0.851	0.084	0.053	0.099
	p-val (F test)	0.556	0.324	0.296	0.000***	0.316	0.427	0.274
	β_1	1.323	-0.308	0.471	1.168	1.086	0.347	-0.419
Huelva	R^2	0.275	0.101	0.528	0.740	0.172	0.169	0.536
	p-val (F test)	0.054**	0.267	0.003***	0.000***	0.141	0.144	0.003***
	β_1	1.340	1.133	1.015	1.106	8.011	3.083	-0.921
Jaén	R^2	0.010	0.021	0.989	0.991	0.779	0.243	0.987
	p-val (F test)	0.738	0.624	0.000***	0.000***	0.000***	0.073*	0.000***
	β_1	1.120	0.136	0.353	0.973	-0.218	-0.128	-0.329
Málaga	R^2	0.085	0.028	0.255	0.905	0.001	0.027	0.236
	p-val (F test)	0.313	0.571	0.066*	0.000***	0.901	0.577	0.078*
	β_1	0.997	0.456	0.738	0.980	-1.125	-0.455	-0.697
Sevilla	R^2	0.079	0.103	0.512	0.922	0.023	0.112	0.470
	p-val (F test)	0.329	0.264	0.004***	0.000***	0.602	0.242	0.007***
	β_1	-0.870	1.789	1.358	1.069	3.535	-1.799	-1.131
Huesca	R^2	0.026	0.750	0.828	0.915	0.614	0.442	0.887
	p-val (F test)	0.584	0.000***	0.000***	0.000***	0.001***	0.009***	0.000***
	β_1	1.530	1.539	1.250	0.992	-3.463	-1.471	-1.243
Teruel	R^2	0.071	0.425	0.847	0.970	0.083	0.441	0.813
	p-val (F test)	0.356	0.012**	0.000***	0.000***	0.317	0.010**	0.000***
	β_1	0.196	0.822	0.583	0.946	2.697	-0.778	-0.566
Zaragoza	R^2	0.003	0.580	0.164	0.913	0.056	0.533	0.170
	p-val (F test)	0.860	0.002***	0.151	0.000***	0.414	0.003***	0.142
	β_1	0.004	0.352	0.399	0.855	-0.385	-0.326	-0.368
Cantabria	R^2	0.000	0.178	0.197	0.859	0.002	0.167	0.180
	p-val (F test)	0.996	0.133	0.112	0.000***	0.882	0.147	0.131
	β_1	0.015	0.339	0.327	1.000	1.451	-0.271	-0.303
Albacete	R^2	0.000	0.173	0.160	0.936	0.091	0.121	0.168
	p-val (F test)	0.989	0.140	0.156	0.000***	0.295	0.223	0.146
Ciudad Real	β_1	-1.952	0.187	0.242	0.971	3.201	-0.160	-0.258

	R^2	0.092	0.083	0.147	0.951	0.218	0.060	0.174
	p-val (F test)	0.291	0.319	0.176	0.000***	0.093*	0.401	0.138
Cuenca	β_1	-0.480	1.317	1.246	1.048	4.132	-1.048	-1.048
	R^2	0.006	0.545	0.746	0.951	0.434	0.324	0.737
	p-val (F test)	0.792	0.003***	0.000***	0.000***	0.010**	0.034**	0.000***
Guadalajara	β_1	1.151	0.924	0.998	0.986	1.005	-0.830	-0.950
	R^2	0.012	0.374	0.584	0.959	0.017	0.321	0.572
	p-val (F test)	0.711	0.02**	0.001***	0.000***	0.655	0.035**	0.002***
Toledo	β_1	-0.893	0.849	0.834	0.880	0.627	-0.739	-0.686
	R^2	0.030	0.661	0.212	0.887	0.016	0.556	0.192
	p-val (F test)	0.556	0.000***	0.097*	0.000***	0.668	0.002***	0.117
Ávila	β_1	0.374	0.941	1.061	0.997	1.042	-1.090	-1.162
	R^2	0.005	0.443	0.547	0.947	0.038	0.474	0.641
	p-val (F test)	0.807	0.009***	0.003***	0.000***	0.507	0.006***	0.001***
Burgos	β_1	0.559	0.710	0.961	1.031	5.275	-0.506	-0.872
	R^2	0.015	0.181	0.691	0.941	0.318	0.098	0.679
	p-val (F test)	0.677	0.130	0.000***	0.000***	0.036**	0.275	0.000***
León	β_1	-1.014	-0.047	0.375	0.789	2.710	0.118	-0.338
	R^2	0.253	0.004	0.498	0.847	0.477	0.030	0.508
	p-val (F test)	0.067*	0.836	0.005	0.000***	0.006***	0.552	0.004***
Palencia	β_1	0.919	1.064	1.097	1.112	4.083	-0.662	-0.950
	R^2	0.034	0.349	0.696	0.916	0.572	0.125	0.737
	p-val (F test)	0.529	0.026**	0.000***	0.000***	0.002***	0.216	0.000***
Salamanca	β_1	2.309	0.387	0.665	1.036	-0.464	-0.295	-0.499
	R^2	0.346	0.084	0.422	0.912	0.014	0.073	0.302
	p-val (F test)	0.027**	0.316	0.012**	0.000***	0.687	0.352	0.042**
Segovia	β_1	-0.417	0.485	0.310	1.023	3.327	-0.451	-0.387
	R^2	0.009	0.339	0.100	0.926	0.385	0.263	0.169
	p-val (F test)	0.754	0.029**	0.272	0.000***	0.018**	0.061*	0.144
Soria	β_1	1.924	2.159	1.147	1.083	6.523	-2.132	-1.081
	R^2	0.047	0.337	0.940	0.988	0.414	0.198	0.954
	p-val (F test)	0.458	0.03**	0.000***	0.000***	0.013**	0.111	0.000***
Valladolid	β_1	2.129	1.543	1.422	1.005	-2.529	-1.405	-1.333
	R^2	0.165	0.647	0.715	0.966	0.097	0.643	0.620
	p-val (F test)	0.149	0.001***	0.000***	0.000***	0.279	0.001***	0.001***
Zamora	β_1	0.615	0.493	0.788	1.096	2.382	-0.272	-0.782
	R^2	0.023	0.108	0.586	0.916	0.303	0.025	0.681
	p-val (F test)	0.605	0.252	0.001***	0.000***	0.041**	0.590	0.000***
Barcelona	β_1	1.354	0.318	0.456	0.996	-2.235	-0.335	-0.357
	R^2	0.260	0.103	0.220	0.881	0.170	0.135	0.145
	p-val (F test)	0.063*	0.262	0.09*	0.000***	0.142	0.197	0.179
Girona	β_1	0.324	0.299	0.354	0.860	0.652	-0.266	-0.354
	R^2	0.014	0.128	0.187	0.797	0.019	0.106	0.197
	p-val (F test)	0.682	0.210	0.123	0.000***	0.638	0.256	0.112
Lleida	β_1	0.847	1.077	1.262	1.094	2.304	-1.129	-1.162
	R^2	0.047	0.416	0.706	0.934	0.209	0.333	0.755

	p-val (F test)	0.459	0.013**	0.000***	0.000***	0.100	0.031**	0.000***
Tarragona	β_1	-0.268	0.482	0.672	0.889	0.449	-0.477	-0.698
	R^2	0.005	0.145	0.482	0.878	0.014	0.128	0.523
	p-val (F test)	0.812	0.179	0.006***	0.000***	0.685	0.208	0.003***
Madrid	β_1	-0.952	0.975	0.995	0.913	-1.451	-0.981	-0.925
	R^2	0.052	0.568	0.470	0.978	0.024	0.587	0.421
	p-val (F test)	0.433	0.002***	0.007***	0.000***	0.597	0.001***	0.012**
Navarra	β_1	0.532	0.194	0.084	0.858	-0.909	-0.211	-0.078
	R^2	0.097	0.126	0.014	0.722	0.021	0.142	0.011
	p-val (F test)	0.278	0.213	0.684	0.000***	0.623	0.185	0.716
Alicante	β_1	0.790	0.192	0.695	0.974	1.691	-0.095	-0.617
	R^2	0.068	0.022	0.555	0.847	0.075	0.007	0.520
	p-val (F test)	0.369	0.611	0.002***	0.000***	0.344	0.779	0.004***
Castellón	β_1	0.386	0.070	0.677	1.031	1.643	0.081	-0.590
	R^2	0.009	0.002	0.640	0.926	0.130	0.004	0.605
	p-val (F test)	0.747	0.874	0.001***	0.000***	0.206	0.832	0.001***
Valencia	β_1	0.017	0.475	0.684	0.971	5.682	-0.360	-0.672
	R^2	0.985	0.154	0.461	0.882	0.514	0.084	0.514
	p-val (F test)	0.984	0.165	0.008***	0.000***	0.004***	0.314	0.004***
Badajoz	β_1	-0.233	0.740	0.892	0.853	1.301	-0.327	-0.702
	R^2	0.012	0.228	0.663	0.765	0.200	0.050	0.630
	p-val (F test)	0.710	0.085*	0.000***	0.000***	0.109	0.440	0.001***
Cáceres	β_1	-0.765	-0.392	0.552	0.951	1.516	0.527	-0.520
	R^2	0.076	0.138	0.801	0.920	0.199	0.255	0.823
	p-val (F test)	0.342	0.191	0.000***	0.000***	0.110	0.065*	0.000***
A Coruña	β_1	-0.385	0.494	0.301	0.763	1.733	-0.389	-0.302
	R^2	0.045	0.402	0.091	0.753	0.227	0.266	0.131
	p-val (F test)	0.465	0.015**	0.294	0.000***	0.085*	0.059*	0.203
Lugo	β_1	1.215	-0.076	0.765	0.977	-0.748	0.011	-0.789
	R^2	0.105	0.003	0.727	0.924	0.024	0.000	0.725
	p-val (F test)	0.260	0.857	0.000***	0.000***	0.599	0.980	0.000***
Ourense	β_1	-0.675	1.029	1.019	0.884	-1.225	-1.081	-0.991
	R^2	0.027	0.358	0.706	0.959	0.055	0.424	0.642
	p-val (F test)	0.575	0.024**	0.000***	0.000***	0.421	0.012**	0.001***
Pontevedra	β_1	-0.146	1.147	1.102	0.922	0.464	-1.113	-1.106
	R^2	0.001	0.293	0.828	0.917	0.006	0.270	0.846
	p-val (F test)	0.911	0.046**	0.000***	0.000***	0.794	0.057**	0.000***
La Rioja	β_1	0.234	0.505	0.522	0.935	2.461	-0.457	-0.501
	R^2	0.007	0.235	0.263	0.878	0.076	0.199	0.268
	p-val (F test)	0.778	0.079*	0.061*	0.000***	0.339	0.110	0.058*
Álava	β_1	-0.004	0.552	0.925	0.985	3.011	-0.207	-0.854
	R^2	0.000	0.075	0.799	0.909	0.232	0.012	0.804
	p-val (F test)	0.998	0.343	0.000***	0.000***	0.081*	0.706	0.000***
Guipúzcua	β_1	-2.002	0.302	0.763	0.971	3.161	0.048	-0.684
	R^2	0.175	0.035	0.740	0.922	0.437	0.001	0.759
	p-val (F test)	0.137	0.521	0.000***	0.000***	0.01**	0.913	0.000***

Vizcaya	β_1	-2.982	1.062	0.934	0.908	3.305	-0.904	-0.819
	R^2	0.548	0.486	0.678	0.984	0.331	0.323	0.677
	p-val (F test)	0.002***	0.006***	0.000***	0.000***	0.031**	0.034**	0.000***
Asturias	β_1	0.856	0.313	0.478	0.872	1.726	-0.263	-0.512
	R^2	0.145	0.103	0.240	0.686	0.076	0.075	0.279
	p-val (F test)	0.179	0.263	0.076*	0.000***	0.339	0.343	0.052*
Murcia	β_1	-0.287	0.705	0.535	0.868	0.537	-0.668	-0.502
	R^2	0.010	0.465	0.201	0.893	0.003	0.436	0.191
	p-val (F test)	0.736	0.007***	0.108	0.000***	0.855	0.010**	0.118

Note: *, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively.
Source: Author's elaboration

References

- Artige, L., & Neuss, L. (2014). A new shift-share method. *Growth and Change*, 45(4), 667-683.
- Cliff, A. D., Ord, J. K., Haggett, P., & Versey, G. R. (1981). Spatial diffusion: an historical geography of epidemics in an island community (Vol. 14). CUP Archive.
- Dunn, E. S. (1960). A statistical and analytical technique for regional analysis. *Papers in Regional Science*, *6*(1), 97-112.
- Duranton G, Puga D (2004) Micro-foundations of urban agglomeration economies. In: Henderson JV, Thisse JF (eds) *Handbook of regional and urban economics*. Elsevier B. V., Amsterdam, pp 2063–2117
- Espa, G., Filipponi, D., Giuliani, D., and Piacentino, D. (2014). Decomposing regional business change at plant level in Italy: A novel spatial shift-share approach. *Papers in Regional Science*, *93*(S1).
- Esteban-Marquillas, J. M. (1972). I. A reinterpretation of shift-share analysis. *Regional and Urban Economics*, *2*(3), 249-255.
- Flores, M., Medellín, S., and Villarreal, A. (2018). Global Markets and the Role of Geographical Proximity in Mexico's Employment Growth. *Growth and Change*, *49*(3), 548-568.
- Grossi, L., and Mussini, M. (2018). A spatial shift-share decomposition of electricity consumption changes across Italian regions. *Energy Policy*, *113*, 278-293.
- Herath, J., Schaeffer, P. V., & Gebremedhin, T. G. (2013). Employment change in LDs of West Virginia: a dynamic spatial shift-share analysis. *American Journal of Rural Development*, *1*(5), 99-105.
- Hewings, G. J. (1976). On the accuracy of alternative models for stepping-down multi-county employment projections to counties. *Economic Geography*, *52*(3), 206-217.
- Hirschman, A. O. (1958). The Strategy of Economic Development. New Haven, CT: Yale University Press.
- Isard W (1960) Methods of regional analysis: an introduction to regional science. MIT, Cambridge.

- Matlaba, V. J., Holmes, M., McCann, P., and Poot, J. (2014). Classic and Spatial Shift-Share Analysis of State-Level Employment Change in Brazil. In *Applied Regional Growth and Innovation Models* (pp. 139-172). Springer, Berlin, Heidelberg.
- Márquez, M. A., Ramajo, J., and Hewings, G. J. (2015): "Regional growth and spatial spillovers: Evidence from an SpVAR for the Spanish regions". *Papers in Regional Science*, 94(S1), S1-S18.
- Mayor, Matías, and Ana Jesús López. (2008) "Spatial shift-share analysis versus spatial filtering: an application to Spanish employment data." *Spatial Econometrics. Physica-Verlag HD*, 2008. 123-142.
- Myrdal, G. 1957. Economic Theory and Under-developed Regions. London, UK: Duckworth.
- Nazara, S., and Hewings, G. J. (2004). Spatial Structure and Taxonomy of Decomposition in Shift-Share Analysis. *Growth and Change*, *35*(4), 476-490.
- Ramajo, J., and Paniagua, M. Á. M. (2008). Componentes espaciales en el modelo Shift-Share. Una aplicación al caso de las regiones peninsulares españolas. *Estadística española*, *50*(168), 247-272.
- Ramajo, J., Cordero, J. M., & Márquez, M. Á. (2017): "European regional efficiency and geographical externalities: a spatial nonparametric frontier analysis". *Journal of Geographical Systems*, 19(4), 319-348.
- Shi, C., Zhang, J., Yang, Y., and Zhou, Z. (2007). Shift-share analysis on international tourism competitiveness. A case of Jiangsu province. *Chinese Geographical Science*, *17*(2), 173-178.
- Zaccomer, G. P., and Mason, P. (2011). A new spatial shift-share decomposition for the regional growth analysis: a local study of the employment based on Italian Business Statistical Register. *Statistical Methods & Applications*, *20*(3), 329-356.

CONCLUSIONES Y CONSIDERACIONES FINALES

El aumento de la globalización en las últimas décadas ha intensificado la interrelación entre países, regiones y sectores económicos. En particular, este fenómeno ha generado el incremento del comercio internacional, así como la influencia que los países y regiones reciben del resto de integrantes del sistema económico al que pertenecen.

En este contexto, la competitividad ha sido uno de los conceptos claves para entender el crecimiento de sectores industriales dentro de una región. Tradicionalmente, la competitividad de un sector particular de una economía específica se ha definido como la capacidad para mantener o incrementar de manera sostenida su presencia en los mercados nacionales o internacionales. Sin embargo, no existe un concepto único de competitividad y, en general, la misma depende de muchos factores domésticos, nacionales y globales.

Esta Tesis se centra en el análisis de dos variables relacionadas con el sector agrícola. Los dos primeros capítulos estudian la competitividad de la industria del grano de soja en el contexto internacional. Para dicho estudio, se utilizaron las exportaciones de los principales exportadores de grano de soja a nivel mundial. El tercer capítulo lleva a cabo una propuesta metodológica que se ilustra para el caso de la evolución del Valor Añadido Bruto del sector agrícola en 47 provincias de España. Para este ensayo, se utilizaron los datos de dicha variable a nivel NUTS-3. De esta manera, los tres capítulos presentan diferentes maneras de estudiar la competitividad y el crecimiento del sector agrícola.

De la presente investigación se han derivado distintas conclusiones que se encuentran al final de cada uno de los capítulos. De este modo, en este apartado final, se presenta un resumen de las principales conclusiones empíricas y metodológicas de cada uno. De igual manera, se destacarán las principales aportaciones originales de la Tesis, así como los trabajos de investigación que se desarrollarán en el futuro.

4.1 Conclusiones generales

Esta Tesis parte de un análisis exploratorio general de las exportaciones mundiales de soja en el **Capítulo 1**, a través de la medición de los cambios registrados en la competitividad de los países exportadores. En concreto, se estudia la evolución de las cuotas de mercado de Argentina, Brasil, Canadá, Paraguay, Ucrania y Estados Unidos durante el periodo 1996-2015. Adicionalmente, se evalúa la respuesta de cada país exportador al aumento de la demanda. Este análisis exploratorio permite formular ciertas hipótesis acerca de la competitividad de estos países en el mercado global de soja. Las mismas son contrastadas en el mismo capítulo, por medio de un modelo explicativo.

Del análisis de las tendencias seguidas por el mercado mundial de soja durante el periodo 1996-2015, se puede observar que la demanda mundial de granos de soja ha aumentado de manera exponencial en los últimos años. Como consecuencia, la intensidad de la producción, así como las exportaciones del producto también han incrementado. En contraste con el gran atractivo del mercado, el mismo ha sido controlado completamente por seis economías durante las últimas dos décadas. Argentina, Brasil, Canadá, Paraguay, Ucrania y Estados Unidos han sido responsables de más del 94% de las exportaciones. Considerando los múltiples usos de este producto, así como la expectativa de un mayor crecimiento de la demanda, el estudio de la capacidad competitiva de los seis mayores exportadores se hace necesaria en términos de la sustentabilidad futura.

Por medio de la evolución de las cuotas de exportación, se concluye que existen capacidades competitivas diferentes en cada país. En general, los países con tendencia positiva en su capacidad competitiva son Brasil, Canadá y Ucrania, mientras que Argentina, Paraguay y Estados Unidos muestran una tendencia negativa. El análisis exploratorio es profundizado por medio de la evaluación de la sensibilidad de las cuotas de exportaciones a los cambios ocurridos en la demanda. Para ello, se propone el uso de la denominada "Curva de Exportaciones". Dicha metodología revela que, efectivamente, estos países no siguieron el mismo patrón de comportamiento ante el aumento de la demanda mundial de granos de soja. De esta manera, Brasil, Canadá y Ucrania mostraron una respuesta favorable (positiva) ante los cambios de la demanda. Por el contario, Argentina, Paraguay y Estados Unidos reaccionaron de manera desfavorable (negativa) ante los mismos cambios. Por lo tanto, se puede concluir que no todos los exportadores tuvieron la misma capacidad competitiva a lo largo del tiempo. Además, aunque la concentración del mercado no cambió durante el periodo de estudio, la estructura del mismo experimentó variaciones. El más importante corresponde a la consolidación de Brasil como líder de mercado, en detrimento de Estados Unidos, que ha sido el histórico líder de las exportaciones mundiales de grano de soja.

A continuación, se aborda el objetivo principal de este trabajo: analizar los factores determinantes de la competitividad de los exportadores de soja en los mercados mundiales. La confirmación de esta hipótesis es contrastada por medio de un modelo empírico basado en la Función de Producción de Cobb-Douglas. Las estimaciones fueron realizadas por medio de Regresiones Aparentemente No Relacionadas (SUR, por sus siglas en inglés). Esta técnica permite obtener un modelo por cada país, así como un modelo para el sistema estimado, es decir, para el mundo. Teniendo en cuenta que se utilizan las mismas variables para cada modelo, los resultados revelan el papel que la intensidad de cada factor considerado tuvo en los cambios registrados en las cuotas de exportación de los principales exportadores. Los resultados señalan diferentes combinaciones de factores relevantes para cada país. Sin embargo, destaca la presencia del uso de la tierra como variable positivamente correlacionada con el aumento de las cuotas mundiales de exportación en cada modelo obtenido

Los hallazgos de este capítulo ponen de manifiesto que la competitividad de los principales exportadores de granos de soja depende en gran medida del uso de la tierra. En otras palabras, lo que diferencia a dichos países del resto del mundo es la explotación de sus recursos naturales. Sin embargo, esta estrategia es peligrosa para el medio ambiente y el desarrollo sostenible a largo plazo. De hecho, estudios recientes han demostrado que el cultivo de grano de soja es uno de los principales factores determinantes del aumento desmedido de la deforestación a nivel global (Deininger, 2013; Le Polain de Waroux *et al.*, 2017; Lambin and Meyfroidt, 2011). Así, los países exportadores deberían mejorar la competitividad de sus exportaciones por medio de la inversión en tecnologías que promuevan el aumento de la eficiencia de la productividad. En otras palabras, los gobiernos deben promover los márgenes intensivos de producción, en lugar de márgenes extensivos que aumenten la cantidad de tierra dedicada al cultivo de granos de soja.

El **Capítulo 2** propone el uso de la técnica *shift-share* para el análisis del comercio internacional. Además, presenta, una nueva extensión a la técnica tradicional, que tiene en cuenta la estructura industrial interna de cada región analizada, constituyendo una versión más comprensiva que la técnica original. Por último, se aplica la nueva técnica desarrollada al análisis del crecimiento de las exportaciones de granos de soja, obteniéndose información que complementa los hallazgos del **Capítulo 1.**

Históricamente, el *shift-share* ha sido utilizado como técnica para estudiar diferencias regionales y sectoriales en los crecimientos de variables económicas. Su uso se ha centrado en el análisis del crecimiento del empleo y la productividad. En este capítulo se exponen los beneficios del uso de esta metodología como herramienta de análisis exploratorio en el comercio internacional. Dichos beneficios están relacionados con la simplicidad en su uso y la información que provee. Así, el *shift-share* tradicional permite evaluar la capacidad competitiva de un exportador (país o región) respecto al mercado en el que opera, en un sector o producto dado.

Sin embargo, se considera que la situación del contexto externo no es el único que impacta en el crecimiento de las exportaciones de un país o región. Por el contrario, la estructura interna del exportador también puede favorecer o desfavorecer las exportaciones de un sector o producto. En este sentido, la estructura industrial representa el grado de especialización de un país en el sector o producto estudiado. Por este motivo, el *shift-share* propuesto en este capítulo agrega efectos que miden las ventajas o desventajas que el producto o sector estudiado tienen dentro de su propia industria, en comparación el resto de productos de la cesta exportadora. De esta manera, este *shift-share* más comprensivo, que tiene como base al *shift-share* tradicional es capaz de examinar el crecimiento de las exportaciones en función de las ventajas competitivas internas y externas que tiene el producto o sector bajo análisis. Adicionalmente, se presenta una clasificación de exportadores basada en el desempeño de los mismos. Dicha clasificación también considera ambos contextos, el interno y externo. Por lo tanto, facilita el diseño de políticas económicas adecuadas para cada tipo de exportador, dependiendo del mercado en el que opera y de las fortalezas y debilidades de su industria interna.

La aplicación de la nueva técnica se realiza a las exportaciones de granos de soja de los seis principales exportadores durante el periodo 1996-2015. Además, se incorpora dentro del análisis a un agregado denominado Resto del Mundo. De los resultados obtenidos a través del cálculo de los efectos tradicionales, se puede concluir que Brasil, Canadá y Ucrania presentaron claras ventajas comparativas respecto a los demás países en las exportaciones de granos de soja. Por el contrario, Argentina, Paraguay, Estados Unidos y el Resto del Mundo mostraron desventajas comparativas. De la aplicación de los efectos incorporados por el *shift-share* exhaustivo, se puede concluir que este producto presentó ventajas comparativas importantes respecto a los demás productos agrícolas en Brasil, Canadá y Ucrania. Por otro lado, Argentina, Paraguay, Estados Unidos y el Resto del Mundo revelaron mayor especialización en otros productos. De esta manera, se puede concluir que la consolidación de Brasil como líder del mercado, estuvo relacionada con la estructura de su industria local, que promovió las exportaciones de grano de soja. La clasificación de los exportadores sugiere políticas económicas similares para todos ellos: especialización en la exportación de granos de soja, para aprovechar las tendencias mundiales seguidas por este mercado. No obstante, enlazando con las conclusiones del **Capítulo 1**, es importante seguir estas estrategias de especialización a través de una política económica que asegure la preservación del medio ambiente.

Finalmente, el **Capítulo 3** aborda la revisión de literatura del *shift-share* espacial. Adicionalmente, se plantea otra contribución metodológica relacionada a dicha técnica. La misma se aplica al estudio del crecimiento del Valor Añadido Bruto del sector agrícola (VAB) de cuarenta y siete regiones españolas durante el periodo 2000-2014.

El *shift-share* con consideraciones espaciales se ha situado como una técnica importante dentro del análisis exploratorio regional. En este sentido, la utilidad de incorporar la influencia de las regiones vecinas en el análisis del crecimiento de variables económicas radica en que ninguna región está aislada y forma parte de un sistema económico mayor.

De la revisión de la literatura, se puede concluir que la mayor parte de las contribuciones se dedicaron a buscar soluciones para los inconvenientes presentados por el primer *shift-share* espacial (Nazara y Hewings, 2004). Dichos inconvenientes están relacionados a la falta de una versión única y a la consideración de efectos combinados que dificultan la interpretación económica de los resultados. En este sentido, en lugar de una sola descomposición, dichos autores presentaron 26 opciones diferentes, con lo cual la elección de la alternativa adecuada para cada caso de estudio, queda en manos del investigador. Por otro lado, los efectos combinados evalúan niveles geográficos y sectoriales que no son similares entre sí, por lo cual muchos de ellos carecen de significado económico. En resumen, a pesar de las mejoras introducidas a la técnica durante la última década, los problemas solamente han sido parcialmente solucionados.

Como consecuencia, en este ensayo se propone otra posible solución a los inconvenientes detectados en las mejoras anteriores. Así, la nueva extensión al *shift-share* presenta una única descomposición que estudia a todas las variables analizadas y sus interacciones. Además, utiliza solamente efectos simples, facilitando la interpretación económica de los resultados.

La aplicación empírica resalta la utilidad de la nueva técnica. En el caso de estudio, se puede concluir que el sector agrícola ha sufrido un declive a nivel nacional. A nivel regional, los mayores crecimientos fueron registrados por las provincias pertenecientes a Andalucía, Aragón, Galicia, Navarra y Comunidad Valenciana. Tomando como punto de partida los efectos tradicionales del *shift-share,* se puede mencionar que el sector agrícola nacional mostró una clara desventaja comparativa respecto a los demás sectores. Además que las regiones con mayor crecimiento fueron las mismas con ventajas respecto a la media nacional.

Por otro lado, el estudio revela que las tasas de crecimiento del VAB agrícola en España están espacialmente correlacionados durante el periodo de estudio, lo cual pone de relieve la necesidad de recurrir a un *shift-share* espacial. Los cálculos de los efectos de esta técnica revelan que, en general, las regiones con bajo crecimiento en el sector estudiado han estado rodeadas de regiones con la misma situación. De la misma manera las escasas regiones con crecimiento positivo están agrupadas espacialmente y han presentado una competitividad regional alta. En otras palabras, han tenido mejor desempeño que sus regiones vecinas.

Como consecuencia, la consideración de los efectos tradicionales, internos y de regiones vecinas, muestra que los tres niveles geográficos tuvieron un impacto en el crecimiento de la variable analizada. En general, la tendencia decreciente de la agricultura no ha sido un fenómeno aislado. Por el contrario, la influencia de la falta de dinamismo del sector agrícola a nivel nacional y regional ha impactado en las industrias locales de las regiones estudiadas. Por lo tanto, las indicaciones de política económica para revertir la falta de competitividad en este sector o para favorecer el crecimiento de los demás sectores económicos deben estar enfocadas en los tres niveles.

Finalmente, es importante destacar que los tres capítulos ponen en evidencia la importancia de la especialización de los países o regiones en un determinado producto, como manera de mejorar la competitividad a largo plazo. Además, resaltan que los fenómenos económicos tienen más dimensiones que el punto de vista nacional. Es decir, los cambios en variables económicas tienen influencias locales e idiosincráticas, impactos de las regiones vecinas, efectos de las tendencias nacionales, y en última instancia, responden al contexto global al que pertenecen. Como resultado, las políticas económicas que se diseñen para mejorar la competitividad de los países o regiones deben considerar todos los niveles anteriormente descritos. En otras palabras, deben ser implicaciones que tomen en cuenta a las regiones como parte de un sistema mayor, pero que poseen su propia autonomía industrial.

4.2 Aportaciones originales

Uno de las principales contribuciones de esta investigación ha sido la caracterización del mercado mundial del grano de soja en los años 1996-2015. Aunque la literatura previa cuenta con estudios para este sector en regiones o países específicos, este trabajo presenta un análisis de la totalidad del mercado mundial. Como consecuencia, aporta un entendimiento global de los cambios que se han producido en el periodo de estudio. Además, este trabajo propone un modelo empírico que identifica los principales determinantes de la competitividad de cada país exportador y del mercado global. Esta problemática cobra gran fuerza en la actualidad, teniendo en cuenta que los resultados señalan que la competitividad de este sector está altamente relacionada al uso de la tierra y por tanto, a la deforestación.

Otra importante contribución guarda relación con la aplicación del análisis *shift-share* al comercio internacional, considerando su escasa aplicación a esta área. Esta tesis ofrece una descripción del uso y la interpretación de la información que brinda esta técnica a nivel regional y sectorial. Adicionalmente, se plantea una contribución metodológica. Así, se propone una extensión a la técnica tradicional del *shift-share* a través de la consideración de todas las interacciones entre las variables estudiadas. La nueva técnica incorpora el análisis de la estructura industrial interna de una región en el crecimiento de sus propias variables económicas. La propuesta de una clasificación basada en el desempeño de los países exportadores, contribuye a la literatura con el diseño de políticas económicas adaptadas a la situación exportadora de cada país. En resumen, este aporte metodológico no solamente contribuye al mejor entendimiento del comercio internacional, sino que constituye un aporte para la técnica del *shift-share* en sí misma.

Finalmente, esta tesis contribuye a la literatura del *shift-share* espacial. En este sentido, esta presenta un doble aporte a esta rama de la economía regional. Por un lado, el análisis exhaustivo de la literatura previa, describiendo los beneficios y detectando las debilidades de las mejoras previas. Por otro lado, la consideración de la estructura industrial interna de la región estudiada y de sus ventajas o desventajas en comparación con sus regiones vecinas ofrece una nueva visión en el crecimiento de las variables económicas. Como resultado, la nueva descomposición provee una visión panorámica que permite comprender la situación de cada región desde diferentes niveles: local, regional y nacional.

4.3 Investigaciones futuras

Para finalizar este trabajo, se realizan algunos comentarios relacionados a investigaciones futuras que se derivan del estudio presentado en esta Tesis.

En primer lugar, los resultados del **Capítulo 1** pueden ser complementados con un análisis más completo de la industria de la soja. En este sentido, esta Tesis abarca el estudio de la competitividad de un solo producto de esta industria. Por ello, resulta interesante investigar los cambios acaecidos en la industria de los derivados de este producto, tales como el aceite de soja, harina de soja, entre otros. Dicho análisis podría ofrecer información sobre el proceso de industrialización de este producto, así como la mejora competitiva de los principales exportadores en la cadena de suministro global de granos de soja.

Desde el punto de vista medioambiental, el **Capítulo 1** proporciona información sobre el daño que el cultivo de este producto está generando. De esta manera, se podría profundizar en este análisis, llevándose a cabo un estudio sobre los impactos ambientales en términos de deforestación, consumo de agua, pérdida de fauna, daño a los suelos, como consecuencia de los márgenes extensivos adoptados para la producción de este. Esta investigación mediría, de forma objetiva, los peligros de seguir la misma estrategia utilizada hasta el momento para satisfacer la demanda de este producto. Además, podría proveer políticas económicas más concretas para mitigar el impacto negativo medioambiental ocasionado.

La aplicación del *shift-share* al comercio internacional daría lugar a la combinación de dicha técnica con otras ya utilizadas. En este sentido, se podría utilizar la descomposición propuesta en esta Tesis como base para incorporar los destinos de exportación (al igual que el Constant Market Share), así como la distribución espacial de dichos destinos.

Como derivación del *shift-share* espacial, sería interesante explorar otros tipos de vecindad regional. Es decir, realizar la descomposición teniendo en cuenta otros tipos de conexiones entre las regiones: flujos de comercio, tratados comerciales, etc.

Finalmente, a partir de las contribuciones metodológicas presentadas, se podría trabajar en el análisis de variables socio-económicas mediante la combinación del análisis determinístico que subyace en el *shift-share* y de los análisis econométricos. Dicha combinación permitiría pasar a realizar análisis confirmatorios que permitirían el contraste de hipótesis derivadas de los análisis exploratorios habituales.