From net importer to global leader: understanding the drivers of Spain's meat export growth since the 1960s

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Abstract

How has Spain transitioned from historically having a relatively low meat production and being a net importer of meat in 1990 to becoming the world's leading exporter of pork in 2020? This is the research question we aim to address in this article. In our quest for an answer, we constructed a gravity model to examine the determinants of Spanish meat exports. We posit that a significant surge in domestic meat consumption since the 1960s led to substantial economies of scale in the sector, rendering it highly competitive by the 1980s. Consequently, when Spain joined the European Union and liberalized the sector, it was sufficiently competitive to conquer international markets. In other words, we aim to study how a Home Market Effect has occurred in Spain and how it has been reinforced by the European Union adhesion. Ultimately, this high competitiveness has allowed Spain to capitalize on China's demand for pork in recent years.

Keywords Meat exports · Home market effect · Gravity equation · Spain · International trade

JEL Classification N54 · N74 · F12 · F13 · F14

1 Introduction

After a period of commercial disintegration and economic slowdown at the global level during the 1930s (Federico and Tena-Junguito 2019; Hynes et al. 2012; Estevadeordal, Frantz and Taylor. M 2003), the decades following World War II were

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characterized by strong economic growth and a reintegration of global trade (Federico and Tena-Junguito 2017). Thus, what the literature has called the second globalization (O'Rourke and Findlay 2007, pp. 473-525) took place. This new era of globalization, unlike the previous one (O'Rourke and Findlay 2007, pp. 363-425), was characterized by an increase in the trade of manufactured products between developed countries (Hummels 2007). Therefore, although the trade of agri-food products increased notably in absolute values, it lost weight very significantly with respect to global trade (Serrano and Pinilla 2012, see Fig. 1).

One of the agri-food products whose trade has increased the most during the twentieth century has been meat. During the second half of the nineteenth century, its international trade was relatively low compared to other products such as cereals. This was due to the lack of widespread mechanical refrigeration, which hindered long-distance trade (Lluch 2019; Perren 2006). However, during the first third of the twentieth century, its global trade gained significance in relation to the overall trade of agri-food products (Delgado et al. 2023). However, after the Second World War, global meat trade exhibited even greater dynamism. Specifically, in the 1960s, the value of its trade in relation to the trade of agri-food products was approximately 6 percent. By the early twenty-first century, its significance had already increased to around 12 percent (Serrano and Pinilla 2013, see Table 1). The explanatory factors behind this dynamic behavior can be summarized in demand, supply, and trade agreements that encouraged its trade.

On the demand side, the culmination of the nutritional transition due to an increase in per capita income and urbanization rates, first in the West and later in developing countries, led to a significant increase in the consumption of meat products due to its higher income elasticity (Chung et al. 2020; Cheng et al. 2015; Pujol Andreu and Cussó Segura 2014; Delgado 2003; Grigg 1995; Popkin 1993). In fact, income elasticity becomes more inelastic over time for products like cereals, while price elasticity becomes more elastic, thus indicating a shift in preferences where utility increases with the consumption of livestock products (Law et al. 2020).[1] Furthermore, although the nutritional transition has tended to occur in most countries, the path toward it has not been uniform, highlighting that the peculiarities of each country are crucial in explaining significant dietary changes (Presa and Román 2023; Langthaler 2018). On the supply side, the strong increase in productivity in the sector due to the implementation of the agribusiness model resulted in a fall in relative prices of meat, thereby boosting its consumption, and consequently its trade (Clar 2008; Rivera-Ferre 2009; Godley 2014). Finally, several trade agreements initiated since the end of World War II, starting with the creation of the European Union as well as other regional agreements such as NAFTA, MERCOSUR, and China's trade liberalization, further encouraged the trade of meat (Karemera et al. 2015; Winders and Ransom 2019, p. 14).

In this context, Spain stands out as one of the countries with the most international penetration of its meat exports. Until the 1960s, the diet in Spain was characterized by the consumption of Mediterranean products, resulting in relatively low

[1] However, in certain countries in Southeast Asia, it has been observed that preferences play a lesser role in the nutritional transition (Lipoeto, Geok Lin and Angeles-Agdeppa 2013).

meat consumption (Garrabou Segura and Cussó Segura 2007). In fact, the country was a net importer of this product. However, between 1960 and 1980, the consumption grew significantly, turning Spain into one of the largest consumers of meat in Europe (Delgado 2023). To meet this increased demand, the meat industry adopted an agribusiness model (Godley 2014), characterized by large vertically integrated companies and massive imports of feed, more productive breeds, and advanced US technology (Clar 2010). Thus, the meat sector became highly productive with large economies of scale (Serrano et al. 2015). Therefore, after Spain's integration into the EU in 1986, its meat exports took off, with pork becoming the world's leading export in 2020 (Clar 2024). However, while Europe has been the primary destination for Spanish meat exports, in recent years, China has gained considerable prominence as an export destination, becoming the top buyer of Spanish meat in 2019 (primarily pork).

However, despite several studies focusing on the remarkable increase in meat production (and its associated environmental costs) and subsequently in the conquest of international markets (Rodriguez Zúñiga and Soria 1989; Domínguez Martín, 2001b; Lence 2007; Ríos-Núñez and Coq-Huelva 2015; Clar et al. 2018; González de Molina et al. 2020, among others), a quantitative analysis of this process has not yet been performed, particularly disaggregated by meat types (Serrano et al. 2015, p. 10).

Therefore, the aim of this paper is to understand how Spain transitioned from being a net importer of meat in the 1990s to becoming the leading global exporter of pork in 2020. In addition, we aim to emphasize two aspects. Firstly, to analyze whether there has been a Home Market Effect. That is, to quantify whether the impulse of domestic demand, reflected in a strong concentration of production and large economies of scale in the sector, has played a relevant role in the growth of exports. Secondly, to quantify the effect of the entry of Spain into the European Union in 1986 on meat exports. Although the literature points out its importance (Clar 2013, p. 346; Langreo 2008, p. 43), it has not yet been quantified in a disaggregated manner. Therefore, this paper complements the work of Serrano et al. (2015), where it is observed that meat exports were driven both by the Home Market Effect and Spain's entry into the European Union. Indeed, although there are certain exceptions where the determinants of exports of various types of meat are analyzed separately (Karemera et al. 2015; Ghazalian et al. 2011; Cao and Johnson 2006), most studies focus either on aggregated meat (Hayat and Ishaq 2023; Serrano et al. 2015; Jayasinghe and Sarker 2009; Schlueter et al. 2009; Koo et al. 1993) or only on some specific type of meat (Prentice et al. 1998; Meneguelli Fasarella, Pinto de Souza and Lee Burnquist 2011; Yang, Reed and Saghaian 2012; Shahriar et al. 2019; Wu 2022). Therefore, in this study, although we emphasize more on pork due to its significant weight in total meat exports, analyzing all different types of meat and relating them to their historical background allow us to better understand the greater or lesser success in global markets of each type of meat and its determinants.

This study will be structured as follows. After this introduction, Section 2 analyzes the evolution of the Spanish meat industry from the 1950s to the present day from the perspective of consumption, production, and exports. In Section 3, we present the data and methodology. In the following section, we present the main results

of the gravity model. Then, we discuss the results before concluding the study with a brief conclusion.

2 Evolution of the meat sector in Spain

The Spanish agri-food industry in the 1950s was relatively weak compared to the European one (Clar et al. 2018). Although limited improvements were made from the demand and supply sides in the first third of the twentieth century (Langreo and Germán 2018), the Spanish Civil War (1936-1939) and post-war period only set back the limited progress made in the agri-food industry and the economy as a whole (Simpson 1995, p. 279; Carreras et al. 2005). Therefore, twenty years after the Civil War, this industry was characterized by small size, low technological level, and production of low-value-added and low-degree of transformation products (Clar 2008, p. 146). The production and productivity of meat (and other livestock products) also showed lower performance than the European average (Ríos-Núñez and Coq-Huelva 2015, p. 519; Domínguez Martín 2001b; Carpintero Redondo 2006; Clar et al. 2018, p. 336). Consequently, the contribution of livestock production to GDP was substantially lower than in countries such as France or Germany (Ríos-Núñez and Coq-Huelva 2015, p. 529). For instance, in 1962, livestock production in Spain accounted for 23 percent of the total agricultural production. In contrast, in Italy, it represented 27 percent, in France 45 percent, and in Germany 55 percent (Clar et al. 2015, see Table 5). Despite the challenging economic conditions faced by the Spanish economy in the second third of the twentieth century, the historically low production of meat in Spain can mainly be attributed to the country's agro climatic conditions. As a Mediterranean country, its comparative advantage was in the production of products such as wine, olive oil, and certain fruits and vegetables (Ayuda and Pinilla 2020; Pinilla and Ayuda 2010). Only in a small region in the north of the country, with agro climatic conditions similar to those of Atlantic Europe, was the production of livestock products higher (Dominguez Martin 1996). Despite the low meat production, it was energetically efficient, sustainable, and diversified (Rodríguez Zúñiga 1980).

In parallel with production, food consumption during the first half of the twentieth century was also dominated by Mediterranean products. In other words, on average, the Spanish diet was based on products such as bread, fruits, vegetables, fish,

Table 1 Meat Production in Spain and Europe continent (thousands of tons). *Source* FAOSTAT

Year	Meat production in Spain	Meat production in Europe	Spain/Europe
1961	659	30,004	2.2
1970	1,489	40,936	3.6
1980	2,643	54,539	4.5
1990	3,466	63,889	5.4
2000	4,913	51,304	6.6
2010	5,443	56,592	6.6
2020	7,503	65,119	11.5

and wine (Cussó Segura and Garrabou Segura 2007; Cussó Segura 2005). Therefore, with the exception of the northern region where consumption of livestock products was higher (Delgado and Pinilla 2023; Hernández-Adell et al. 2019; Collantes 2015), the consumption of meat in the majority of the population was reduced (Delgado 2023; Marrodán, Montero and Cherkaoui 2012; Bernabeu-Mestre 2008; Moreno et al. 2002) in comparison with the European average, and even lower than countries such as Turkey or Greece (Clar 2008; Bernabeu-Mestre et al. 2007). Consequently, the low consumption of livestock products resulted in a deficit in certain micronutrients such as calcium or vitamin A in large population groups (Medina-Albaladejo and Calatayud 2020; Cussó Segura et al. 2018; Cussó Segura 2005).

Regarding meat exports, they were virtually non-existent around the 1950s (Clar, Serrano and Pinilla 2015, p. 154). In fact, Spain was a net importer of meat, with most of it coming from Argentina (Gómez Mendoza 1995, p. 154). Nonetheless, meat imports were relatively low due to both the aforementioned limited domestic consumption and the Spanish economy's commercial isolation. Thus, during the decade following World War II, there was a clear correlation between meat production, consumption, and trade with the country's agro climatic conditions.

However, the scenario was completely different around the 1980s and 1990s. On the supply side (production), there was a spectacular take-off. Specifically, meat production rose from around 650.000 tons to over 3, 5 million between 1960 and 1990 (see Table 1). Furthermore, meat production went from representing less than 6 percent of total agricultural production in the 1950s to representing nearly 23 percent in the 1990s (Clar et al. 2015, see Table 3). Thus, the weight of Spanish meat production with respect to European production doubled (see Table 1), and the (constant) value multiplied by 5 in the same period (calculations based on FAOSTAT). However, not all types of meat participated in this expansion process. Specifically, beef and, especially sheep meat, lost weight in total meat production. In contrast, chicken and pork production increased significantly. The reason behind these patterns lies in the degree of industrialization in the production of each type of meat. In other words, it reflected what the literature has called the crisis of traditional livestock farming and the expansion of intensive livestock farming (Domínguez Martín 2001a, b, pp. 40-42). On the one hand, beef and sheep production remained tied to the land (Segrelles Serrano 1993, p. 40), so it could not meet the increasing demand for cheap proteins from the Spanish population (Domínguez Martín 2001b, p. 58). On the other hand, following Western patterns (Godley 2014), as well as the recommendations of the FAO (BIRD and FAO 1967) the industrialization of production, first of chicken, and then of pork, was implemented in Spain. Thus, the agribusiness model was implemented for both types of meat (Clar 2010). Broadly speaking, this production model that explains the sharp increase in chicken and pork production is based on four pillars. Firstly, the introduction of foreign breeds such as the broiler chicken in the case of poultry or the Jersey-Duroc in pigs (Clar 2024, p. 9). These breeds were clearly more productive compared to native breeds (such as the Iberian pig), resulting in significant loss in weight of the latter (Langreo and Germán 2018, p. 175). Secondly, there was massive imports of feed, and the USA emerged as the primary exporter. This trade relationship was established following the 1953 agreement between the two countries (Clar 2005). Consequently, meat production became

heavily dependent on the imports of foreign feed (Rodríguez Zúñiga 1980). In fact, the massive imports of feed are key to explaining the negative coverage rate in total agri-food trade during this period (Clar et al. 2015, p. 65). Thirdly, and related to the previous point, there was ease in the penetration of high-tech foreign capital in the production of poultry and pork, mainly from the USA.[2] Finally, recent literature has also highlighted the importance of improving the use of substances for animal fattening (Estévez Reboredo and Sánchez de Lollano Prieto 2022).

Thus, the production of poultry and pork was characterized by strong vertical integration in the value chain, with broiler chickens reaching a 95 percent integration level (Domínguez Martín 2001b, p. 51; Clar 2008). During this time, feed companies were the main axis of integration (Clar 2024). Meanwhile, sheep were left out of the vertical integration process (Langreo 2008, p. 45), while beef would be integrated in later years.

This intense vertical integration in poultry and pork production, in turn, led to a concentration of production both at a geographic and business level. At the geographic level, there was a process of decoupling between areas with suitable agro climatic conditions for livestock production and meat production. That is, meat production was no longer located in areas with abundant high quality grassland, such as the north, but in those closer to major consumption centers, in areas with easy access to imported feed and where there was a certain dynamism of feed companies, among other factors (Castell and Ramon-Muñoz 2022). Therefore, a large part of production was relocated to the northeast, Levant, and areas near Madrid and Barcelona
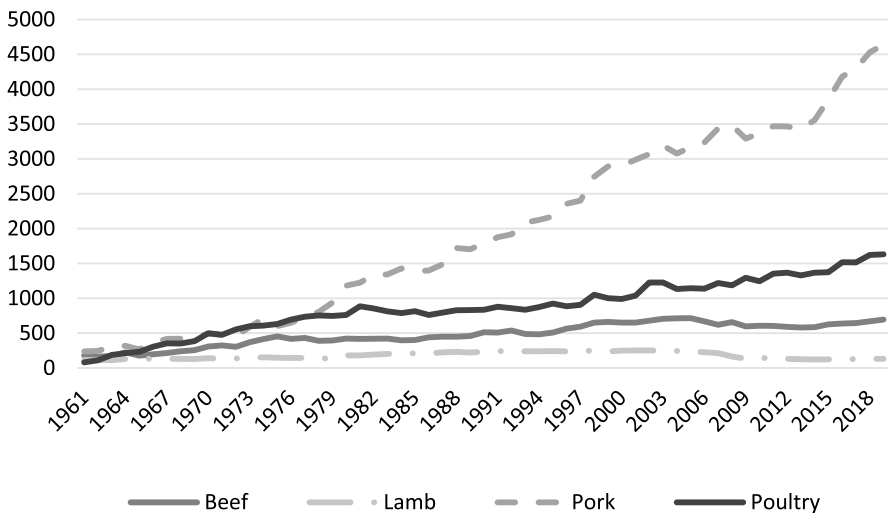

Fig. 1 Meat production in Spain (thousands of tons). *Source* FAOSTAT

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[2] At this juncture, Clar underscores the significance of domestic intermediaries for this process (Clar 2010).

(Sineiro García and Lorenaza Fernández 2008; Garcia Pascual 1998; Domínguez Martin 1996; Segrelles 1993; Rodríguez Zúñiga 1980).

Regarding corporate concentration, both in the pork and poultry industries (as well as in the agri-food industry as a whole (Rodríguez Zúñiga and Soria 1989)) it also increased. For example, in 1962 there were around one and a half million farms with 3.3 pigs per farm. By 1990, the number of farms had been reduced to less than four hundred thousand, with around 32 pigs per farm. This spatial and vertical corporate integration generated sufficient economies of scale to produce meat at a low price in response to a growing demand from the population.

In other words, the combination of an increase in disposable income due to the Spanish economic growth since the 1950s and a availability of low-priced meat due to the economies of scale in the meat industry resulted in a strong expansion in domestic meat consumption, surpassing countries such as France and England in the 1990s (Delgado 2023b, p.236). Besides income and prices, preferences also played a significant role in the substantial expansion of meat consumption (especially chicken and pork). This is evident when observing that the growth in the consumption of both meats was greater than the growth in purchasing power, thus indicating that they were superior goods (Delgado 2024). Moreover, these preferences could have been influenced by various factors, such as urbanization processes or large investments in advertising by major meat companies (Langreo 2008). In other words, just as with dairy products (Collantes 2015, 2019; Hernández-Adell et al. 2019), the increase in meat consumption by the less affluent classes and historically less consuming regions generated mass consumption of total meat (Delgado and Pinilla 2023) (Fig. 2).
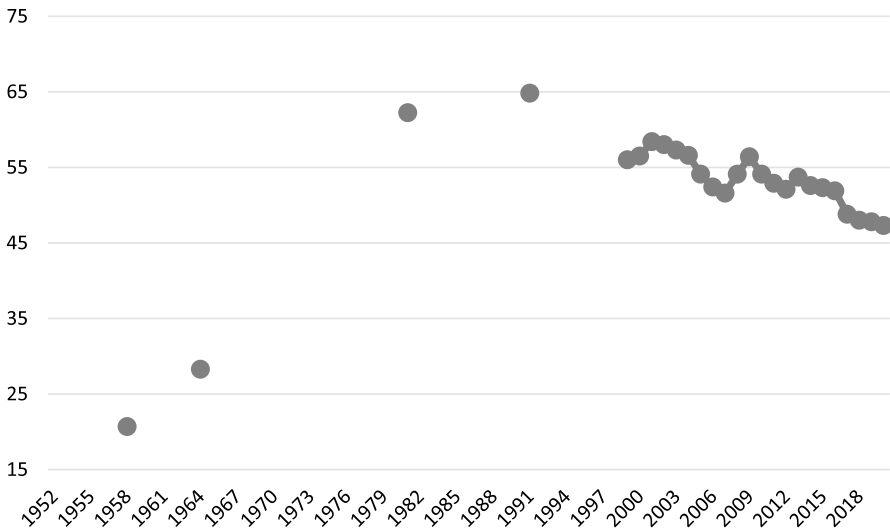
Fig. 2 Meat consumption in Spain (kg per capita). *Source* own elaboration based on Delgado (2023). Notes: Only household consumption

The implementation of this livestock production model in the post-World War II era originated in the USA in the 1930s and spread to Europe from the 1950s, well ahead of Spain. In some countries with a high penetration of this production model and significant production growth, by the late 1970s, livestock saturation issues due to the generation of huge surpluses of manure were evident (Frouws 1993). This situation worsened throughout the 1980s, not only hindering further production expansion but also resulting in a reduction or stabilization in the number of animals in some significant producers (Kemp et al. 2011). These issues were particularly prominent in countries such as the Netherlands, where intensive livestock production had grown substantially, but agricultural space was limited, and rural population density was high (Staritsky et al. 2011), or in regions with a high concentration of intensive farms, such as pig farming in Brittany (Roguet et al. 2015). In the Netherlands, environmental measures implemented as a consequence led to a stagnation in livestock numbers (Rieu and Roguet 2012). In some countries like Denmark or the Netherlands, these limitations have led to a specialization in piglet production, which are then exported to Germany for fattening, as there is insufficient space to complete the process locally (Roguet and Rieu 2011; Roguet et al. 2010).

The delayed development of intensive livestock farming in Spain has led to the establishment of larger-scale farms, particularly in the case of pig farming, and, more importantly, a stronger vertical integration compared to other countries, resulting in higher economies of scale (Benecke 2018). Only Denmark and the Netherlands have generated larger farms. Compared to Germany, Spain had a significant advantage. In 2010, nearly 60% of farms in Spain had more than 200 animals, compared to just under half in Germany. By 2020, this percentage had increased to over 80% in Spain, while in Germany, it had risen to 60% (Roguet et al. 2017). Integration plays a much more significant role in Spain than in most European countries. In the Spanish model, integrative companies oversee the entire value chain, but some phases of the process are carried out on contract farms with the integrator, who pays per animal or per space occupied by the animals. This arrangement means that these contract farms primarily do not employ wage labor but rather farmers invest in setting up the facilities and then handle production by receiving inputs from the integrator, who also buys their output. The result is a more industrial model that closely resembles that of the USA, although in this case the process tends to be internalized in the integrating company (Rieu and Roguet 2012). Thus, cooperation between independent farmers and the integrator company dominates the production model in Spain. This implies close cooperation and sharing of investment and risk.[3] Finally, Spain's low population density, exacerbated by the rapid rural exodus to cities that began around 1950, created an additional advantage for the new livestock farming model. The disturbances caused by the new farms were less significant in sparsely populated areas, where this activity was also dynamic in retaining population.

[3] To understand the Spanish business model and its differences with those prevailing in other countries, interviews with Francisco Mur (Director of Engineering, Production and R&D&I of Grupo Jorge) and Patricia Mazana (Deputy Director of Mazana Group) have been particularly useful. In 2023, Grupo Jorge is ranked 43rd among the world's leading pork producers (https://jorgesl.com/en) and with sales of 1,750 million euros. Mazana is a company specialized in pig production with sales of 371 million euros (https://www.mazana.es/index.php?mod=page&id=57).

Additionally, the availability of extensive agricultural land allowed for the absorption of slurry generated by the livestock.

As for exports, until the early 1990s, Spain was still a net importer of meat (see Fig. 3). This occurred despite the fact that the sector was already mature and competitive (Clar 2024; Langreo 2002). For example, in the 1990s, producer prices for chicken were the lowest in Europe after Denmark (Clar 2024, p. 10). There are two reasons why Spain did not yet export meat in significant quantities in the 1980s. First and foremost, all production was absorbed by the growing domestic consumption (see Fig. 2), something that is currently happening in developing countries such as China (Hasiner and Yu 2019; Cheng et al. 2015). Second, outbreaks of swine fever also delayed pork exports until it was eradicated in 1989 (Segrelles Serrano 1993, pp. 205–206; Langreo 2008, p. 50). That is to say, with the liberalization of meat trade in 1986, imports of meat increased while exports remained stagnant due to swine fever.

Meat consumption in Spain reached a plateau in the 1980s, followed by a continuous decline that has persisted to this day (a trend also observed in other Western countries (Stewart et al. 2021)). The stagnation in consumption may have caused problems of excess meat production. Consequently, once the domestic market became saturated, meat had to be placed in foreign markets. Given a mature sector (Langreo 2008, p. 49) due to a strong increase in domestic demand since the 1960s, geographic and business concentration, and integration in the value chain, meat was competitive enough to be exported. This process, as with the entire agri-food sector (Clar, Serrano and Pinilla 2015), was reinforced by Spain's entry into the European Union. In other words, the commercial liberalization of the meat sector, which was heavily controlled in the years before joining the EU (Langreo 2008, p. 50), further reinforced the concentration and efficiency process of the sector due to a reallocation of resources (Melitz 2003), since smaller companies had difficulties adapting
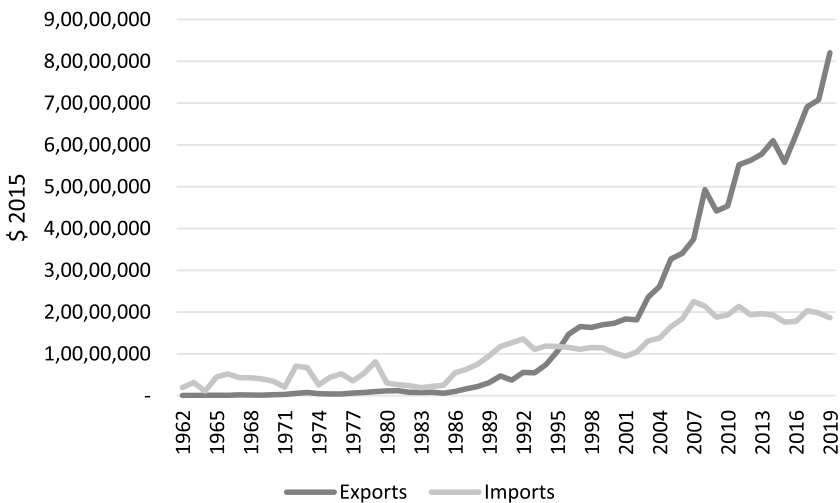

Fig. 3 Imports and exports of meat in Spain (real 2015 US dollars). *Source* COMTRADE

to cutting-edge technology and the new health regulations required to enter the EU (Segrelles 1994, p. 29). In other words, a home market effect was taking place (Clar, Serrano and Pinilla 2015; Serrano et al. 2015).

Therefore, as shown in Fig. 3, the 1990s witnessed a surge in meat exports. In value terms, between 1990 and 2019, they increased almost tenfold. Table 2 emphasizes the importance of Spain's entry into the EU (1986) for the sector. In 1980, extra-community countries such as Equatorial Guinea (former Spanish colony until 1968), Japan, or Andorra had a significant weight in Spanish meat exports. This is probably due to their subsequent re-exportation to third-party countries. The same was true for external sales of cava (Badia-Miró et al. 2022). Despite UN-COMTRADE indicating that Andorran and Guinean re-exports were 0, it is difficult to think that these two countries absorbed the same amount of meat as France. However, 10 years later, almost all foreign sales were directed to the EU. Specifically, France, Italy, Portugal, Germany, and the UK have dominated a large part of Spanish meat exports until recent years. Regarding pork exports, the pattern is similar due to its importance relative to total meat exports (see below).

In the first wave of globalization, transportation costs played a crucial role in the increase in global meat exports due to the diffusion of mechanical refrigeration, which facilitated long-distance trade (Delgado et al. 2023). However, as explained in the introduction, during the second wave of globalization, trade between developed countries increased, notably observed in the meat sector, where Spain primarily exported its meat to neighboring European countries (see Table 2). UN-COMTRADE data allow for the disaggregation of exports by type of transportation starting from the year 2000, indicating that between 95 and 99 percent of Spanish meat exports to its main partners were made by road. In this regard, Spain has benefited from two factors. Firstly, expansions and improvements in both the road transportation network and technological innovations in truck refrigeration. Secondly, and particularly in the Spanish context, greater integration within the meat value chain (Benecke 2018), likely fosters reduced transportation costs by avoiding outsourcing. However, with the rise of China as Spain's main meat buyer, a significant portion of Spanish sales in recent years has shifted to sea transportation. In this regard, Spain's meat trade has benefited from one of the key technical innovations in transportation during the second wave of globalization: the use of containers (in this case, refrigerated) (Levinson 2016). While it is not clear to what extent containers have reduced transportation costs (Hummels 2007; Serrano and Pinilla 2010, p. 3509), it is evident that they have had a qualitative impact on meat transportation.

However, as outlined throughout the article, not all meats have participated in the export boom in the same manner. As shown in Table 3, since the 1990s, the majority of meat exports have been attributed to pork, accounting for around 70 percent of total exports in the last decade. In other words, the conquest of the global market by Spanish meat exports is mainly due to pork exports (see Appendix Table 8 for a perspective on absolute values). Despite being initially more competitive than pork, chicken did not adapt to the needs of the foreign market. The preferences for the type of chicken meat consumed in Spain and abroad are different, so the industry, focusing on conquering the domestic market, failed to do so in international markets (Clar 2024).

Table 2 Main destinations of Spanish meat exports in value (%). Source COMTRADE

Total meat	1980	Total meat	1990	Total meat	2000	Total meat	2010	Total meat	2019
Andorra	19,7	France	29,6	France	27,8	France	28,3	China	18,1
France	19,2	Portugal	23,7	Portugal	26,1	Portugal	17,7	France	15,7
Japan	16,2	Italy	22,1	Italy	13,2	Italy	10,5	Portugal	10,5
Equatorial Guinea	12,6	Germany	7,1	Germany	10,8	Germany	7,9	Italy	7,8
Germany	7,9	UK	5,4	UK	4,1	UK	4,4	Japan	6,7
Romania	7,4	Russia	4,2	Russia	3,1	Russia	4,1	Germany	3,8
Switzerland	3,9	Greece	2,6	Netherlands	2,1	Netherlands	2,6	UK	3,6
Italy	3,5	Netherlands	1,2	Denmark	1,7	Denmark	2,1	Poland	3,0
Argentina	2,8	Belgium	0,7	Japan	1,6	Japan	1,9	Republic of Korea	3,0
Chile	0,9	Argentina	0,6	Belgium	1,1	Belgium	1,9	Czech Republic	2,3
Europe	64,3	Europe	97,7	Europe	95,5	Europe	90,9	Europe	62,5
Total (millions $)	46,1	Total (millions $)	282,6	Total (millions $)	1.291,6	Total (millions $)	4.161,0	Total (millions $)	8.558,7
Pork	**1980**	**Pork**	**1990**	**Pork**	**2000**	**Pork**	**2010**	**Pork**	**2019**
Andorra	76,1	Andorra	31,9	France	33,1	France	31,9	China	19,6
Equatorial Guinea	15,4	France	24,5	Portugal	24,3	Portugal	12,3	France	15,2
Chile	2,8	Italy	15,2	Germany	16,2	Germany	10,1	Japan	9,1
UK	1,6	Portugal	8,8	Italy	8,5	Italy	9,5	Italy	7,3
South Africa	0,8	Germany	7,7	Russia	2,7	UK	4,7	Portugal	6,0
Argentina	0,8	UK	2,8	Argentina	1,7	Russia	3,5	Germany	4,0
Gabon	0,7	Belgium	2,5	Belgium	1,7	Denmark	2,8	UK	3,9
Uruguay	0,4	Netherlands	1,5	Greece	1,5	Japan	2,6	Poland	3,9
Portugal	0,4	Lebanon	1,3	Netherlands	1,4	Poland	2,6	Republic of Korea	3,7
France	0,3	Mexico	0,8	UK		Netherlands	2,2	Czech Republic	3,1
Europe	79,5	Europe	96,1	Europe	96,0	Europe	91,3	Europe	60,3
Total (millions $)	6,5	Total (millions $)	31,3	Total (millions $)	713,2	Total (millions $)	2.918,1	Total (millions $)	6.185,8

Table 3 Weight of each type of meat on total meat exports (current dollars). *Source* COMTRADE

	1980	1990	2000	2010	2019
Lamb	11.5	2.8	3.9	3.5	2.5
Beef	10.2	73.6	23.1	11.3	9.7
Poultry	9.7	4.7	6.9	5.4	5.0
Pork	14.1	11.1	55.2	70.1	72.3
Other meats	54.5	7.8	10.8	9.8	10.5
Total	100,0	100,0	100,0	100,0	100,0

Notes: Lamb includes "Meat of sheep and goats, fresh, chilled or frozen (digit 112)," beef includes "Meat of bovine animals, fresh, chilled or frozen" (digit 111), poultry includes "Poultry, incl. offals ex. liver fresh, chilled, froz" (digit 114), pork includes "Meat of swine, fresh, chilled or frozen" (digit 113), " Bacon, ham and other dried, salted, smoked pig meat" (digit 121), "Meat and edible offals, nes. Dried, salted, smoked" (digit 129), and "Sausages, whether or not in airtight containers" (digit 134), Other meats includes "Meat of horses, asses, mules and hinnies, fr.ch.fro" (digit 115), "Edible offals of animals, fresh, chilled, frozen" (digit 116), "Other fresh, chilled, frozen meat and edible offals" (digit 118), "Meat extracts and meat juices" (digit 133), and "Other prepared or preserved meat" (digit 138)

The significant relative weight of "other meats" exports in the 1980s is mainly due to the export of offal

Over the last two decades, meat production has increased significantly compared to Europe (see Table 1). Currently, the weight of the meat industry within the total Spanish agri-food production is 22.6 percent, accounting for 2.24 percent of the total GDP in 2019 (Huerta 2020). In that same year, Spain had 21 percent of Europe's pig population, surpassing Germany (17.6 percent) and followed by France (9.1 percent) (Giménez García et al. 2021, p. 203). In fact, the first two countries account for 10 percent of global pig production (although well below the USA and especially China) (Giménez García et al. 2021, p. 206). Additionally, meat companies have climbed positions in the total turnover of the food industry, both nationally and internationally (Clar 2024). Since domestic consumption has continued to decline, the increase in pig production in the last decade is explained by the increase in exports.

This is precisely what Table 4 shows, where it is observed that Spain has been gaining weight in the world pork exports. In 2019, the market share (in value) was greater than that of major exporters such as the USA, Denmark, and Germany. Undoubtedly, the rise in demand from China is the main reason for the great performance of Spanish pork exports abroad in the last decade (see Table 2). Traditionally, the Chinese diet was based on a high content of cereals and vegetables, with low consumption of animal products. However, the reforms of 1978 led to strong economic growth and thus its process toward nutritional transition, where meat consumption notably increased, and pork has

Table 4 Percentage of pork and pork product exports from each country relative to total global pork and pork product exports (current dollars). *Source* COMTRADE

	1962	1970	1980	1990	2000	2010	2019
USA							
Meat of swine, fresh, chilled or frozen	9.30	3.36	5.52	3.99	12.13	14.13	15.89
Bacon, ham and other dried, salted, smoked pig meat	3.09	2.87	2.93	1.66	4.37	9.52	7.83
Germany							
Meat of swine, fresh, chilled or frozen	0.18	2.17	2.59	5.59	5.32	16.57	15.38
Bacon, ham and other dried, salted, smoked pig meat	0.11	0.73	1.40	5.23	3.26	11.31	10.23
Denmark							
Meat of swine, fresh, chilled or frozen	22.61	10.41	23.30	22.31	21.15	12.47	8.44
Bacon, ham and other dried, salted, smoked pig meat	82.23	75.87	58.74	30.58	21.26	10.71	4.60
Spain							
Meat of swine, fresh, chilled or frozen	0.00	0.22	0.08	0.21	5.61	9.16	15.62
Bacon, ham and other dried, salted, smoked pig meat	0.01	0.05	0.16	0.52	6.21	10.59	17.23

been gaining more prominence (Huang et al. 2021; Popkin 2003). However, due to relatively low production costs and relatively high tariffs, pork imports did not start to increase until the late 2000s when the sector became less competitive (Cheng et al. 2015). Therefore, to meet its domestic demand, China developed a powerful pork industry through massive imports of feed (Schneider 2015). From 2018 onward, imports grew much more strongly due to the detection of African swine fever (Shao et al. 2018).

3 Data and methodology

With regard to the data, United Nations COMTRADE database has been used to collect the value of bilateral flows of Spain's meat exports from 1963 to 2019. Thus, a total of 12 products with 4 digits have been obtained according to the SITC (revision 1) classification[4]: *meat of bovine animals, fresh, chilled or frozen (111); meat of sheep and goats, fresh, chilled or frozen (112); meat of swine, fresh, chilled or frozen (113); poultry, incl. offals ex. liver fresh, chilled, frozen (114); meat of horses, asses, mules and hinnies, frozen, chilled and frozen (115); edible offals of animals, fresh, chilled, frozen (116); other fresh, chilled, frozen meat and edible offals (118); bacon, ham and other dried, salted, smoked pig meat (121); meat and edible offals, nes. dried, salted, smoked (129); meat extracts and meat juices (133); sausages, whether or not in airtight containers (134); and other prepared or preserved meat (138)*. These 12 products have been aggregated into 5 types of meat: total meat (sum

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[4] Revision 1 is utilized because it enables the presentation of homogeneous products throughout the entire study period.

of all previous digits), poultry meat (114), pork meat (113 + 121 + 134), sheep meat (112), and beef meat (111).[5]

To understand the main determinants of Spanish meat exports, we use the structural gravity model as a tool for the econometric analyses, first proposed by Tinbergen (1962). Currently, it is one of the most used models in the literature to understand the determinants of international trade due to its great explanatory power and its solid theoretical framework (Shepherd 2016). In its simplest version, the gravity model indicates that trade between two countries (ij) is positively determined by the product of the production of both countries (i.e., their GDPs: $Y_i Y_j$), and negatively related by distance between them (as a proxy measure of trade costs (D)) as shown in Eq. 1.

$$X_{ij} = \frac{Y_i Y_j}{D_{ij}} \tag{1}$$

As explained, the history of meat exports in Spain since the second half of the twentieth century can be divided into two clearly differentiated stages (see Fig. 3). The first stage would span from the 1960s to approximately the 1980s. During this stage, meat exports in Spain were virtually non-existent. The second stage would span from approximately the 1980s to the present day and meat exports would soar spectacularly. For this reason, we have estimated the gravity model for the second period (1984–2019). To be clear, for the econometric analysis, we focus solely on the period when meat exports began to gain significance. To identify a structural break and separate the second period, we used the Clemente et al. (1998) Innovational Outlier statistic. Using this statistic, we identified the structural break at the year 1984. Therefore, we propose the following estimation for the augmented gravity model.

$$X_{ij,t} = \exp \left[\begin{array}{c} \alpha + \beta_1 \ln \left(Y_{i,t} \right) + \beta_2 \ln \left(Y_{j,t} \right) + \beta_3 \ln \left(Dist_{ij} \right) + \beta_4 \ln \left(\text{Vol.Exchange\_rate}_{ij,t} \right) + \\ + \beta_5 UE_{ij,t} + \beta_6 GATT\_WTO_{ij,t} + \Omega_t \end{array} \right] + \varepsilon_{ij,t} \tag{2}$$

We use as dependent variable the Spain's meat exports in nominal value (i) to each importing country (j) in each year (t). As in the basic gravity equation, we include a supply variable (log of Spain's GDP or livestock production in nominal value (Y_i)), a demand variable (log of the importing country's GDP or log of total meat consumption (Y_j)), and a variable representing trade frictions (log of the distance between both countries (Distij)). This variable is the geographical distance, in km, between Madrid and the importing country's capital. In addition to GDP as a supply variable, we consider it is interesting to alternatively use livestock production because it is more closely related to meat exports than GDP. To estimate demand, Yotov et al., (2016) proposes using sectoral expenditure instead of GDP. Since meat expenditure data in nominal values is unavailable in our case, we have

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[5] Digits 129 and 134, while not specified as being derived from pork, are assumed to be so given that the majority of sausages consumed in Spain are of porcine origin.

utilized quantities as an alternative. Shepherd (2016) notes that if sectoral expenditure data are unavailable, GDP can serve as an acceptable proxy. Consequently, we have estimated the models by combining the two available supply variables with the two existing demand variables. In addition to this, we augment the standard structural gravity model by including the log of volatility exchange rate for 10 years between exporting and importing country following Cho et al. (2002) calculated using the standard deviation of the first differences in the logarithm of the nominal exchange rate for a time period spanning 10 years prior to t, to measure the impact of the exchange rate uncertainty on bilateral trade flows. Additionally, we include dummy variables for the membership to the European Union and the General Agreement on Tariffs and Trade/World Trade Organization. The first one takes a value of 1 if Spain and the importing country are members of the European Union, 0 otherwise, whereas the last dummy variable takes value 1 if both Spain and the importing country belong in year t to the GATT/WTO, 0 otherwise.[6] Finally, the model incorporates time fixed effects (Ω_t) However, in addition to the model presented in Eq. 2, we estimate a second model. The primary distinction between the two models lies in the inclusion of distance in the first model and fixed importer effects in the second model. In other words, the first model carries a more economic interpretation as distance serves as a proxy for transportation costs. In the second model, the incorporation of fixed importer effects entails a loss of economic explanation; however, it allows for control over additional country-level variables that the first model does not account for. We did not include distance and fixed importer effects in the same model to avoid issues of collinearity.

Spain's GDP and the GDP of each importing country, as well as the two dummy variables (EU and WTO), are from CEPII database. The exchange rate is from the World Bank's World Development Indicator database, and meat consumption by country is from the Food and Agriculture Organization (FAOSTAT). To construct the livestock production in value, we used the Agricultural Statistics Yearbooks for the years 1984–2019. These yearbooks provide the carcass weight for each species each year and the price received by farmers in pesetas. We multiplied both values to obtain the value, which we then converted into dollars. Besides, all monetary amounts are expressed in current/nominal terms (Shepherd 2016; De Benedictis and Taglioni 2011).

In order to estimate the model, we rely on the Poisson Pseudo-Maximum Likelihood (PPML) estimator, proposed by Santos Silva and Tenreyro (2006). Additionally, we have clustered standard errors at the country-pair level. The main advantages of this estimator are that it is a nonlinear estimator that is robust to different

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[6] It would have also been interesting to measure the impact that tariff rates might have had on meat exports. There are two databases that would allow us to include this variable: the Market Access Map (https://urldefense.com/v3/, https://www.macmap.org/__;!!D9dNQwwGXtA!QwLl0IeyhHcKzSTscYa5m8qS80awCfBtl1gbcSnMj8GQjS82QOqJAA1umyMBNlXqqt2sZMGnQg0BFU5iWA$) and the WITS database (https://urldefense.com/v3/, https://wits.worldbank.org/WITS/Restricted/Login.aspx__;!!D9dNQwwGXtA!QwLl0IeyhHcKzSTscYa5m8qS80awCfBtl1gbcSnMj8GQjS82QOqJAA1umyMBNlXqqt2sZMGnQg0OxmrAqA$). However, neither of these databases allows us to introduce bilateral tariffs on meat for our study period, as both provide data for more recent years. Difficulty in obtaining data on tariff rates has generally prevented the use of this variable in gravity equations (Bayar 2018).

forms of heteroskedasticity and to the presence of zero trade flows, both frequent problems in international trade data (Ayuda et al. 2022). The fact that it is a nonlinear estimator allows us to estimate the dependent variable without a natural logarithmic transformation, so this permits not to omit zero trade flows, unlike other methods such as ordinary least squares (OLS) or the Heckman model (Heckman 1979). Therefore, in our case, the dependent variable (trade flows) is expressed in levels, and the continuous independent variables are in logarithms, which are interpreted as elasticities. Within this context, this estimator has converted in the workhorse in the international trade applied literature due to its desirable econometric properties. Particularly, this zero problem is quite frequent in our trade flows dataset.[7]

As emphasized, the two main objectives of the article are to determine if there has been a Home Market Effect process and the effect of the EU on meat exports. To empirically analyze if there has been an HME, the elasticity of Spanish GDP or livestock production has to be greater than the elasticity of the importer's GDP or meat consumption (Feenstra et al. 1998). This would indicate that supply has a greater weight in the take-off of meat exports.

4 Results

Tables 5 and 6 present the regression results for aggregated meat and pork for the 1984–2019 period. Table 5 displays the model including distance (Eq. 2), while Table 6 includes fixed importer effects. As a supply variable, both Spanish GDP (1) and livestock production (2) are shown. For the demand side, we utilize both the importer's GDP and meat consumption (differentiated by types of meat). The results for beef, sheep, and poultry are shown in Tables 9 and 10 of Appendix.

Overall, although with some exceptions, it can be concluded that Spanish meat exports have been boosted by both supply (either GDP or livestock production) and demand (either GDP or meat consumption) from importing countries. For the first model,[8] where distance is included as a proxy for transportation costs, it similarly exhibits the expected sign, namely negative and significant (with the exception of pork, which is not statistically significant). One of the main objectives of the article is to verify the existence of a Home Market Effect. As explained in the methodological section, this effect occurs if the elasticity of supply (GDP or livestock production) is greater than the elasticity of demand (importing country GDP or meat consumption) as an explanatory variable for meat exports. For both aggregated meat

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[7] Although it would be interesting to conduct an analysis of Spanish meat exports at the margins, we have discarded this idea as we only have 12 products, which are aggregated into 4. Therefore, the extensive margin at the product level would not make much sense.

[8] Typically, gravity models include other dummy variables such as whether both parties share a language as a proxy for cultural proximity or whether both countries share a border. When running the regression incorporating these variables, we obtain coherent results (not shown). Specifically, the common border variable is positive and significant, as both Portugal and France are countries with significant weight in Spanish meat exports. The shared language variable is usually negative, which is also normal given that Spain hardly exports meat to countries where the language is shared. However, we prefer not to include both variables because the RESET test indicates that the model is misspecified for all types of meat.

Table 5 Results of the gravity model for total meat and pork (including distance): 1984–2019

	Aggregate			Pork		
Log of exporter GDP	1.643***			2.898***		
	(0.286)			(0.324)		
Log of exporter meat production		1.947***	2.564***		4.188***	4.922***
		(0.333)	(0.364)		(0.467)	(0.377)
Log of importer GDP	0.838***	0.838***		0.868***	0.868***	
	(0.113)	(0.113)		(0.110)	(0.110)	
Log of importer meat consumption			0.913***			0.809***
			(0.075)			(0.064)
Log of distance	−0.647*	−0.647*	−0.744**	−0.351	−0.351	−0.820**
	(0.366)	(0.366)	(0.330)	(0.445)	(0.445)	(0.361)
GATT/WTO	−0.470	−0.470	−0.041	−0.379	−0.379	0.084
	(0.677)	(0.677)	(0.633)	(0.731)	(0.731)	(0.608)
EU	1.164**	1.164**	1.450***	1.649**	1.649**	0.867*
	(0.543)	(0.543)	(0.436)	(0.663)	(0.663)	(0.456)
Log of excvol	−0.431***	−0.431***	−0.444***	−0.390**	−0.390**	−0.304***
	(0.139)	(0.139)	(0.084)	(0.152)	(0.152)	(0.084)
Constant	−8.580***	−1.754	−4.574**	−21.149***	−4.752	−1.858
	(2.825)	(2.749)	(2.276)	(3.492)	(3.543)	(2.614)
RESET test statistic	0	0	0.18	1.49	1.49	0.08
Year F.E	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.529	0.529	0.598	0.469	0.469	0.612
Observations	4,908	4,908	4,549	4,908	4,908	3,887

Notes: Robust-clustered standard errors by country pair in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

and pork, we observe a Home Market Effect in the first model (Table 5). For the second model (Table 6), this effect is also present except when we include GDP as a supply variable. However, as indicated in the methodological section, it is more appropriate to include sectorial production and demand rather than GDPs. This means that total meat and pork exports in Spain have grown due to the growth of domestic demand, which has allowed the creation of strong economies of scale that have made the sector very competitive.

For beef and poultry, the results differ depending on the model utilized. If we include distance (Table 9 in Appendix), the Home Market Effect is observed, although it is much smaller compared to pork when considering livestock production as a supply variable and meat consumption as a demand variable. On the other hand, if we incorporate fixed importer effects (Table 10 in Appendix), the effect is much more ambiguous depending on the variables used and, in any case, the effect is much smaller. For lamb, the effect occurs in some cases when including distance, but never when including importer fixed effects.

Table 6 Results of the gravity model for total meat and pork (fixed importer effects): 1984–2019

	Aggregate			Pork		
Log of exporter GDP	0.464			1.202*		
	(0.463)			(0.636)		
Log of exporter meat production		1.932**	2.732***		1.736*	3.764***
		(0.974)	(0.550)		(0.920)	(0.483)
Log of importer GDP	1.326**	1.326**		1.569**	1.569**	
	(0.533)	(0.533)		(0.617)	(0.617)	
Log of importer meat consumption			1.526***			0.870***
			(0.579)			(0.335)
GATT/WTO	−1.688***	−1.688***	−1.334**	−1.682***	−1.682***	−1.191*
	(0.398)	(0.398)	(0.574)	(0.388)	(0.388)	(0.620)
EU	1.723***	1.723***	2.906***	4.372***	4.372***	3.095***
	(0.527)	(0.527)	(0.752)	(0.931)	(0.931)	(0.910)
Log of excvol	0.090	0.090	0.040	0.175***	0.175***	0.103
	(0.059)	(0.059)	(0.076)	(0.059)	(0.059)	(0.076)
Constant	−8.388***	−7.617***	−17.903***	−14.519***	−7.720***	−15.602***
	(2.003)	(2.803)	(3.030)	(2.476)	(1.701)	(0.798)
RESET test statistic	0.34	0.34	0.08	0.8	0.8	0.04
Year F.E	Yes	Yes	Yes	Yes	Yes	Yes
Importer F.E	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.943	0.943	0.873	0.935	0.935	0.850
Observations	4,852	4,852	4,517	4,643	4,643	3,759

Notes: Robust-clustered standard errors by country pair in parentheses

***$p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Therefore, in a context where countries trade goods, even if they are substitutable due to consumer preferences for variety, and under imperfect competition and increasing returns to scale, exports are more responsive to changes in domestic production than to changes in external demand (Serrano et al. 2015; Feenstra et al. 1998; Krugman 1980). Therefore, this Home Market Effect occurs especially in meats where industrial production and value chain integration have been stronger, thus generating greater economies of scale (pork). For the remaining meats, the effect is much less clear than for pork. The case of poultry is particularly interesting; despite its early industrialization, the sector did not adapt to international preferences, and its exports did not grow significantly.

Another objective of this study is to quantify the weight of Spain's entry into the EU as an explanatory variable for meat exports. For total meat and pork, the results are less ambiguous. Specifically, in both models, the fact that Spain and the importing country are part of the EU has a large and positive effect on exports of total meat and pork. For beef and lamb, EU membership is also positive and significant in both models. As for poultry, it is positive but only significant if we include consumption as a demand variable. Once again, the industry's failure to

adapt to international markets may be the reason behind the lack of significance of EU membership in chicken exports (Clar 2024).

In line with other studies on agri-food trade (Ayuda et al. 2022; Serrano and Pinilla 2012), the membership of the exporting and importing country in the GATT or the WTO does not have significant effects. For both total meat and pork, the aforementioned variable exhibits a negative coefficient and lacks statistical significance in the model incorporating distance as a factor. Conversely, in the model incorporating importer fixed effects, the variable in question demonstrates a negative coefficient that is statistically significant. Indeed, for beef, lamb, and poultry, WTO membership only exhibits the "expected" results (positive and significant) for the case of poultry in the first model. A possible explanation for this counterintuitive result could be that China, despite being in the WTO, maintains relatively high tariffs on meat imports (Yu and Cao 2015). However, excluding China from the regression analysis yields similar results (results not shown). Another possible explanation would be that WTO accession may have led to an increase in non-tariff barriers. Nevertheless, it is not clear whether non-tariff barriers hinder meat trade. In fact, the most recent evidence shows the opposite (Ridley et al. 2024). Indeed, since Rose (2004), it is quite common to find a negative effect on trade when both countries are in the WTO, especially in the case of food products (Mujahid and Kalkuhl 2016). Regarding exchange rate volatility, its overall effect is small and negative, although in several cases it is not statistically significant. Notably, in the gravity model estimates of pork exports with importer fixed effects the estimates for this variable are positive and statistically significant, which is a counterintuitive result. Nevertheless, the elasticity confirms that its relative importance is low too. All these results align with prior research, such as Rose et al. (2000) or Cho et al. (2002).

The R-squared of the model including fixed effects is significantly higher than that of the model including distance. This can be attributed to the fact that by controlling for numerous unobservable country effects, the explanatory power of the model is enhanced. Furthermore, when conducting a reset test to assess the model's goodness of fit, the results indicate potential misspecification for beef, lamb, and poultry in the model that includes distance. In contrast, the reset test suggests that the model with fixed effects is correctly specified. Therefore, despite exhibiting somewhat counterintuitive results in certain variables and lacking the inclusion of distance, the latter model generally produces more reliable findings.

5 Discussion

How did Spain go from being a net importer of meat in the 1980s to becoming the world's leading exporter of pork in 2020? To explain this fact, we can resort to structural and cyclical factors. Regarding the structural ones, the economic success of the meat industry in Spain is explained by the competitiveness generated by the boost in domestic demand. Historically, meat consumption in Spain has been relatively low and production has been based on extensive livestock farming. The strong increase in Spanish income from the 1960s onward led to a growth in demand for meat that

supply could not satisfy. Faced with this situation, the regime granted great facilities for American capital meat companies to establish themselves in Spain and quickly adopt the agribusiness model (Clar 2010). In this way, in just a few years, both the poultry and pork sectors were characterized by massive imports of feed, highly productive breeds, and great vertical integration in the value chain. As a result, large economies of scale were generated in both sectors. The result of this was a sharp drop in prices that drove meat consumption in Spain above the European average, further fueling economies of scale. Spain's entry into the EU in the late 1980s meant the liberalization of the sector (as it was still heavily regulated for international trade (Langreo 2008)) and therefore a reallocation of resources toward the most competitive companies, which absorbed smaller companies and economies of scale were even further reinforced (Melitz 2003). Therefore, with a saturated domestic market, the 1990s witnessed the growth of pork exports in Spain. The HME as a driving force has been observed in meats whose production underwent stronger industrialization, with the industry adapting to both domestic and international market preferences, particularly in the case of pork. Conversely, in meats where production was industrialized but the industry did not adapt to external markets, the HME either does not occur or occurs to a lesser extent, as seen in poultry. In contrast, meats with significantly lower productivity and lacking economies of scale, such as lamb and beef, did not experience export promotion through the HME. In the last decade, the pork sector in Spain has taken advantage of the increase in demand from China to become the world's leading exporter ahead of major producers such as Germany. The fact that large economies of scale are key to explaining the competitiveness of the Spanish pork sector can be seen by comparing the production cost structure of the two main pork exporters in Europe: Spain and Germany (Table 7).

In recent years, with the exception of feed, where Spain has a greater dependence on imports than Germany, production costs in the Spanish pork sector are lower. The cost of labor, although Germany also pays low wages in this sector, mainly to immigrants from Poland (Stępień and Polcyn 2016, p. 5), is still higher than in Spain. However, the bulk of the difference in cost structure is based on fixed costs and other variable costs. Regarding the latter, although reports from the Agriculture and Horticulture Development Board (AHDB) do not specify this, it is highly likely that these are costs related to transporting the pigs to the slaughterhouse. Therefore, if fixed and transportation costs are lower in Spain, this would indicate that economies of scale in the Spanish pork industry are greater than in Germany (Clar 2024, p. 15). Greater vertical integration of the value chain in Spain than in Germany may explain this greater efficiency in production (Klein 2018). Other factors, such as Spain having a lower population density and therefore being able to install large farms far from urban centers, as well as greater promotion of the sector by the state, also help explain Spanish success (Lence 2007). In fact, many of the farms were installed not far from the large centers of consumption but in rural areas with very low demographic densities due to the intense depopulation they had previously experienced (Collantes and Pinilla 2011). In these areas, the scarcity of economic alternatives meant that intensive livestock farming was one of the few economic activities capable of generating employment, so that the possible nuisances caused by the farms were considered a tolerable negative externality (Langreo 2008). Therefore, having a vast available area in territories with low rural population density has been an

advantage for the expansion of pig production in Spain. Thus, among the twelve EU countries with the largest livestock herds, Spain ranked the lowest in Gross Livestock Units per square kilometer and per hectare of agricultural land in 2010. Furthermore, the difference compared to other major producers was significant (Roguet et al. 2015).

Environmental legislation is common to all European Union countries, which limits the amount of nitrates that can be discharged based on soil availability (for example, the famous Nitrates Directive of 1991). The expansion of pig farming in Spain has therefore benefited from a large area with low population densities. Additionally, some national regulations may have limited herd growth, as was the case in the Netherlands since the 1980s. Opposition in this country to the developing model was not only related to pollution caused by manure but also to animal welfare, impact on landscape and environment, and the model being judged as too industrial. The institutional response was to limit the size of farms, also initiating a public debate on the issue. Paradoxically, the number of animals per farm continued to increase, while the number of farms plummeted (Rieu and Roguet 2012).

Other institutional variables may also help explain Spain's success. For instance, appropriate institutions are crucial for meat exports to China (Hasiner and Yu 2019). Although there are indices that measure institutions in the long term (Martín-Retortillo and Pinilla 2022), the low variability since 1984 for the Spanish case prevents us from including it in the model. Nevertheless, we know that the Spanish government has promoted pork exports. For example, as noted in Van Ferneij and Lecuyer (2018) Spain facilitated meat exports outside the EU in 2016 through the Royal Decree 993/2014, streamlining the process and cooperation with importing countries to obtain import certificates. This process is more costly in the German case. Additionally, as the authors argue, in Spain, there is greater effort by companies to differentiate the product's quality (cutting level, packaging, quality certificates, etc.), whereas in Germany, the focus is on volumes and providing a standardized brand with little differentiation.

Table 7 Cost structure in pig production by country (pounds per kilo of carcass weight) *Source* AHDB

	2014	2015	2016	2017	2018	2019	2020
Spain							
Depreciation and finance (fixed costs)	0.11	0.1	0.11	0.11	0.12	0.12	0.12
Labor	0.07	0.07	0.08	0.09	0.09	0.09	0.09
Other variable costs	0.16	0.17	0.19	0.20	0.22	0.22	0.22
Feed	0.84	0.72	0.76	0.80	0.83	0.83	0.84
Total	1.18	1.06	1.14	1.20	1.26	1.26	1.27
Germany							
Depreciation and finance (fixed costs)	0.18	0.17	0.20	0.21	0.2	0.23	0.23
Labor	0.12	0.10	0.12	0.13	0.12	0.14	0.13
Other variable costs	0.24	0.22	0.25	0.27	0.23	0.27	0.27
Feed	0.76	0.65	0.69	0.75	0.80	0.77	0.80
Total	1.3	1.14	1.26	1.36	1.35	1.41	1.43

However, there are also cyclical arguments that help explain the success of Spanish meat exports, specifically, episodes of swine fever. This disease entered Spain in the 1960s and was endemic until its eradication in the 1990s (Barcelona 1990), thus delaying exports due to embargoes by potential importing countries. In 2014, outbreaks were detected in nearby countries such as Poland or Romania and in 2018 in China. Therefore, Spain has benefited from swine fever in two ways. Firstly, from outbreaks in both competing countries (although it was not detected in Germany until 2020) and importers (China). Secondly, the increasing importance given by the EU to animal health has favored verticalization and integration in Spain (Langreo 2002), as integrators provide all sanitary inputs to farmers. Thus, economies of scale and competitiveness have increased.

To our knowledge, the only study that analyzes whether there has been a Home Market Effect in the meat sector is the aforementioned Serrano et al., (2015) where the results complement those of this study. However, other studies have used gravity models to analyze the determinants of meat trade, allowing us to interpret whether HME has occurred or not, even though it is not the objective of these studies. For example, using a sample of 186 pork-exporting countries, Yang, Reed and Saghaian (2012) find that the supply elasticity (GDP of the exporter country) is greater than the demand elasticity (GDP of the importing country), although the difference is, on average, smaller than in the Spanish case. In Schlueter et al. (2009), analyzing the aggregated meat exports of the top 10 major exporting regions globally (including the European Union as a whole) between 1996 and 2007, no HME is found. In this case, they use livestock production as the supply variable and consumption as the demand variable. In Meneguelli Fasarella, Pinto de Souza and Lee Burnquist (2011) they analyze the determinants of chicken exports in Brazil between 1996 and 2009, and the result regarding whether there has been an HME process is ambiguous depending on the model used. In Wu (2022), it is observed that global rabbit meat trade since the 1960s has been primarily driven by demand factors, indicating no HME process. Lastly, Cao and Johnson (2006) find HME in New Zealand exports between 1994 and 2003 for sheep meat but not for beef. The difference in this study is that by analyzing what has happened with the consumption and production of each type of meat from a historical perspective, we can better understand why HME has occurred in some meats and not in others.

6 Conclusions

This study aimed to quantify the most relevant variables that explain how the meat sector in Spain conquered international markets. To achieve this, we conducted a gravity model from 1984 to 2019 with aggregated meat and several types of meat. Thus, we complemented previous literature that had done the same exercise from the point of view of the agri-food sector as a whole (Serrano et al. 2015) or with other products such as wine (Ayuda et al. 2019; Castillo and García Cortijo 2014; Pinilla

and Ayuda 2002). The results varied depending on the type of meat, demonstrating the importance of disaggregated studies to understand the commercial dynamics of agri-food products.

The findings revealed the presence of a Home Market Effect process in meats that underwent the most intensified production and whose industry adapted to external markets (specifically, pork). That is, in a context where Spain was completing its nutritional transition with a clear preference for pork consumption, implied the formation of large economies of scale in the sector. Therefore, when the sector was liberalized with Spain's entry into the European Union, the sector was competitive enough to gain market share in international markets. Thus, although exports of all types of meat grew tremendously in absolute terms, the pork sector eventually became the world's leading exporter. The results also demonstrate that, overall, Spain's membership in the European Union was a significant factor in the growth of meat exports. Furthermore, China's economic development and its own nutritional transition also fostered an increase in its consumption, from which Spain has been able to benefit in recent years through massive pork exports to the Asian country.

In summary, the abrupt transformation of a net meat importer into a super exporter is considered an extremely intriguing case study. It highlights how, in a context characterized by underdeveloped livestock production and low meat consumption, rapid economic growth, which spurred a profound shift in dietary patterns, along with new technological offerings such as improvements in transportation networks, the development of refrigerated containers, or the implementation of intensive livestock farming, facilitated a swift expansion of meat production to cater to the dynamic domestic market. A deep vertical integration within the production chain fostered the achievement of economies of scale, which, once the domestic market reached saturation, made rapid export growth possible, further aided by Spain's integration into the European Union. The growth of a production sector that generates evident adverse environmental effects and inconveniences for nearby populations was facilitated by the low population densities that the previous rural exodus had generated in the rural areas where production expanded. The new industrial livestock farming emerged as a crucial economic alternative for these regions, addressing the challenges they faced.

However, the economic success of the meat industry in international markets is overshadowed by the environmental issues caused by this process. Livestock production is one of the sectors that generates the most greenhouse gas emissions (Ilea 2009), making it a clear contributor to climate change (Willett et al. 2019; Lassaletta et al. 2014; Gerber et al. 2013). In order to meet the growing demand for meat and livestock products in Spain since the 1960s, the implementation of the agribusiness model has generated several environmental impacts that have degraded agro-ecosystems (Guzmán et al. 2018). Greenhouse gas emissions from Spanish livestock production have increased from 8 to 75 million CO_2e emissions since the beginning

of the twenty-first century (Aguilera et al. 2020). In particular, the management of manure use and its environmental impact remains a fundamental problem in the pig industry (Giménez García et al. 2021; Díaz Yubero 2018).

Furthermore, the ecological footprint of intensification in livestock production is not limited to Spanish borders. The strong dependence on feed imports, especially from countries such as Argentina and Brazil, is related to deforestation processes and other environmental and social issues (Infante-Amate et al. 2018). Therefore, this raises questions about the viability of this model in the long term, as although various decrees have attempted to improve the environmental conditions of intensive meat production (Giménez García et al. 2021), they are not sufficient to adopt a sustainable model.

Regarding future lines of work, we believe that two aspects should be further explored. Firstly, as mentioned earlier, other disaggregated products should be used to quantify their expansion process. Secondly, as outlined at the end of the discussion, the environmental impacts of meat exports should be quantified. Although this has been done for agriculture or livestock as a whole (Infante-Amate et al. 2018; Soto, Infante-Amate, Guzmán, et al. 2016a, b), we consider that a disaggregated perspective is also necessary.

Appendix

See Tables 8, 9 and 10.

Table 8 Spanish exports of different types of meat in millions of current US dollars. *Source* see Table 3

	1980	1990	2000	2010	2019
Lamb	5.3	7.9	50.4	143,9	215,5
Beef	4.7	208,0	298,5	468,8	829,1
Poultry	4.5	13.3	89.6	223,2	430,6
Pork	6.5	31.3	713,2	2.918,1	6.185,8
Other meats	25.2	22.1	140,0	406,9	897,8
Total	46.1	282,6	1.291,6	4.161,0	8.558,7

Table 9 Results of the gravity model for poultry, beef, and lamb (distance): 1984–2019

	Lamb			Poultry			Beef		
Log of Exporter GDP	0.726* (0.432)			2.681*** (0.676)			1.315*** (0.452)	0.970** (0.432)	
Log of Exporter Meat Production		1.668* (0.997)	2.132** (1.084)		2.420*** (0.665)				0.255 (0.403)
Log of Importer GDP	0.932*** (0.140)	0.932*** (0.140)				0.573*** (0.136)	0.849*** (0.145)	0.744*** (0.129)	
Log of Importer Meat Consumption			0.694*** (0.087)	0.466*** (0.125)	0.466*** (0.125)				0.871*** (0.213)
Log of Distance	−1.747*** (0.294)	−1.747*** (0.294)	−1.138*** (0.227)	−1.348*** (0.279)	−1.348*** (0.279)	−1.312*** (0.246)	−2.162*** (0.380)	−2.817*** (0.383)	−2.711*** (0.267)
GATT/WTO	−0.489 (0.612)	−0.489 (0.612)	0.425 (0.481)	1.569** (0.789)	1.569** (0.789)	1.892** (0.788)	−1.755** (0.796)	−1.134 (0.733)	−0.880 (0.558)
EU	1.054** (0.512)	1.054** (0.512)	2.367*** (0.539)	0.530 (0.427)	0.530 (0.427)	0.751 (0.461)	1.263** (0.559)	1.636*** (0.564)	1.823*** (0.412)
Log of Excvol	−0.218 (0.135)	−0.218 (0.135)	−0.232*** (0.086)	−0.191 (0.120)	−0.191 (0.120)	−0.247** (0.111)	−0.499*** (0.172)	−0.040 (0.051)	−0.033 (0.093)
Constant	1.939 (3.538)	7.682*** (1.945)	4.369** (1.734)	−4.100 (2.928)	4.122* (2.193)	2.023 (2.002)	3.658 (5.124)	17.549*** (2.468)	15.672*** (1.938)
RESET test statistic	22.16***	22.16***	22.16***	55.6***	55.6***	17.46***	17.79***	25.99***	14.88***
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
R-squared	0.685	0.685	0.425	0.600	0.600	0.569	0.813	0.678	0.598
Observations	4,908	4,908	4,143	4,908	4,908	4,485	4,908	4,908	4,499

Robust-clustered standard errors by country pair in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 10 Results of the gravity model for poultry, beef, and lamb (fixed importer effects): 1984–2019

	Lamb		Poultry		Beef		
Log of Exporter GDP	-0.415 (0.589)		0.838* (0.439)		1.086* (0.603)		
Log of Exporter Meat Production		-0.767 (1.329)		1.731* (0.970)		-0.113 (0.287)	1.592*** (0.409)
Log of Importer GDP	1.593** (0.648)	1.593** (0.648)	1.193*** (0.455)	1.193*** (0.455)	-0.350 (0.515)	1.524*** (0.359)	
Log of Importer Meat Consumption		1.387*** (0.524)		1.990*** (0.484)			1.577* (0.886)
GATT/WTO	1.013 (0.752)	1.625** (0.780)	-0.268 (0.637)	-0.623 (0.685)	-2.186*** (0.559)	-1.982*** (0.198)	-1.168*** (0.302)
EU	3.376** (1.404)	8.203*** (1.039)	1.286 (0.901)	3.151*** (1.184)	5.560*** (1.242)	4.915*** (0.875)	5.306*** (0.827)
Log of Excvol	-0.296 (0.203)	-0.308** (0.138)	-0.228* (0.128)	-0.274* (0.152)	-0.230*** (0.060)	-0.090 (0.061)	0.013 (0.091)
Constant	-7.923* (4.100)	-8.990*** (1.957)	-15.020*** (3.246)	-10.361*** (3.754)	-4.832* (2.854)	-12.627*** (2.314)	-1.931*** (0.266)
RESET test statistic	0.74	0.67	1.68	1.13	2.32	4.51**	2.31
Year F.E	Yes	Yes	Yes	Yes	Yes	No	No
Importer F.E	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.911	0.866	0.827	0.788	0.939	0.901	0.788
Observations	3,103	2,719	3,566	3,306	3,574	3,574	3,287

Robust-clustered standard errors by country pair in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

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