

Article

Comparison of the Competitiveness for Danish, Dutch, and German Piglet Producers under Consideration of Country-Specific Methods of Piglet Castration with Anesthesia

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Abstract: Pig producers in Europe adopt different production methods for male pig fattening. More than half of the animals are surgically castrated. The different interpretations of animal welfare in different countries lead to market differentiation and economically different production conditions, which do not restrict trade, but economically lead to drastic competitive changes for local producers. While the Netherlands has already implemented surgical castration for the export market, using CO₂ narcosis (NL), Denmark and Germany are each introducing their strategies with local anesthesia (DK) and isoflurane anesthesia (DE), respectively. Using typical pig farms from the agri benchmark Pig Network, the additional costs and economic impacts of animal welfare regulations are calculated. In Germany, isoflurane anesthesia increases costs by EUR 28.54 to EUR 49.86 per sow, or EUR 1.93 to EUR 3.81 per male piglet. This corresponds to a cost increase of around 5% per piglet. In Denmark, the costs of local anesthesia with procaine increase more moderately by EUR 3.55 to EUR 5.05 per sow, or around EUR 0.30 per male piglet. The cost increase here is less than 1% per piglet. The additional costs are leading to a loss of competitiveness for Denmark and Germany compared to the Netherlands. However, Germany is also losing profit significantly compared to Denmark. This study highlights that animal welfare regulations can negatively impact the competitiveness of the pig sector. It emphasizes the need for countries to implement such regulations carefully, ensuring that they do not lead to the loss of production or international competitiveness. A balanced approach that supports both animal welfare and economic sustainability is essential.



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1. Introduction

Historically, pig castration, for both males and females, has been used to prevent domestic pigs from mating with wild boars in forest pasture systems. Only later did the reason for the surgical castration of male animals start to revolve around the prevention of boar taint in the meat [1]. To date, this method is still used for male animals to the extent that, in many European countries, the proportion of male castrated animals is well over 90%. However, raising awareness about animal rearing conditions and welfare has fueled public criticism of pig surgical castration. Piglet castration without anesthesia, within the first seven days of life, is accepted as an exception to the Animal Protection Act in the European Union [2]. Nevertheless, pig farming systems in some countries, such as the Netherlands and Spain, have successfully improved the fattening process of male pigs without surgical castration (entire males). To minimize the risk of boar taint and suppress sexual behavior, farmers can immunocastrate male pigs by using a vaccination [3–5]. These methods of production without the surgical castration of male piglets can have a positive impact on profitability [6] if the industry in the supply chain behind pork producers does not discriminate economically against uncastrated animals [1,6]. Different payment systems or a lower price for intact males could affect this.

Table 1 shows the different market shares of pig production utilizing different production methods for male pigs. Countries such as Belgium, Denmark, Hungary, Italy, and Romania produce barrows. Germany and France have a slightly higher share of entire males, at around 20%, whereas most pigs in the United Kingdom, Spain, and, to a lesser extent, in the Netherlands, are kept as entire males. The proportion of immunocastrated animals is deficient, except in Belgium. This list shows that, within Europe, the production methods and market situations are very heterogeneous [7,8].

Table 1. Population shares of male pigs raised as entire males, immunocastrates, or barrows in the top ten pig producing countries in Europe (2017) [7,8].

Country	Entire Males	Immuno-Castration	Surgical Castration	with Analgesia and Anesthesia	with Analgesia Only	Without Analgesia or Anesthesia	Pig Population
	% Total	% Total	% Total	% Total Surgical	% Total Surgical	% Total Surgical	×1000
Belgium	8	15	80	3	6	91	6351
Denmark	<2	0	>97	0	95	5	12,402
France	22	<0.1%	78	0	50	50	11,835
Germany	20	<1%	80	1	90	9	27,600
Hungary	1	0	99	0	0	100	2935
Italy	2	5	93	0.5	2.5	97	8561
Netherlands	65	0	35	0	0	100	12,013
Romania	0	5	95	2	4	94	5180
Spain	80	5	15	1	1	98	28,500
UK	98	<1%	2	4.5	4.5	91	4383

Germany, Denmark, and the Netherlands are the most crucial piglet and pork producers in Europe. While Germany has a substantive influence on pig price, Denmark and the Netherlands necessarily figure out the factors of piglet production [9,10]. The castration methods of male piglets are the key indicators influencing piglet production and live trade between these countries. In Denmark, almost all male piglets are castrated surgically [7,8,11] with analgesia only (Table 1). For German pork production, about 80% of all male piglets are castrated surgically within their first week of life [8,10]. Painkillers are used for 90% of the total number of male piglets. Surgical castration plays a lesser role in the Netherlands, as it is only applied to 35% of piglets, i.e., those for the live export market. These are castrated utilizing CO₂ narcosis, without pain relief medication. The remaining pigs are fattened as entire males for the Dutch supply chain.

Consumers perceive surgical castration without anesthesia very critically [3,11]. The ban on piglet castration without anesthesia has been a burning issue over the past decade in Europe. Within the European Union, representatives of farmers, the meat industry, the retail trade, research, the veterinary profession, and animal welfare organizations have formulated the goal of ending the surgical castration of piglets by 2018 in the “Brussels Declaration” of December 2010 [12,13]. However, this was preceded by the so-called “Düsseldorfer Erklärung” [13], driven by social pressure, in which the German actors in the pig supply chain committed themselves to the aim of ending the surgical castration of piglets without anesthesia by the producers. From socio-economic perspectives, efforts then led to an amendment of the German Animal Welfare Act in 2013, and, thus, this became agricultural policy in Germany. The interpretation and design of the Animal Welfare Act in Europe is the responsibility of the individual states. While CO₂ anesthesia is used in the Netherlands for these piglets that are still being castrated, piglet castration without anesthesia should have been banned in Germany as of January 2019. In Denmark, there had been no attempts to change the castration practices until the changes occurred in Germany. Contrary to the planned change in the law, the government of the Federal Republic of Germany agreed in November 2018 to postpone the implementation of the

change by two years [13]. The German government argued that there were no competitive alternatives and, thus, a ban on surgical castration without pain relief could harm German pig production [6].

In the report of the German Federal Government on the status of the development of alternative procedures and methods for piglet castration without anesthesia, according to § 21 of the Animal Welfare Act, it states the following: “The prohibition of the castration of piglets without anaesthesia is justified and necessary for animal welfare reasons. However, the regulation puts domestic producers at a disadvantage on the domestic and especially on the international markets in competition with producers from other countries. In particular, the procedure of surgical castration under anaesthetic is likely to have economic disadvantages due to additional costs for the material and narcosis as well as the additional labour, especially when market prices for selling castrated animals are not high enough to compensate these costs” [12].

Table 2 shows the number of piglets traded between the following three countries considered: Germany, Denmark, and the Netherlands. A considerable proportion of piglets from Denmark and the Netherlands are exported to Germany to be fattened due to the lower production costs on finishing farms in Germany [14].

Table 2. The total number of piglets traded between Germany, Denmark, and the Netherlands in 2018 [14].

Origin	The Export Destination for Piglets		
	Germany (DE)	Denmark (DK)	Netherlands (NL)
Germany (DE)	-	1464	29,739
Denmark (DK)	6,652,307	-	291
Netherlands (NL)	4,465,332	0	-

On the other hand, very few piglets born in Germany are traded back into these neighboring countries. The Netherlands produces the entry males for the domestic market and, thus, castrates with CO₂ anesthesia due to Dutch legislative standards for the export of piglets to Germany. Consequently, political changes in the Animal Welfare Act may have an impact on trade or the competitiveness of national sectors. This strongly proves the importance of analyzing the economic effect of the practice change in the surgical castration methods used at the farm level (in order) to have a comprehensive understanding of the issue. Denmark has approved local anesthesia with procaine for piglet castration. In Germany, the inhalation of the anesthetic isoflurane has been approved. In both countries, farmers with a certificate of competence can perform the anesthesia themselves [15,16].

This study aims to comprehensively analyze the economic effects of differing interpretations of the Animal Welfare Act, specifically on the ban on piglet castration without anesthesia, as applied in Germany, Denmark, and the Netherlands. It examines how these legislative variations influence the profitability of piglet producers and assesses the international competitiveness of farms in these countries. The focus is on the impact of these policies on piglet production costs, the trade of castrated piglets, and how these factors affect the overall farm-level competitiveness in the European market. By comparing the different approaches, this study aims to highlight the economic advantages and disadvantages arising from each country’s regulations and how they shape the competitive dynamics in the piglet production sector.

2. Materials and Methods

2.1. Generating Economic Data of Typical Sow Farms for Modeling in Germany, Denmark, and The Netherlands

The analysis of the economic effects and the international competitiveness of piglet production with the alternatives for piglet castration without anesthesia was conducted with data from so-called ‘typical farms’ of the global Pig Network agri benchmark [17,18]. The description of the methodical approach for generating data of typical pig farms is

explained in detail by Kress and Verhaagh [3], Feuz et al. [19] as well as by Chibanda et al. [18]. It is also used for typical sow farms. This data concept describes representative regional farms, which are constructed from the datasets of several real farms and evaluated for plausibility by a group of local experts [18,20].

The determination of typical farms involves several standardized steps, applied consistently across all countries and sectors in collaboration with research partners from agri benchmark partner institutions [17,18], as follows:

1. Identification of Key Regions: The first step involves finding key regions for pig production, focusing on indicators like the total number of pigs per region and regional pig density per hectare. This is typically performed using official statistics.

2. Relevance of Farms: Once the key regions are identified, it is decided whether all farms are relevant for analysis. Only farms that derive at least half of their income from agriculture are considered, with part-time farms excluded, unless they significantly contribute to regional production.

3. Defining Typical Production Systems: This step involves defining the degree of specialization (e.g., specialized sow farms or fattening farms) and analyzing other factors like integration with other operations (e.g., crop production) and the level of vertical integration. Productivity, feed purchasing, and labour type is also considered.

4. Data Collection: Country-specific data are collected through focus groups composed of research partners, local experts, and producers, using a standardized questionnaire.

5. Data Processing and Evaluation: The collected data are processed using the TIPI-CAL model, analyzed, and evaluated until a consistent dataset is achieved. The results are compared with other economic analyses to ensure alignment with broader findings.

6. Annual Updates: Input and output prices, as well as yields, are updated annually, with a comprehensive update of all data every 3–4 years, in collaboration with local partners.

The results show the typical economic situation of a common farming business type in a region [18,20]. The evaluation of the economic indicators was based on the TIPI-CAL model. It is a production and accounting model that provides a detailed representation of the production technology and the physical interrelationships in farms. Furthermore, it is a deterministic, recursive, and dynamic simulation model for various farm sectors and can map ten years, including the trends of all output variables [21]. Thus, it enables full-cost accounting for the business model of the typical regional farm. On this basis, changes in the production process (e.g., new methods of surgical castration) and the predicted cost and revenue implications can be related to the profitability of the whole farm. The typical farms were surveyed according to a standardized protocol, as described by Verhaagh and co-authors [17]. In short, a focus group consisting of a consultant and three to six participants from operating enterprises in each region were included to guarantee a valid basis for the database. The focus group was organized as a round table discussion, in which all necessary operating data were collected based on a standardized questionnaire by Verhaagh [17]. The focus group formed a consensus on each parameter to describe what a typical enterprise would look like, instead of adopting the average values of the participating producers. The database of the international, typical sow farms is updated annually, in cooperation with a focus group whose experts are familiar with the local circumstances of piglet-producing farms. For this study, the three most crucial piglet-producing regions in Denmark and the Netherlands, as well as the six most important piglet-producing areas of Germany, were selected. Table 3 shows the key characteristics of the selected typical farms. The typical farms used in this study are partly specialized in piglet production. In all farms in the 3 countries, the ratio of female to male piglets is 50%.

Table 3. Key figures for typical sow farms in Germany, Denmark, and the Netherlands—baseline scenario in 2018 [14].

Farm	Country	Number of Sows	Production Principle	Number of Piglets Sold (per Year)
DE_170_0	Germany	168	rearing piglets	4093
DE_220_6300	Germany	220	closed system	7343
DE_350_0	Germany	350	rearing piglets	9578
DE_400_12K	Germany	400	closed system	11,818
DE_800_0	Germany	800	rearing piglets	26,691
DE_2490_0	Germany	2490	rearing piglets	81,539
DK_350_5000	Denmark	390	closed system	11,636
DK_600_20K	Denmark	586	closed system	21,345
DK_1100_0	Denmark	1106	rearing piglets	36,174
NL_460_0	Netherlands	476	rearing piglets	14,195
NL_490_3900	Netherlands	490	closed system	15,078
NL_1100_0	Netherlands	1100	rearing piglets	32,538

Farm	Number of litters (per sow/year)	Number of piglets reared (per sow/year)	Live weight (kg per piglet)	Piglet Price (EUR per head and per kg)
DE_170_0	2.37	24.4	31.6	54.54/1.73
DE_220_6300	2.30	33.4	28.0	52.34/1.87
DE_350_0	2.30	27.4	29.0	55.50/1.91
DE_400_12K	2.39	29.5	30.0	47.87/1.60
DE_800_0	2.30	33.4	30.0	53.24/1.77
DE_2490_0	2.40	32.7	27.0	46.60/1.73
DK_350_5000	2.30	29.8	25.7	42.99/1.67
DK_600_20K	2.31	36.4	31.3	49.18/1.57
DK_1100_0	2.27	32.7	30.8	50.99/1.66
NL_460_0	2.35	29.8	25.1	42.02/1.67
NL_490_3900	2.35	30.8	26.5	41.58/1.67
NL_1100_0	2.36	29.6	25.0	41.42/1.66

2.2. Specification of Country-Specific Scenarios for Piglet Castration for the Economic Analysis of the Effects

This section specifies country-specific scenarios for analysis. The baseline reflects the actual situation of male castration in the selected countries, without analgesia or anesthesia in DE and DK, and the CO₂ narcosis in practice in NL. For the analysis of the conversion to a new castration procedure, local anesthesia is considered in the procedure of Danish farms and isoflurane anesthesia in German ones. For the Dutch farms, it is not necessary to specify the different scenarios, because the piglets are already treated with CO₂ narcosis in practice, and all parameters are considered in the Dutch data baseline. The implementation of the identified practices entails additional costs and a higher workload. For the calculations, all changes and effects on the existing production process had to be identified, specified, and quantified, and the economic effects were analyzed in cooperation with the expert group [18,20]. The economic indicators of the baselines and castration scenarios in the selected countries are represented as absolute values, as evaluated in the literature indicated in Tables 4–6. Additionally, the extra labour time was determined by experts [16] and sourced from the literature [6,22]. The additional labour is assigned to the primary workforce on a farm-specific basis and evaluated based on the assumed wage level of the baseline. Table 4 shows the specification of the change parameters for the isoflurane anesthesia scenario in Germany. This method of anesthesia for the surgical castration of piglets is legal in Germany but not allowed in other countries currently. The pig farmer can apply isoflurane him/herself. It is not allowed in Germany to apply the local anesthesia with procaine as it is in Denmark.

Table 4. Specification of the change parameters for the isoflurane anesthesia scenario in Germany [6,22].

Farm	Additional Time (Min per Male Piglet)	Cash Costs of Isoflurane and Material (EUR per Male Piglet)	Investment in the Anesthesia Device (EUR)	Prices of the Certificate of Competence (EUR)
DE_170_0	5.26	1.15	9800	300
DE_220_6300	5.93	0.96	9800	300
DE_350_0	5.70	0.90	9800	300
DE_400_12K	5.44	0.86	9800	300
DE_800_0	5.64	0.78	9800	300
DE_2490_0	5.14	0.73	9800	300

Table 5. Specification of the change parameters for the local anesthesia scenario in Denmark [16].

Farm	Additional Time (Min per Male Piglet)	Costs of Procaine and Material (EUR per Male Piglet)	Prices of the Certificate of Competence (EUR)
DK_350_5000	0.50	0.13	157
DK_600_20K	0.50	0.13	157
DK_1100_0	0.50	0.13	157

Table 6. Additional total costs of production compared to baseline in different units.

Farm	Additional Total Costs of Production		Total Cost Comparison (Percentage Change)	
	EUR per Sow	EUR per Male Piglet and per Piglet Sold	per Sow	per Male Piglet
DE_170_0_S_Iso	46.42	3.81/1.91	+2.91%	+5.83%
DE_220_6300_S_Iso	49.86	2.99/1.50	+2.52%	+5.05%
DE_350_0_S_Iso	45.80	3.35/1.68	+2.82%	+5.63%
DE_400_12K_S_Iso	28.54	1.93/0.97	+2.41%	+4.82%
DE_800_0_S_Iso	41.15	2.47/1.24	+2.08%	+4.15%
DE_2490_0_S_Iso	36.55	2.23/1.12	+2.10%	+4.19%
DK_350_5000_S_Local	3.55	0.24/0.12	+0.30%	+0.59%
DK_600_20K_S_Local	4.91	0.27/0.14	+0.30%	+0.59%
DK_1100_0_S_Local	5.05	0.31/0.16	+0.28%	+0.56%
NL_460_0_S_CO ₂	±0.00	±0.00	±0.00%	±0.00%
NL_490_3900_S_CO ₂	±0.00	±0.00	±0.00%	±0.00%
NL_1100_0_S_CO ₂	±0.00	±0.00	±0.00%	±0.00%

With increasing litter size, the time per piglet decreases. Collecting the piglets and castrating them takes the same amount of time. However, the set-up, maintenance, and cleaning of the device is constant and, therefore, higher with fewer piglets. The same applies to the expenditure, since the prices of the medication isoflurane are variable. The equipment and maintenance costs are reduced per piglet when used for a higher number of castrations. The investment for the anesthesia device is financed through fixed assets, depreciated over five years, at an interest rate of 4%. In family farms, there are no direct costs of labour, but opportunity costs for the time working in the enterprises were evaluated with country-specific wages for comparable work.

Table 5 shows the specification of the change parameters for the local anesthesia scenario in Denmark. Anesthesia with procaine for the surgical castration of piglets is only allowed in Denmark. Procaine can be injected by the farmer.

The injection of procaine takes the same amount of time (0.5 min) for each piglet and costs EUR 0.13 per male piglet.

2.3. The Procedure of Economic Comparisons

The agri benchmark Network focuses on benchmarking typical pig farms from different countries using a standard process. This comparison looks at production systems, costs, returns, and profits specifically for pig farming. Evaluating these factors helps farmers to see how competitive they are internationally. Benchmarking allows them to find ways to improve their farm's performance and increase their profits by understanding the key factors that drive success in pig farming. The baseline and the respective scenario are compared for each farm in a before-and-after comparison. The comparison means that the change in the operating economy due to the change in practice is calculated for the same time on a selected farm. A profit and loss account considers the revenues and cash costs to show short-term profitability. However, to cover the depreciation costs of the anesthesia device, as well as the opportunity costs of capital and family labour, the economic change was calculated to reflect long-term profitability. This was performed by deducting cash, labour, and opportunity costs from total returns.

The competitiveness of the three countries is also compared. For this purpose, the countries are aggregated based on their typical farms by forming average values from the results. Analyses are then carried out in several steps, as follows: the comparison of aggregated long-term profitability for baseline and country-specific scenarios in piglet production and the differences between countries in profitability and relative changes in the profitability of the three countries are all utilized to illustrate their economic competitiveness relative to each other.

3. Results

3.1. Before-and-After Comparison of Typical Farms Within Countries

The before-and-after comparison shows the changes in profitability for each farm compared to the baseline for the various scenarios applied, as follows: in German farms, the isoflurane anesthesia (Iso); in Danish farms, the application of local anesthesia with procaine (Local); and, in Dutch farms, the CO₂ narcosis (CO₂). Table 6 presents the results for the single-sow enterprises reflecting changes in long-term profitability. The changes in the level of production costs are presented in some detail.

Isoflurane anesthesia worsens the economic situation of the farms, due to profitability decline, which is between EUR 28.54 and EUR 49.86 per sow. This corresponds to the added costs per male piglet ranging from EUR 1.93 up to EUR 3.81. The increase is thus about five percent per male piglet. In Danish farms, the changes are more moderate, as follows: the profitability decreases by EUR 3.55 to EUR 5.05 per sow, due to the additional costs of the local anesthesia, which is around EUR 0.30 per male piglet. The increase is thus less than one percent per male piglet. The analysis showed no changes in the baseline of the Dutch farms, because there is no practice change calculated. The baseline already includes the practice of using CO₂ narcosis for surgical piglet castration.

To make statements about the competitiveness of the respective national piglet production sectors, the typical farms of every country were aggregated. Table 7 shows the before-and-after comparison of aggregated long-term profitability for the baselines and country-specific scenarios in piglet production.

Table 7. Before-and-after comparison of aggregated long-term profitability for the baselines and country-specific castration scenarios in piglet production.

Profitability in EUR	Germany (DE)	Denmark (DK)	Netherlands (NL)
Baseline (per sow)	−64.49	105.72	−11.44
Baseline (per piglet sold)	−2.15	3.17	−0.42
Scenario (per sow)	−105.88	101.21	−11.44
Scenario (per piglet sold)	−3.55	3.03	−0.42

On average, the producers in Germany and the Netherlands are making losses in the current situation. This can occur at times when the output prices are volatile. In the year under consideration, production is, therefore, not in a suitable position to cover the additional costs of alternative castration methods. Denmark, on the other hand, shows a high positive value. The additional costs of the anesthesia scenarios reduce the economic viability in both Germany and Denmark. In the Netherlands, the value stays unchanged.

3.2. Changes in the International Competitiveness of Piglet Production Considering Country-Specific Methods of Piglet Castration with Anesthesia

The differences in profitability of piglet production between countries, under the baseline and country-specific scenarios, show how under noted piglet production in the states is (Table 8). Danish production has an advantage of EUR 170.21 per sow or EUR 5.32 per piglet sold above German production (numbers), which rises to EUR 207.09 and EUR 5.68, respectively, due to the different anesthesia procedures. The business in the Netherlands can almost double its advantage over that in Germany. It rises from EUR 53.05 to EUR 94.44 per sow and EUR 1.73 and EUR 3.13 per piglet sold. The production in Denmark has higher profitability of EUR 117.16 per sow and EUR 3.59 per piglet sold compared to that of Dutch farms. However, under the changed scenarios, the Netherlands improves its competitive position, reducing its disadvantage relative to Denmark to EUR 112.66 and EUR 3.45, respectively.

Table 8. Differences between countries in profitability in piglet production under the baseline and country-specific scenarios.

Differences in Long-Term Profitability (EUR)	DK Comp. to DE (Basis DE)	NL Comp. to DE (Basis DE)	DE Comp. to DK (Basis DK)	NL Comp. to DK (Basis DK)	DE Comp. to NL (Basis NL)	DK Comp. to NL (Basis NL)
Baseline per sow	170.21	53.05	−170.21	−117.16	−53.05	117.16
Baseline per piglet sold	5.32	1.73	−5.32	−3.59	−1.73	3.59
Scenario per sow	207.09	94.44	−207.09	−112.66	−94.44	112.66
Scenario per piglet sold	6.58	3.13	−6.58	−3.45	−3.13	3.45
Changes in Long-Term Profitability (%)	DK comp. to DE (basis DE)	NL comp. to DE (basis DE)	DE comp. to DK (basis DK)	NL comp. to DK (basis DK)	DE comp. to NL (basis NL)	DK comp. to NL (basis NL)
Scenario per sow	21.67%	78.01%	−21.67%	3.84%	−78.01%	−3.84%
Scenario per piglet sold	23.72%	80.58%	−23.72%	3.79%	−80.58%	−3.79%
Scenario per male piglet	47.43%	161.16%	−47.43%	7.59%	−161.16%	−7.59%

Table 8 summarizes the results. It shows the changes in the relative profitability of the countries under the specified scenarios, compared to the initial baseline. The production competitiveness of the Netherlands and Denmark compared to Germany increases by 78.01% and 21.67%, respectively, per sow. The figure is two percentage points higher per piglet sold. The gap between the Netherlands and Denmark is marginal, at around 3.8% per sow and per piglet sold, with better profitability in the Danish sector.

4. Discussion

Moving away from piglet castration without anesthesia has been a key issue in European pig production for over a decade. In the “Brussels Declaration”, a unique European action has negotiated a European approach, which is implemented within the framework of national animal protection laws. For reasons of animal welfare, the three methods for piglet castration without anesthesia are evaluated differently concerning the elimination of pain. This procedure is urgently needed in Germany. The methods involve added costs at various levels. Therefore, it was necessary to compare them. This comparison has not been forthcoming in the literature to date, as a standardized database is also needed. The

typical farms from the agri benchmark Network are, however, fully comparable, due to the standard methodology of data collection across countries [17,18].

In both Germany and Denmark, the introduction of anesthesia for piglet castration leads to higher costs. The Netherlands has already completed this process and is internationally competitive, both with piglet castration and with the fattening of boars. In the three countries, in general, farms have various levels of productivity and profitability. Denmark has a clear advantage on the performance level, as well as economically, followed by the Netherlands. Following studies of individual farm effects at the national level, it was necessary to conduct a competitive analysis for concentrated markets using a comparable database [17]. Different interpretations of animal welfare legislation in relation to castration may lead to different market situations, highlighting a clear need to evaluate the differences between the individual castration methods of individual countries. It is essential for farmers to perform the anesthesia themselves, with the help of a certificate of competence, to keep the additional costs of anesthesia application at a low level [6]. German and Dutch farmers are inferior to those in Denmark in terms of the long-term profitability of piglet production. German production costs increase, and the farmers lose even more competitiveness through the application of isoflurane anesthesia. The Netherlands are also inferior to Denmark, but are catching up and improving their cost efficiency compared to Denmark. From a competitiveness perspective, the results of this study show that the deadline for the entry into force of the amendment to the Animal Welfare Act was correct. However, the question is whether this agricultural policy approach is “unconstitutional”, given that the economic interests of farmers do not allow for a fundamental intervention in animal protection law [23,24]. Since 1 January 2018, the question of competitiveness has still been unresolved. In this context, it is essential to pay special attention to Germany, Denmark, and the Netherlands as the leading piglet production countries in Europe [2]. With the ban on piglet castration without anesthesia in Germany entering into force, piglets will still be traded between the three countries mentioned. All of these piglets will have been castrated according to the respective case law. Since the method used in one country is prohibited in another, it is crucial to examine how piglet trade across Europe can be organized on equal terms in the future. However, this applies to Denmark and the Netherlands, which represent the main exporters to Germany (Table 2).

Within the European Union, the principle of free trade extends to agricultural goods, such as live pigs. This means that member states can engage in the exchange of these goods without meeting the restrictions imposed by national legislation. The free movement of live pigs within the EU promotes economic integration across borders. However, despite the principle of free trade, certain quality standards imposed by individual businesses can potentially restrict this trade. Companies may implement specific quality criteria or standards for their products, which could differ from those of other producers within the EU. Such quality assurance systems exist in all three countries. These are QS GmbH in Germany, the Danish Agriculture and Food Council (DAFC) in Denmark, and the IKB Nederland Varkens (DGB) in the Netherlands. These safety mechanisms ensure quality and standards above the national legal requirements. These institutions should, therefore, not import piglets that have not been produced and castrated according to the legal standards of the importing country [25]. QS, for example, has developed its own standards and quality criteria, which, in some cases, are less strict than those of German legislation, especially about piglet castration. These differences in standards can lead to competitive disadvantages for German piglet producers, as foreign producers who work according to less strict standards can have cost advantages. In addition, it also meets the responsibility requirements of agriculture and industry to follow and review the proclaimed rules [25]. Moreover, this is the only available mechanism to counteract the distortion of competition. The structural change in German sow keeping is drastic [26], and it is driven by the deterioration of competitiveness. Piglet exports from Denmark and the Netherlands will increase, as they can keep added costs low through more efficient castration methods. The legal argumentation suggests that German piglet producers may be able to file lawsuits

against QS. They could argue that QS violates competition law due to its dominant position and that QS's quality criteria should follow the standards applicable to Germany [25]. The German state wants to support German piglet farms with subsidies for the anesthesia stock, however, as indicated by [6], such a measure is expected to have little influence on the economic effects without a significant improvement in the competitive situation.

The aim of stopping piglet castration without anesthesia is to increase animal welfare. The abandonment of castration would have the highest positive impact on animal welfare. However, raising entire males presents specific welfare challenges as well, particularly those related to their behavior. Entire males are more active and aggressive, leading to higher risks of fighting, mounting behavior, and subsequent injuries, such as leg problems and penile injuries [27–29]. These behaviors can compromise animal welfare, especially if the social hierarchy within groups is unstable. These issues not only affect animal welfare, but also complicate management practices for farmers. Aggressive behavior is notably more pronounced in boars compared to castrated males (barrows) and females (gilts). Producing pork with immunocastration offers several advantages, particularly in terms of animal welfare and environmental impact [8], and it would also provide an economic advantage for farmers if the vaccinated male animals continued to be paid for like barrows [6].

5. Conclusions

In Denmark and the Netherlands, surgical castration methods have already been introduced, which are conducted under anesthesia or local anesthesia. In Germany, implementing the use of isoflurane narcosis by farmers is the most economical method to continue castrating piglets with a positive impact on animal welfare. The different interpretations of the “Brussels Declaration” clearly distort competition in the European Union’s internal market. This ignores the fact that surgical interventions on piglets are still being conducted. However, there are more beneficial ways of doing so from an economic and animal welfare point of view. To move the market in this direction, boar fattening and immunocastration would give rise to political measures (such as a ban on surgical castration), private-sector coordination (an exit from piglet castration through the supply chain), or quality assurance systems, which at least have the possibility of restricting trade in irregularly castrated piglets. Due to the differences between the German laws and the QS standards, German piglet producers are at a competitive disadvantage compared to foreign piglet producers, especially those from the Netherlands and Denmark, who work according to less strict standards for the elimination of pain. This study demonstrates that animal welfare regulations can reduce the competitiveness of the pig meat sector. This often necessitates government subsidies to support these less-competitive industries, leading to an inefficient use of economic resources. These findings highlight the importance of learning from these examples, as follows: other countries should ensure that the implementation of animal welfare regulations does not lead to the displacement of specific types of production or a loss of international competitiveness. Striking a balance between animal welfare standards and economic sustainability is crucial.

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