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Socio-economic Implications of Banning Conventional Farrowing Crates in EU Pig Farming: A CAPRI-based Scenario Analysis

This paper presents an analysis of the potential socio-economic implications of the European Commission's policy initiative to ban the use of cages in EU livestock farming, with a specific focus on conventional farrowing crates in the pig sector. Using the CAPRI (Common Agricultural Policy Regionalised Impact) tool, a multi-purpose comparative-static partial equilibrium modelling framework, the study examines two scenarios: an immediate phase-out of conventional farrowing crates by 2025 and a 10-year transition period until 2035. The simulation results indicate that the ban would lead to a significant decline in pork production in the EU, with production decreasing by 23.6% in the immediate phase-out scenario and by 8.4% in the 10-year transition scenario. The decline in production affects domestic demand and weakens the EU's net trade position. However, the ban would also result in an increase in consumer prices and producer prices for pork, partly moderating the decline in profits for the pig sector. Moreover, the study highlights the interconnectedness of agricultural policies and the importance of a global assessment of their impact on greenhouse gas (GHG) emissions. The simultaneous decline in EU pork exports and increase in EU pork imports trigger emission leakage: while GHG emissions from EU pork production are significantly reduced, the Global Warming Potential (GWP) of non-EU pork production increases by 4.2%. We find that the length of the transition period fundamentally defines the potential economic effects on the EU pig industry, the impacts on trade balance, and on global environmental effects. This finding emphasises that the implementation details of policy initiatives must be carefully designed to address both domestic and foreign challenges arising from the sustainable transformation of livestock farming practices in the EU.

Keywords: cage ban, pig sector, socio-economic implications, CAPRI, agricultural policy

JEL classificationa: Q13, Q18

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Introduction

On June 30, 2021, the European Commission unveiled a policy initiative (C(2021) 4747 final) (European Commission, 2021a) to ban the use of cages in EU livestock farming, including conventional farrowing crates (confinement) in the pig sector. The main objective of this paper is to analyse the potential socio-economic implications of the ban on conventional farrowing crates at both the European and global levels. It draws inspiration and recapitulates some of the key findings from the report published by Copa-Cogeca (the largest European farmers' umbrella organisation), titled *An assessment of the impacts the phasing out of cages in EU livestock farming: the pig and layer sectors*, which the authors of this paper co-authored. The findings presented here are based on scenario analyses utilising the CAPRI (Common Agricultural Policy Regionalised Impact) tool, a multi-purpose comparative-static partial equilibrium modelling framework.

There is a significant scientific literature comparing the efficiency and economic performance of sows in different housing systems, but the results presented in these studies are mixed. The variation in findings can be attributed to specific conditions such as pig breed, scale of operation, feeding systems, assumptions, and other factors under which the assessments were conducted. A major shortcoming of the literature is the generalisation of housing system descriptions without providing detailed information about their designs.

In their 2004 study, McGlone *et al.* (2004) conducted meta-analyses on scientific literature to examine the impact of housing systems on sow behaviour, performance, and physiology. Their findings showed that sows kept in individual stalls consistently exhibited equal or superior reproductive performance compared to sows in other housing systems. For instance, the farrowing rate in individual stalls was equal to or higher than in alternative systems, including group housing with dynamic social groups.

Multiple studies reported that the use of conventional farrowing crates resulted in a higher number of piglets weaned per litter compared to free farrowing pen systems (Chidgey *et al.,* 2015; Quendler *et al.,* 2009). Lactating sows in group housing systems with electronic sow feeders (ESFs) had poorer litter weaning performance compared to sows housed individually in stalls (Bates *et al.,* 2003). Furthermore, studies have shown that the incidence of piglet crushing is higher in free farrowing groups compared to sows housed in farrowing crates (Zhang *et al.,* 2020; Hales *et al.,* 2015; Buoio and Costa, 2020; Ko *et al.,* 2022). Farrowing crates consistently yielded the highest average number of weaned piglets per litter, 3-6% more than farrowing pens with temporary crating (Ko *et al.,* 2022).

Sows in group housing systems, particularly those with ESFs, exhibited higher injury scores compared to sows in individual stalls or tethers (McGlone *et al.,* 2004). Sows in free farrowing pens had a significantly higher proportion of culling, both overall and specifically due to lameness, compared to stall-housed sows. Anil *et al.* (2005) identified lameness and poor reproductive performance as the major reasons for culling sows in pens with ESFs.

Quendler *et al.* (2009) conducted an evaluation of labour time requirements and economic performance across eight different housing systems using farrowing pens and crates.

In terms of labour demand, sow pens had the highest time requirements for routine, special, and monitoring tasks, ranging from 4.20 (farrowing crate) to 5.99 (farrowing pen) hours per sow per year. The difference in labour time for sow pens was as high as 22.3%, while for farrowing crates, it was less than 10%, indicating more efficient work operations. The output per sow or piglet varied based on litter size and piglet weight, with gross margins for the systems ranging from €318 (farrowing pen) to €412 (farrowing crate) per sow per year, or €16.5 (farrowing pen) to €19.6 (farrowing crate) per piglet sold. Notably, significant gross margin differences of up to 29.3% were observed for sow pens compared to up to 7.7% for farrowing crates, highlighting variations in design.

The CAPRI scenarios presented in the followings were designed based on these findings and on data for individual EU Member States from the InterPIG (a global network of pig sector economists and experts) 2021 database.

Methodology

CAPRI was specifically developed for analysing the agricultural sector, with a primary focus on the European Union (EU). Those interested in detailed information about CAPRI can refer to the documentation (2022).

CAPRI was designed to assess the potential impacts of agricultural, environmental, and trade policies in advance (ex-ante). It consists of two interconnected main components: a set of supply models for the European agricultural sector and a market module which covers global agri-food markets.

The supply part of CAPRI calculates the optimal EU agricultural supply by maximizing profits and then passes this information to the market module. Conversely, the market module calculates adjustments in global agri-food trade and provides price feedback to the CAPRI supply models. This interconnectedness ensures a comprehensive evaluation of policy impacts on the agricultural sector.

The CAPRI database reconciles various data sources in a consistent manner, aiming to produce a complete database for the simulation exercise. The CAPRI database is composed of several parts, constructed in a sequence:

1. starting from the Complete and Consistent (COCO) database for the European countries,
2. the regionalised database for European NUTS-2 regions (CAPREG), which is the regionalised version of the COCO database and includes additional (regional level) domains from Eurostat, and data from the Farm Structure Surveys (FSS) and the Farm Accountancy Data Network (FADN),
3. the FAOSTAT global database for international agri-food markets, which serves as the key data source for the market module of CAPRI,
4. and additional databases, such as a database on EU agricultural policies, including financial subsidies under the EU Common Agricultural Policy (CAP), covering both direct payments and rural development support, and a database incorporating several domains from Eurostat in a consistent form (CAPRI-FAO database).

Pig breeding and pig fattening are two separate but interlinked activities in CAPRI. The pig breeding activity produces piglets for fattening, as well as meat from sows after their productive life cycle is over. The pig fattening activity uses piglets as production inputs and produces pork as the primary output. Both activities produce manure, depicted in CAPRI with its NPK-nutrient content, which is treated as a partly marketable intermediate product. In most regions, it has value for covering the nutrient needs of crops as a fertiliser source. Figure 1 depicts the relevant production inputs and outputs of the two pig activities.

Assigning herd size, process length, activity levels, yields, and other production-related data to the countries and sectors often requires significant re-aggregation from the slaughtering statistics. Furthermore, technical coefficients are also consolidated in the respective data consolidation models of the COCO database. These consolidation models aim to complete the often-incomplete time-series/input data

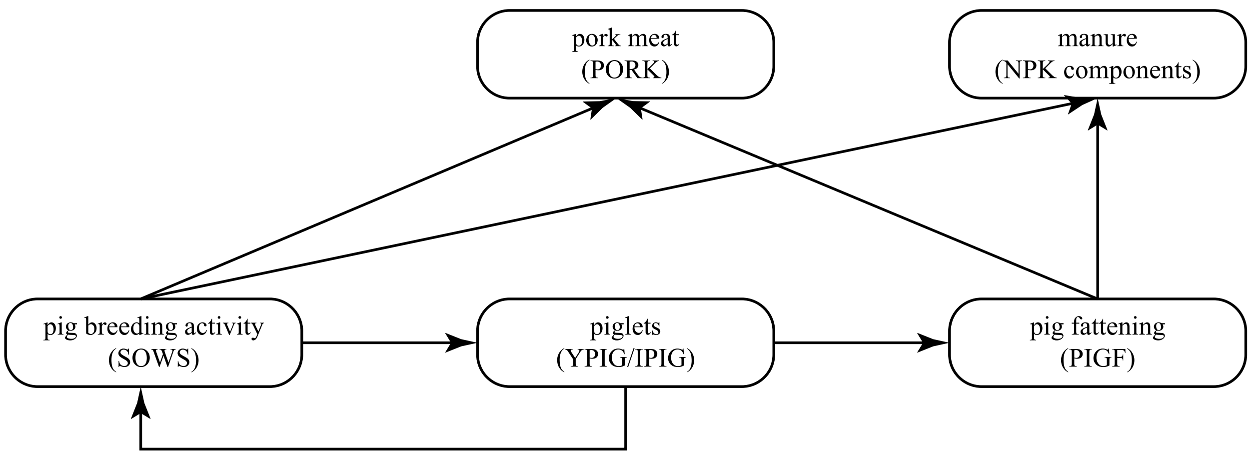

Figure 1: Input-output flows of pig activities in CAPRI.
Source: Own compilation

Table 1: InterPIG prior information in the CAPREG cost allocation model.

CAPRI cost item	InterPIG data
Feed cost (FEED), including own produced (fedg) and purchased feed (fedp)	Feed cost per sow/year (EUR)
Pharmaceutical inputs (IPHA)	Vet-Med & breeding cost per sow/year (EUR)
Maintenance and buildings related costs (REPM, REPB)	Building & equipment maintenance per sow place/year (EUR)
Electricity and heating costs (ELEC, EGAS)	Energy cost per sow/year (EUR)
Other costs (INPO)	Miscellaneous costs per sow/year (EUR)

Source: Own compilation

and ensure consistency between different data sources and the CAPRI structure.

Data from the InterPIG database for 2021 were collected to refine physical efficiency parameters and improve cost estimations for pig breeding[1]. The InterPIG dataset includes country averages from major pig-producing Member States and some Eastern Member States of the EU.

The standard CAPRI approach derives sow replacement rates from annual livestock inventories, assuming sows are first mated at 240 days old. For this study, country-specific replacement rates were obtained from the InterPIG database. These new rates directly impact input coefficients for pig breeding.

The adjusted physical efficiency parameters were incorporated into the COCO database generation part of CAPRI. The baseline process adopts these new values and adjusts the projected physical efficiency parameters for selected years as possible deadlines for full transition.

CAPRI uses FADN data to estimate input use and costs for production activities. The FADN database covers the EU with standardised questionnaires for farm accounts. However, production costs are not detailed at the agricultural activity level. Thus, input/cost allocation models were developed.

Input (or cost) allocation describes how aggregate input demand is distributed to production activities, with resulting activity-specific input coefficients measured in value (e.g., €/ha) or physical terms (e.g., kg/ha). For inputs other than nutrients and feed, FADN sample results were combined with current national input demand from the Economic Accounts for Agriculture (EAA) and standard gross margin estimations using the Highest Posterior Density (HPD) framework.

CAPRI's cost estimation follows a Bayesian approach, maximising the HPD estimator with prior information and structural constraints. The prior information includes: (1) FADN-based estimates at the activity level, (2) unit value statistics from EAA, and (3) standard gross margins from Eurostat. Input coefficients and costs were estimated for historical and base years in CAPREG. Base year estimates were then projected for agreed-upon simulation years, considering input-saving technological progress and macroeconomic inflation projections.

The cost estimation for pig breeding was extended with additional prior information from the InterPIG database for 2021, covering feed, veterinary costs, building and equipment maintenance expenses, energy, and miscellaneous costs (Table 1).

CAPRI baseline

To model alternative transition periods, the CAPRI baseline was simulated for 2025 and 2035 using the same calibrated model. The CAPRI baseline includes approved agricultural, environmental, and trade policies, including measures from the 2014-2020 CAP implemented at the EU Member State or regional level. The future development of agricultural markets was calibrated to the European Commission's medium-term outlook for agricultural markets and income (European Commission, 2020). This outlook provides commodity market projections within a consistent modelling framework, using external sources for assumptions on macroeconomic developments (GDP growth, exchange rates, crude oil prices, inflation, and population growth).

Himics *et al.* (2014) provide more details and a comprehensive discussion of the CAPRI calibration process. For 2035, beyond the time horizon of the EU Agricultural Outlook, we extrapolated and supplemented the European Commission's projections with additional information from other sources, such as projections from the GLOBIOM and PRIMES models, to arrive at the CAPRI reference scenario for 2035.

First, trend projections were prepared from the historical period up to 2035. The base year for the CAPRI version used in this study is 2017, a three-year average of 2016-2018. The CAPRI database included data up to 2019. After this ex-post period, projections for agricultural markets and agricultural production were established.

To validate the CAPRI baseline, key baseline results were compared to historical data/statistics and projections from other studies and modelling exercises. The validated baseline results include market developments in the sectors of interest, covering EU agricultural production and demand, prices, and international trade. Data sources for the comparison included Eurostat, FAOSTAT, national statistics on agricultural production and prices, and preliminary AGMEMOD baseline results from 2022.

[1] InterPIG EU Member States include Austria, Belgium, Czech, Denmark, Finland, France, Germany, Ireland, Hungary, Italy, Netherlands, and Spain. Of the non-InterPIG EU countries, for Poland data were provided by Edward Majewski and Agata Malak-Rawlikowska from the Warsaw University of Life Sciences, for Portugal and Greece the French InterPIG data, for Bulgaria, Croatia, Romania, and Slovakia the Hungarian InterPIG data, for Lithuania the Polish data were used. The sow herds in Cyprus, Latvia, Estonia, Slovenia, Luxembourg, and Malta are too small to be taken into consideration for any adjustments.

Scenario assumptions

The scenario exercise is a comparative static analysis that compares the simulated state of the economy with the policy change (i.e., the full implementation of the ban on the use of cages in EU livestock production as part of the revamped EU animal welfare legislation) to the baseline.

In the CAPRI simulations, switching to alternative housing systems in the pig sector includes the use of temporary crating or non-confinement in farrowing, or specialising in fattening. The pig sector simulations cover two different transition periods: (A) an immediate phase-out by 2025, and (B) a 10-year transition period until 2035.

- Scenario A (immediate transition, full EU policy impact): In this scenario, all farmers are assumed to transition by January 1, 2025.
- Scenario B (transition by 2035, full EU policy impact): In this scenario, farmers are assumed to refrain from further transitioning before the deadline. However, it is important to note that this assumption does not consider the future ban on conventional farrowing crates set by national legislation in Austria (by 2033) and Germany (by 2036). This is because the minimum recommendation for farrowing pen footprint by the European Food Safety Authority Panel on Animal Health and Welfare is 6.6 m² per sow, which is higher than the minimum set by national legislation in both Austria (5.5 m²) and Germany (6.5 m²). Additionally, in Germany, incentives to invest in modernising pig farms are assumed to be limited due to producing losses over the past 5 and even 10 years, on average, as indicated by InterPIG data.

Both scenarios use a 5% nominal social discount factor, as recommended by the Commission (European Commission, 2021b). The differences between livestock housing systems were grasped through technological parameters gathered from literature reviews and expert consultations. These parameters were then converted into changes in the input/output efficiency of the CAPRI production activities, except for Sweden, which already has compulsory free farrowing systems since 1993, and Finland, where comparable values were provided by the largest pork integrator in the country.

The following technical parameters were considered in setting up the scenarios:

1. sow replacement rate: +22.0% (capped to not exceed the corresponding value for Sweden from the 2021 InterPIG database)
2. litters per sow/year: -1.9%
3. pre-weaning mortality: +17.0% (capped to not exceed the corresponding value for Sweden from the 2021 InterPIG database).

Other technical parameters were included in the CAPRI analysis only through their impact on costs. For instance, changes in stocking density or the need for additional space were combined as investment cost assumptions, while labour intensity indicators influenced labour costs.

The transition to alternative housing systems also affects feed costs. Although direct feed cost estimations were available for the various systems, the approach used in CAPRI was to model changes in feeds by modifying related technical parameters. This was because CAPRI employs a cost-minimising modelling approach for feed, deriving feed costs from feed use/feed mix and the corresponding feed prices.

The feed-related technical parameters in CAPRI include those that define feeding efficiency and feed requirements for sows. When these feed efficiency-related parameters were adjusted due to the transition to alternative housing systems, feed costs were affected. Specifically, for sows kept in temporary and non-confinement stalls, an increase of 7.3% in kg of feed per sow per year was assumed, based on AHDB (2020).

The transition to alternative housing systems incurs additional costs, which can be categorised as follows: (1) the cost of investing in new buildings and equipment, (2) costs associated with decreasing physical efficiency, and (3) costs related to increasing labour intensity. The compliance cost estimations were derived from a systematic comparison between cage-free compliant and non-compliant housing systems. The comparison was based on economic and technological indicators collected from literature and experts.

The estimated changes in specific production cost elements for sows kept in temporary and non-confinement stalls are as follows:

1. Vet-Med and breeding cost per sow/year: +7.5%
2. energy cost per sow/year: +1.0%
3. building and equipment maintenance per sow/place: +63.9%
4. miscellaneous costs per sow/year: +1.0%
5. average cost of labour per sow: +22%.

An increase of 30% in the average cost of sow places with temporal and non-confinement was estimated at the country level. This estimation was based on expert consultations, extensive literature reviews, and InterPIG country-specific data. The significant cost increase is attributed to factors such as the need for increased space and circumference of individual pens, the creeping area, and the special equipment required for temporal confinement (AHDB, 2020; Baxter *et al.,* 2011; Seddon *et al.,* 2013).

The average cost of sow places with temporal and non-confinement reflects the average investment required for implementing alternative housing systems in both existing and new buildings.

A market premium for cage-free products is not considered in the analysis due to two main assumptions: (1) the price premium for cage-free products will erode as the entire sector transitions to alternative housing systems, (2) all consumers, including price-sensitive ones, will shift to consuming cage-free products, driven by the EU's demand for compliance of imported goods with EU animal welfare rules, which will result in conventional system products not being available on the EU market.

Despite the absence of a market premium, the CAPRI simulations do yield new producer and consumer equilibrium prices for the relevant products, which represent the average for pork from different alternative housing systems. In the partial equilibrium framework of CAPRI, the increase in consumer prices is triggered by the rise in average production costs. This is significant since the demand for food items in the EU is relatively inelastic. Consequently, compliance costs are largely passed on to consumers in our analysis by design.

Table 2 presents the assumed share of free farrowing sows in commercial pig farms across EU Member States. As official EU statistics are not available, estimates were provided by InterPIG experts. For non-InterPIG EU Member States, the estimates for the current share of free farrowing sows were derived from consultations and by considering similarities in the pig sector between countries.

Results and Discussion

In the following section, we present the simulated impacts on supply balances and prices, with a focus on the income effects, which serve as the main drivers of the optimisation philosophy behind CAPRI. Additionally, we will discuss the most significant environmental aspects from the global perspective.

The modelling exercise outcomes are reported as percentage differences, representing the net change induced by the new policy (ban on conventional farrowing crates) against the CAPRI baseline for specific simulation years (2025 and 2035).

Pork production in the EU is projected to decline markedly in both scenarios, with the rate inversely proportional to the time frame envisaged for implementing the new policy. Production plummets by 23.6% against the CAPRI baseline when farmers are required to transition immediately (Scenario A). However, extending the transition deadline by 10 years (Scenario B) significantly lessens this negative development to 8.4% (Table 3).

Depending on the length of the transition period, the decline in pork production triggers changes across the EU meat supply balances. The model predicts two major effects: (1) a decrease in domestic demand and (2) a weakening of the pork trade balance. The decrease in the domestic use of pork is primarily marked in the short-term horizon for the EU-27, with 8.8% in Scenario A (Table 3). Regarding trade, the EU is not a major importer of pork on the global market, sourcing less than 200 thousand tonnes of pork (live animals and processed products included) from third countries annually between 2019-2021 (Eurostat – Comext, not shown). Nevertheless, in Scenario A, pork imports surge almost eleven-fold in volume terms against the CAPRI baseline as production declines drastically, and net trade of the EU-27 crumbles by 93.5%. The dependence on imported pig meat appears considerably smaller when the transition deadline is shifted from 2025 to 2035, increasing in Scenario B to 92.7% (Table 3).

A comparison of pig farming across the EU macro-regions (EU-14 and EU-13) provides important insights into the scenario outcomes. Regardless of the length of the transition period, the new policy appears to have a lasting dividing effect on the economic performance of the EU-West (EU-14) and EU-East (EU-13) livestock sectors. Irrespective of the transition period's length, the percentage decline in pork supply is considerably higher in the EU-East compared to the

Table 2: Assumed share of commercial sow herds in temporal and non-confinement housing systems in EU Member States.

<table>
<tr><th rowspan="2">EU-14</th><th colspan="2">Scenario</th><th rowspan="2">EU-13</th><th colspan="2">Scenario</th></tr>
<tr><th>A</th><th>B</th><th>A</th><th>B</th></tr>
<tr><td>AT*</td><td colspan="2">5%</td><td>BG</td><td colspan="2">1%</td></tr>
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<tr><td>FR*</td><td colspan="2">4%</td><td>LV</td><td colspan="2">5%</td></tr>
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<tr><td>PT</td><td colspan="2">1%</td><td>SI</td><td colspan="2">5%</td></tr>
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Note: * = EU Member States of InterPIG.
Source: Own compilation

Table 3: Estimated changes in the EU pork balance against the CAPRI baseline in response to the ban on conventional farrowing crates.

	EU-27		EU-14		EU-13	
	Scenario		Scenario		Scenario	
	A	B	A	B	A	B
Supply	–23.6%	–8.4%	–21.2%	–7.9%	–37.2%	–11.4%
Domestic use	–8.8%	–2.0%	–7.2%	–1.5%	–13.5%	–2.0%
Imports	+1,086.4%	+92.7%	533.8%	75.3%	3,135.1%	131.3%
Exports	–87.1%	–39.3%	–86.8%	–38.7%	–96.1%	–56.4%
Net trade	–93.5%	–40.0%	–89.6%	–39.2%	–212.0%	–66.9%

Source: Own compilation

EU-West (Table 3, and for estimated changes at the Member State and NUTS-2 levels see Figure 2). The stronger resilience of the pig sector in the EU-West is highlighted by the changes in trade indicators. In fact, the decline in production is better offset by the drop in exports, making trade with third countries act as a buffer, absorbing most of the loss.

The average producer price of pork surges by 47.4% in the EU-27 against the CAPRI baseline in Scenario A (Table 4). When a 10-year long transition period is allowed (Scenario B), the rise in the producer price for pork becomes much smaller due to a more moderate shock caused by the ban on cages compared to Scenario A under the prevailing market conditions projected in the CAPRI baseline.

Increases in consumer prices are, in part, driven by the increases in production costs, resulting in a 15.3% hike for pork against the CAPRI baseline at the level of the EU-27 in Scenario A. Both producer and consumer prices for pork exhibit a larger increase in the EU-East (Table 4). This is due to the lag in transitioning to cage-free housing systems in the EU-13. It is important to note that in the CAPRI baseline, producer prices of pork remain at a higher level in the EU-West throughout the projection period.

Profits in the pig sector of the EU-27 shrink by a considerable 37.8% against the CAPRI baseline in Scenario A (Table 5), explaining the sizeable decline in pork production. Although the estimated impacts on profits in the pig sector erode over time, the 28.2% drop in Scenario B can still be considered relatively high.

Taking a closer look at the EU macro-regions, the profit loss in the pig sector is markedly higher in the EU-West (41.5%) than in the EU-East (21.6%) in Scenario A (Table 5). However, this position appears to reverse over time due to the improving relative competitiveness of the pig sector in the EU-West (Scenario B).

The ban on conventional farrowing crates in the EU pig sector would have significant repercussions on the production and consumption of agricultural products in non-EU countries. In terms of greenhouse gas (GHG) emissions, it becomes evident that non-EU pork production would experience a 4.2% increase in Global Warming Potential (GWP) against the CAPRI baseline (Table 6), amounting to 5.76 million metric tons of CO_2 equivalent. This increase is primarily driven by the declining exports of pork from the EU-27 and the rising demand for imported pork in Scenario A.

In contrast, within the EU-27, pork production sees a notable reduction in GHG emissions, with a 22.3% drop in GWP (equivalent to 7.94 million metric tons of CO_2 equivalent) when compared to the CAPRI baseline (Table 6). Consequently, at the global level, the overall GWP of the pig sector declines by 1.3%.

Table 4: Estimated changes in EU pork prices against the CAPRI baseline in response to the ban on conventional farrowing crates.

Prices	EU-27		EU-14		EU-13	
	Scenario		Scenario		Scenario	
	A	B	A	B	A	B
Producer	+47.4%	+11.0%	+45.6%	+10.7%	+57.6%	+12.9%
Consumer	+15.3%	+3.2%	+14.5%	+2.9%	+17.9%	+4.2%

Source: Own compilation

Table 5: Estimated changes in the profits of EU pork against the CAPRI baseline in response to the ban on conventional farrowing crates**.**

	EU-27		EU-14		EU-13	
	Scenario		Scenario		Scenario	
	A	B	A	B	A	B
Profits	–37.8%	–28.2%	–41.5%	–27.5%	–21.6%	–31.7%

Source: Own compilation

Table 6: Estimated changes in the GWP of the EU, non-EU, and global pork sector, measured in CO_2 equivalents (net emissions).

	EU-27		non-EU		World	
	Scenario		Scenario		Scenario	
	A	B	A	B	A	B
GWP	–22.3%	–7.9%	+4.2%	+1.7%	–1.3%	–0.2%

Source: own compilation

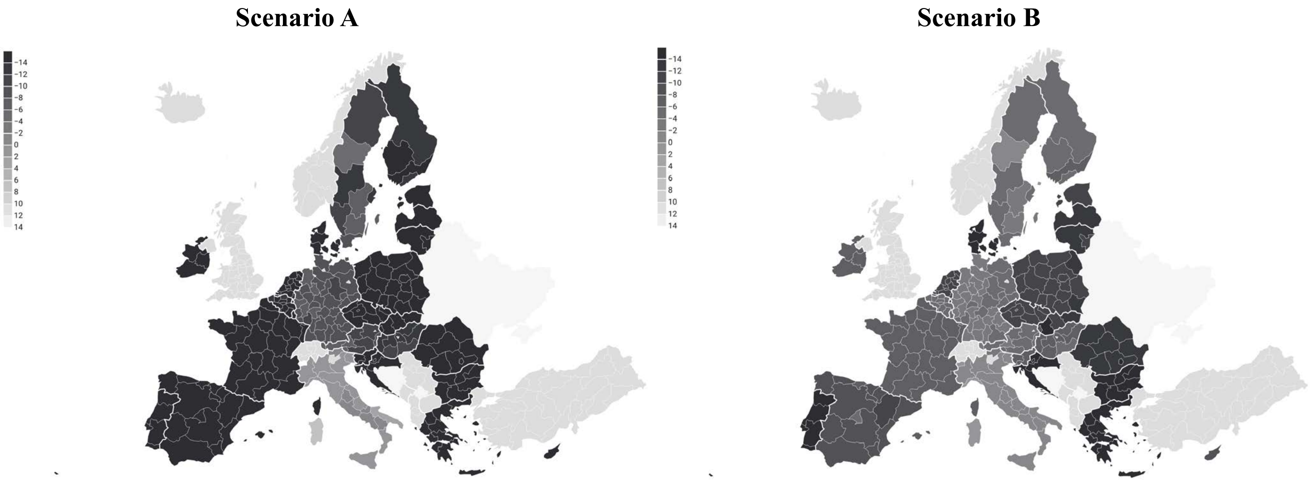

Figure 2: Estimated changes in pork production at the NUTS-2 level of individual EU Member States against the CAPRI baseline in response to the ban on conventional farrowing crates in Scenario A and B.

Note: NUTS2 regions with missing data are intentionally left empty, but recently reorganised region's data are interpolated. Note that for some countries with multiple NUTS2 regions CAPRI provides only country-level representation (i.e., DK, LT, SI, CR).

Source: Own compilation

Conclusions

Agricultural policy design in the European Union is becoming increasingly sophisticated, posing challenges for the modelling community to fully capture the complexities of upcoming legislation. It can be likened to an arms race, where only a few modelling tools can keep pace with the rapid output of the European Union's legislative measures, providing reliable *ex ante* quantitative assessments before enactment.

This paper focuses on one policy initiative linked to the animal welfare enhancing efforts within the broader context of the EU's Farm to Fork and Biodiversity Strategies. Using a comprehensive modelling approach, the impact of one specific sector (the pig sector) is evaluated in detail. Our simulation results suggest that implementing the ban on conventional farrowing crates would lead to reduced pork production in the EU, with trickle-down effects on the EU's trade balance. That decrease in pork production translates to profit losses for the European pig industry, which are only partly offset by higher consumer prices. We also find that these simulated impacts largely depend on the transition period. In Scenario B, where compliance is delayed by a decade, the adverse effects of transitioning are mitigated, by allowing ample time to fully depreciate fixed assets typical in the industry, resulting in less than a 10% drop in supply.

Like our results, a draft report from DG SANTE (European Commission, 2021a) also recommends a 10-year phase-in period for the ban, which could reduce the overall economic loss by providing sufficient time for the orderly market exit of the most vulnerable smallholders. Our results also underline that the ban on farrowing cages not only impacts domestic production and consumption in the EU but also global GHG emissions. The decrease in EU pork meat exports leads to an increase in GHG emissions elsewhere, as some non-EU countries increase their pork production and exports to take over market shares on global markets. Our findings thus highlight the multifaceted impacts of agricultural policies and their impact on global climate and environment. Policymakers should consider the potential ripple effects of agricultural and food policies (here an animal welfare enhancing ban on farrowing cages) and develop comprehensive strategies to deal with the trade-offs between domestic and foreign economic and environmental impacts.

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