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The regulations for the protection of the environment in selected EU countries: recent evolution

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Differences between national legislations are often accused of being one of the causes of the discrepancies in the development of pig farms and value chains between the European countries. In order to have a better understanding of these differences and foresee the next evolutions, 18 environmental experts in the five main pig producing countries in the EU (Germany, Spain, France, Denmark, and the Netherlands) were interviewed. They scored the impact of the main environmental constraints affecting the development of the pig farms in their own country, for both the present situation (2016) and within the next five years. Eight topics were scored and discussed, concerning manure management, airborne emissions, and administrative procedures for being granted a permit. The main European and national laws, as well as technical standards and numerous expert reports were used to discuss the interviewed experts' assessments. The results tend to show that different rules were applied in the five countries. Spain seems to be a unique case because its development relies on low costs and also low environmental constraints. Germany benefitted from more favorable manure spreading standards during the early 2000's, but those conditions have now changed. On the other hand, France, Denmark and the Netherlands were subject of tougher laws and standards: extreme density and high manure disposal costs in the Netherlands, authorization procedures and obligation to use treatments in France, restrictive spreading rules in Denmark. Nowadays and in the near future, there is no evidence that any of these four countries benefits from a competitive advantage due to the enforcement of European environmental directives.

Les réglementations pour la protection de l'environnement dans quelques pays de l'UE : évolutions récentes

Les différences entre réglementations environnementales nationales sont régulièrement accusées d'être l'une des causes des disparités de développement des élevages de porcs et des filières entre pays de l'UE. Afin de mieux apprécier ces différences et envisager les prochaines évolutions, 18 experts en environnement des cinq principaux pays producteurs de porcs en UE (Allemagne, Espagne, France, Danemark, Pays-Bas) ont été interrogés. Ils ont hiérarchisé les principales contraintes environnementales affectant le développement de l'élevage dans leur pays, à la fois dans la situation actuelle (2016) et à un horizon de cinq ans. Huit thèmes ont été abordés, portant sur la gestion des effluents liquides et solides, les rejets atmosphériques, les procédures administratives de permission d'exploiter. Les principaux textes européens et nationaux (directives, lois, normes techniques) et de nombreux rapports d'expertise ont été analysés pour discuter des avis des experts. Les résultats vont dans le sens d'une appréciation différenciée de la situation entre les cinq pays. L'Espagne semble être un cas à part dans la mesure où son développement repose sur un modèle à bas coûts et faibles contraintes. L'Allemagne a également bénéficié de normes d'épandage plus favorables au début des années 2000, mais ces conditions sont aujourd'hui révolues. La France, le Danemark et les Pays-Bas ont en revanche été l'objet de réglementations et normes plus contraignantes : densités animales extrêmes qui ont pour conséquence des coûts de gestion des effluents très élevés aux Pays-Bas, procédure d'autorisation d'exploiter et obligation de traitement dans les ZES en France, normes d'épandage restrictives au Danemark. Actuellement et dans un proche avenir, il ne semble qu'aucun de ces quatre pays ne dispose d'un avantage concurrentiel consécutif à la transposition des directives européennes sur l'environnement.

Keywords: Regulations, environment, competition, European Union, pig farms
Mots clés : Règlementations, environnement, concurrence, Union européenne, élevages de porcs

Introduction

Over fifty years of fast-expanding farm and farming-region specialisation has changed the make-up of farming in Europe, where livestock production sectors have increasingly coalesced into strongly geographical concentrations (Le Goffe, 2013; Roguet *et al.*, 2015). Nowhere is this process more apparent than in the pig/pork sector, where the top ten administrative regions of EU-28 for pig/pork output in 2015 hold 49% of the EU's pig herd yet represent just 8% of the EU's UAA.
In a pre-emptive effort to contain and control the pollution risks inherent to geographic over-concentration, the EU member states and pan-EU authorities moved in the mid-1980s to start setting up specific regulatory and administrative measures. The 1990s brought a surge in momentum behind environmental protection and sustainable development issues that propelled the EU to the forefront of environmental policy. The sheer number of EU directives on environmental protection translates how the member states are committed to harmonizing the resources deployed to drive environmental policy forwards.
However, what is not harmonized is the way the EU directives are transposed into national law, and there are divergences—sometimes big divergences—that, in practice, artificially create market distortions between production-centres regions inside Europe. **These "competitive distortions" are regularly singled out as one of the major causes of disparity in livestock farm and sector development between EU countries** (Daridan *et al.*, 2004; CRPA, 2014).

Here we led a study to compare the main sets of EU legislation on environmental protection and their national **transpositions in force in 2016 in Europe's big five producer countries, i.e. Germany, Spain, France, Denmark and the Netherlands.** Complementary information obtained in 2016 from 18 national experts from these big five countries served **to gain a sharper picture of the differences in how standards and regulations are implemented.** These experts were asked to rank the **regulatory factors that they deemed most strangled the current pig farming economy in their own country, and to evaluate the trajectories these regulations are expected to take over a five-year horizon.**

Material and Methods

Analysis of the standards and regulatory instruments

The EU uses numerous legislative acts for environmental policy, but some of them are thought to have a bigger impact on growth and development options for pig farms and the pig farming economy. Interviews with the 18 experts from the big five countries under study highlighted the major role played by five directives: the nitrates directive (91/676/EEC), the water framework directive (2000/60/EC), the industrial emissions directive (2010/75/EU), the environmental impact assessment directive (2011/92/EU), and the national emission ceilings directive (2001/81/EC).

The implementation of these five directives in the five countries studied gave rise to **38 pieces of national legislation** that were included in the analysis. There is no strict correspondence between national and EU-level enactments: the implementation of an EU directive may get diluted down into several national laws or, conversely, these national laws may overlap up into several EU directives, and add provisions that are not set at pan-EU level. Our analysis also focused on the **many technical standards and policy guidelines used to implement the regulations.**

An extensive literature review was led to complement our reading of the national norms, standards and pieces of legislation, with a focus on source material detailing how the regulations get implemented in the five target countries and the consequences on the pig farming economy. On top of the 18 interviews purpose-led specifically for this study, we also mobilized 13 interviews led in July and August of 2013 as part of an earlier project (8 interviews in Germany, 4 in Denmark, 1 in the Netherlands), as they usefully informed our understanding of how standards and regulations are implemented in these three countries.

Interviews with the experts

We interviewed 18 experts face-to-face or by videoconference, between May and July 2016. Eleven of the 18 experts were environmental research and engineering specialists (Table 1), another three were jurists, and the last four were economists. The organizations employing these experts were producer groups and associations (n=5 experts), technical institutes, research centres and universities (n=10 experts), administrative authorities (n=2), and a design-engineering office (n=1).

Table 1: Specialist field of the 18 experts interviewed

	Environmental science	Law	Economics
Germany	2		2
France	6	2	
Denmark	1	1	1
Netherlands	1		1
Spain	1		
Pooled total	11	3	4

The experts were interviewed with open-ended questions on the constraints that environmental regulations impose on pig farms in their home country. At the end of the interview, they were given a closed-ended survey asking them to

'score' the influence of eight constraints on the pig farming economy in their home country:

- **water quality: 1) nitrogen and 2) phosphorus;**
- **3) availability of land;**
- **4) administrative constraints;**
- **5) public opposition to pig farming projects;**
- **air quality: 6) ammonia, 7) odour nuisance, 8) particulates.**

Each expert thus scored the incidence of these 8 items on a scale of one of 10, where 10 is a maximal constraint and 1 is practically zero constraint. The scores were collected and compiled to characterize the current situation, but also the projected 5-year-horizon situation, in order to highlight those constraints that the experts feel are set to become tighter. The result for Spain is not charted as it comes from the opinion of just one expert.
In an effort to harmonize the picture across countries, we produced a linear plot of the 16 mean scores obtained for each country on a scale of 1 to 5 (Table 2).

Calculation of a nitrogen fertilization indicator

Mineral nutrient losses

Each country employs baseline-reference losses to calculate the mineral N losses in kgN and mineral phosphorus losses in kg P_2O_5 of a farrow-to-finish operation per sow in the herd. In every country studied, the baseline-reference losses used correspond to pigs reared on wall-to-wall **slatted flooring**, with no emissions-reducing techniques other than **two-phase feeding**. Number of pigs produced per sow is identical across countries (22.9), but the **weights of pigs exiting the farm to market** correspond to the national averages, which range from 100 kg liveweight in Spain to 119.5 kg in Germany (107 kg in Denmark, 110 kg in the Netherlands and 112 kg in France).

Standard land application values

These manure nitrogen and phosphorus losses are squared up against the field-spreading options authorized under the regulations in a standard-case situation of land application on a **50% corn–50% wheat crop** system on soil types representative of the big pig-producing regions, to give a mean national output. In this standard-case situation, the field area for spreading on-farm on a farrow-to-finish operation is calculated per sow in the herd (Figure 1).

Different countries face different constraints hierarchies

In Germany, France, Denmark and the Netherlands, the experts surveyed think that the main constraints on pig farms revolve around **effluent management** (the nitrogen, phosphorus and land-use constraints) and around getting **permits to operate** (administrative and public opposition constraints) (Table 2). Restrictions on **odour nuisance and ammonia emissions to air** visibly impose varying degrees of constraint between countries. **Restrictions on particulates emissions** visibly impose few constraints.

The experts surveyed qualified as strong the constraints that act as barriers to the starting pig farm projects or that drum up added outlays that farms simply cannot cope with given the current situation. That said, the demands for which pig farms have found answers to, even if they sometimes entail **extra outlay,** are deemed **less of a handicap**. These effects are relatively downplayed by the experts,— ammonia control planning in the Netherlands, for instance, is one example, as the Dutch standard-value for losses are tougher but Dutch pig farmers have already invested in emissions mitigation techniques.

Effluent management—a major constraint

High densities and limited land available

The German, French and Dutch experts flagged up **the high density of pig farms as a factor limiting further production growth.** Pig densities are already very high in places, with the south-east Netherlands for instance registering 1500 pigs/km² UAA in 2015, or certain subdistricts of north-west

***Table 2:** Current intensity of environmental constraints on pig farms (as gauged by expert opinion)*

	France	Germany	Denmark	Netherlands
Nitrogen				
Phosphorus				
Land				
Administrative				
Opposure				
Ammonia				
Odour nuisance				
Particulate matter				

Intensity of constraints in 2016 as a function of scores out of : > 3,7 ;]3,7 ; 2,3] ; < 2,3 ; . No response on odour nuisance and particulate matter from the Netherlands

Germany registering over 1000 pigs/km² UAA (Roguet, 2013). The fact that pig farmers struggle to find available farmland translates into prohibitively **high land prices and increasing reliance on expensive effluent management methods** (long-distance manure export, treatment solutions). Land price inflation has been contained in France by national land-use policy and compulsory treatment plants in ZES ('structural surplus zones') up until 2014.
These high pig densities, pushed by **economies of agglomeration** at every step in the value chain (Roguet *et al.*, 2015), are precisely one of the main causes driving environmental regulations to tighten up, in an effort to constrain all further pig farm expansion.

Mineral and organic nitrogen fertilization

According to the experts, **management and control of mineral and organic nitrogen fertilization** is one of the big constraints in France, Denmark and the Netherlands. Germany is visibly less affected under the current legislation, although there are reforms in the pipeline.

The extension of **nitrate-vulnerable zones** (NVZ) under the nitrates directive is the biggest differentiating factor between countries. Whereas Germany, Denmark and the Netherlands have elected to class their entire territory as NVZ, France and Spain chose to only designate their most nitrogen-vulnerable areas, **leaving 70% of UAA mapped as NVZ in France** (essentially the north–west half of the country plus a swathe of the south-west), **but just 17% in Spain,** where a majority of the Autonomous Communities have simply not designated vulnerable zones. The European Commission has been petitioned with dispute claims on this issue several times since the late 1990s (Gault *et al.*, 2015). In Catalonia—a big livestock centre (home to 27% of the Spanish national herd) and also dependent on intensive irrigated farming—NVZs cover 70% of UAA.
Inside NVZs, the two big disparities between the countries under study concern **i) the ceilings capping the amount of livestock manure that can be spread and ii) the measures framing compliance on balanced mineral and organic nitrogen fertilization.**

Denmark stands out here, as the field-spreading manuring of pig and poultry-farm effluent has long been capped at **140 kg N/ha** against 170 kg organic N/ha in the other countries. Since 2017, this limitation has been lifted to 170 kg N/ha for pig finishing operations, as a measure to curb the decline in number of finisher-unit places in the country. Certain countries have managed to secure substantial derogations on this maximum nitrogen fertilization rate of 170 kg N/ha. **Dutch farmers can spread up to 250 kg N/ha** on grassland if at least 70% of their holding is grass, with slightly tougher restrictions on sandy and loam soils where the ceiling rate is 230 kg N/ha if at least 80% of their holding is grass. This grassland derogation applies to 32% of Dutch holdings and 45% of Dutch UAA (Gault *et al.*, 2015). **Denmark** runs this same kind of grassland derogation, capped at 230 kg N/ha, but it concerns just 4% of its UAA. **Germany** had a similar grassland derogation capped at 230 kg N/ha that concerned less than 1% of its UAA, but the EC has postponed the measure in 2014 pending regulatory reforms in Germany.

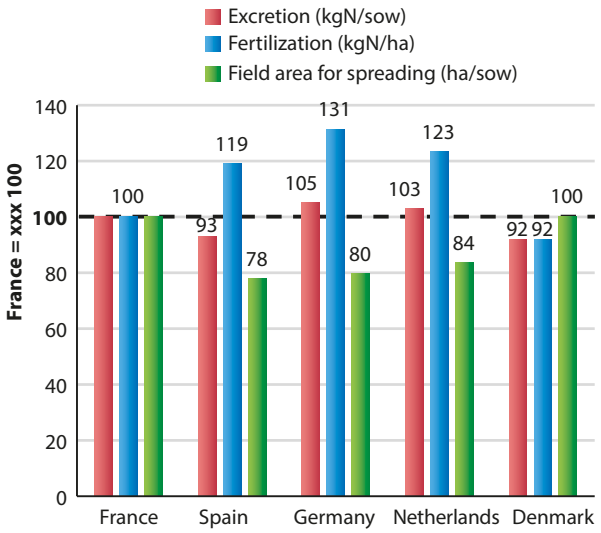

Figure 1: Nitrogen excretion from a farrow-to-finish operation and field area for spreading on-farm for nitrogen on corn–wheat crop-system (vs. France = base 100, year-2016 practice standards)

Balanced nitrogen fertilization is a principle that is implemented in all five countries studied and verified by applying standard values that are issued at national or regional scale and computed according to cropping and soil type. The permutations are huge (276 practice standards in Denmark, 210 crops and 5 soil types in the Netherlands, etc.). Assessment is performed for a standard-case farrow-to-finish operation and for land application on a 50% corn–50% wheat crop system (Figure 1).
The standard values used to calculate **the nitrogen excretion of pigs** result in few inter-country differences (compared to France: from -8% to +5% per sow). These differences are partly attributable to the differences in **the weights of finishing pigs exiting the farm to market.** In contrast, the standards of fertilization practice on a 50% corn–50% wheat crop system show greater inter-country disparity. Compared to France, area permitted for land application is 8% lower in Denmark and 31% higher in **Germany**, which is the only country studied where excess over balanced nitrogen fertilization (60 kg N/ha/year) is structurally tolerated (excluded from the assessment charted in Figure 1). Finally, field area for spreading on-farm on a farrow-to-finish operation is **identical in Denmark** and France (although the pigs are 4.5% lighter in Denmark). After accounting for the standards of land application practice,

the land areas in the standard-case situation may turn out smaller in the other countries (-16% in the Netherlands, -20% in Germany, -22% in Spain). Competitively advantageous situations (grassland derogation for spreading in the **Netherlands** with a ceiling cap at 250 kg N/ha) can result in bigger differences. Accounting for phosphorus can lead to even bigger areas needed, but is currently far short of mature practice in the countries studied.

Accounting for phosphorus

According to the experts interviewed, phosphorus management and control is a **major problem, especially in Denmark and the Netherlands**, even though restrictions on field-spreading manure phosphorus are still only partially applied in the five countries studied (Amery & Schoumans, 2014). **Spain** has not accommodated any regulations that target phosphorus directly. Restrictions on organic manure phosphorus are indirectly tied to the restrictions on organic manure nitrogen. The situation is much the same in **Denmark,** except that the ceiling capping organic nitrogen at 140 kg N/ha/year for pig and poultry manure and excreta also indirectly restricts added phosphorus input. In Germany, phosphorus, in practice, is no more limiting for the fertilization plan than nitrogen. German farmers are free to use their own methods for assessing crop phosphorus exports—on condition that they are available for auditing by the authorities, who in practice very rarely audit them, which prompts questions as to the effectiveness of this system (Amery & Schoumans, 2014).

The **Netherlands** has committed to compliance on a national-scale ceiling capping organic phosphorus input to soil (173,000 tonnes/year), which is one of the conditions for securing a derogation on nitrates directive requirements. According to soil P_2O_5 content, total phosphorus inputs are restricted to 80–120 kg P_2O_5/ha/year for permanent grassland and 50–80 kg P_2O_5/ha/year for tillage land. It has been compulsory to treat or export a share of excess phosphorus since 2014—a share fixed at 55% in the south (parts of the North Brabant and Limburg provinces), 35% in the east (parts of de Gelderland and Overijssel) and 10% in the rest of the country.

In **France**, the Loire-Brittany SDAGE* policy instrument sets **the toughest conditions**, as it forces farms that produce over 25,000 kg N/year to demonstrate compliance with soil phosphorus balance, albeit accommodating a 10% tolerance on P input over P export. For other operations governed under the Loire-Brittany SDAGE*, on-farm fertilization is limited to 95 kg P_2O_5/ha/year for poultry operations and 85 kg P_2O_5/ha/year for all others. In 14 priority catchments

**Schéma Directeur d'Aménagement et de Gestion des Eaux—policy outline for coordinated water resource use planning*

Manure spreading in the Netherlands.

from 2014 and 22 from 2016 (measure 3B1), the limits have been tightened down to 90 and 80 kg, respectively. The SDAGE also legislates that at each substantial change in the farm operation, the administrative permitting authorities can only license or register the farm if it achieves balanced phosphorus fertilization.

Permits and permitting

The German, French and Dutch experts claim that **the administrative procedures governing permit to operate are particularly heavy. Likewise, public opposition from pressure groups or local residents against pig farm projects** is deemed a particularly big barrier to permitting in **Germany and the Netherlands**.

National regulations on permits to operate apply the industrial emissions directive (IED) and the environmental impact assessment directive (EIA) in different ways. **The IED directive** stipulates that any farm counting over 2000 finishing pigs or 750 herd sows is to require a permit from **the administrative authorities.** This permit is based on an integrated assessment of the environmental impacts, comparison against the best available techniques (BAT), and public community participation. **The EIA** directive makes a detailed environmental impact assessment compulsory for farms with herd size of at least **3000 pigs or 900 sows.** Among the five countries studied, only **Denmark** requires permitting for smaller farms than specified in the IED directive: 75 pig units (PU), i.e. 2700 finishing pigs or 322 sows. Pig headcounts only add these animal categories together in Germany and Denmark, **which handicaps farrow-to-finish operations.** Simplified arrangements exist for farm sizes below the permitting thresholds (registration in France, permission in Denmark) so as to speed up procedures and cut administrative costs.

The farm-size thresholds requiring the completion of EIA-directive impact assessments are identical to the IED-directive permitting thresholds in France, Denmark and Spain, and EIA directive-compliant in Germany and the

Netherlands (3000 finishing pigs or 900 sows). Simplified impact assessment procedures are introduced for farms headcounting 2000–3000 finishing pigs or 750 –900 herd sows. These simplified procedures are designed to assess whether a full environmental impact assessment is warranted. In Germany, these simplified assessments may be required from upwards of 1500 finishing pigs in priority zones, but they very rarely lead to a full environmental impact assessment actually getting completed.
Timeframes for processing permit applications are relatively comparable between countries, and generally take **between one and two years.** Exceptional situations, in which permit to operate may not be delivered until after a three to five-year wait, also appear relatively rare in France and northern Europe, and **in many cases stem from situations where projects run into public opposition at the public consultation phase.** Costs for processing permit applications, however, are relatively different. The costs are substantially higher in **Germany** as the pig farmer has to pick up the entire public consultation bill. The environmental impact assessments, that include dispersion models of emissions to air, are very complex and very expensive. According to experts opinions, the cost to the farmer of processing a permit application amounts to around **€10K in France against somewhere between €50K and €100K in Germany.**

In France, the legislation on nitrates (production quotas and compulsory treatment in ZES structural surplus zones) **and ICPE** (facilities classified for environmental policing) in force up until 2014 has left French pig farms **with an infrastructural retrofit and restructuring gap.** However, since the pig farm registration scheme introduced in 2014, French pig farmers no longer appear to suffer major distortions of competition compared to their main European rivals. Permits to operate are generally **obtained as fast if not faster** than in the other countries studied, and sometimes at less administrative cost.

Emissions to air

The management and control of odour emissions is seen as a fairly heavy constraint in most of the countries studied, where it features as a criterion in applications for a permit to operate. Particulates emissions are not yet integrated as a vector for odour emissions, but may soon become subjected to standards.
There are huge inter-country disparities in control and planning on ammonia emissions. In application of the national emission ceilings directive, the Netherlands has committed to compliance on a particularly low national emission ceiling, which means that the compliance ceilings on ammonia emissions needed before securing a permit to operate are particularly tough. Most Dutch pig farms employ emissions-reducing techniques: air-scrubbing, partially-slatted floors, under-slat muck-out, slurry acidification, outdoor slurry pits are covered. Dutch pig farms are already compliant to tougher standards that those set to be ushered in with the new livestock-sector BAT reference documents (BREF) in 2017 (Table 3).

In **Germany and Denmark,** emissions-reducing techniques are less common but more concentrated around vulnerable ecosystem zones, and large numbers of farms have already invested in air scrubbing or other emissions-reducing techniques, on which issuance of a permit to operate is contingent. Air scrubbing is compulsory for all new farm/expansion projects requiring a permit to operate in the German Länder of Lower Saxony and North Rhine–Westphalia.

In **Spain**, the new ammonia emissions limits to be introduced in 2017 will not pose pig farmers any major problems as the baseline-reference emissions values used for pig units on slatted flooring and static-pressure ventilation systems are below these ceilings for all animal categories—except breeding sows (Table 3). **France** is likely to be more significantly hit by this upcoming emissions limits reform, since the standard values for breeding pigs and weaned piglets will exceed the emission limit values of the upcoming BREF. New farms that are bigger than EIA-directive permitting thresholds will need to invest to implement emissions-reducing techniques.

***Table 3:** Regulatory emission limit values and standard-reference emission values for ammonia (kg NH_3/place/year)*

	Emission limit values		Standard-reference emission values	
	BREF	NL2014	FR	ES
Breeding sows	2.7	2.6	3.26	3.00
Nursing sows	5.6	2.9	3.26	3.75
Post-weaning	0.53	0.21	0.68	0.27
Finishing pigs	2.6	1.5	2.49	1.81

BREF: final draft of the BREF, existing buildings on all-slatted pen flooring, NL2014: Dutch pig farms standard in force until 30/6/2015 (and then tightened). FR: GEREP, pigs farmed on all-slatted pen flooring with two-phase feeding. SP: Registro Estatal de Emisiones y Fuentes Contaminantes.

Towards tougher environmental requirements?

The experts also scored the environmental constraints as projected trajectories at the 5-year horizon. Table 4 charts the tightening of these constraints, calculated as the difference against the scores for the current situation.
The German experts expect to see much tighter constraints across the broad. This is largely because its regulatory control of **effluent management and land fertilization** showed critical inefficiencies up until the early 2010s,

which is probably what enabled pig production to continue expanding in the densest zones of north-west of the country. However, there has been a brutal turnaround since 2013. Germany has been petitioned to amend its national nitrates action programme, in the wake of the complaint filed by the European Commission.

In **France**, the issues of **restrictions on gaseous emissions** have so far had little impact compared to the competition in Northern Europe. However, the situation is likely to change with the recast IED directive and upcoming release of new BREF. French pig farms are going to have to invest in atmospheric emissions-reducing techniques, which could also have a knock-on effect of increasing the volumes of manure nitrogen for spreading.

In France, like Germany, the experts expect to see much clearer tighter rules and regulatory standards on **phosphorus**. Getting a permit to operate could also prove harder—there will likely be top-down pressure as the authorities will end up pushing pig farmers to make extra investments to curb mineral and losses and gaseous emissions, and bottom-up pressure as rising tension with civil-society will likely lead **to more and more pig farm projects running into public opposition.**

In **Denmark**, the experts expect to see increasingly restrictive emissions standards (on ammonia, phosphorus, and nitrates). However, the direction regulatory debate is taking would appear to temper this appraisal. In moves to spark a recovery in the fattening-finishing sector and contend with spiralling land prices, the professional trade associations have successfully lobbied for softer regulatory standards on spreading manure nitrogen and to simply have to comply with the ceiling set in the nitrates directive.

In the **Netherlands**, extremely high pig density figures, production quotas, high population density and agricultural zoning are all very tight constraints that strangle the options for further production growth and add to already hugely expensive effluent control costs. The Dutch experts do not see their constraints tightening up as hard as in the other countries. Given its long-standing advance in dealing with its own constraints on gaseous emissions from agriculture, the Netherlands is already on top of its game in terms of cutting ammonia emissions and does not expect to need major outlays to meet the new pan-EU emissions standards set to come into effect in 2017.

In **Spain**, the minimal transposition of EU regulations means that the constraints are relatively softer. Manure spreading options are already very limited in certain zones of Catalonia and Aragon. However, regional planning policy (clustered settlement growth) with integrator-led coordination means that there is room to develop livestock farming in lower-density zones, in which case the added cost burden is limited to the transport of feed and livestock. Phosphorus control planning and limitation of gaseous emissions are two points that appear less of a constraint than in the other countries studied. That said, Spain will almost certainly be forced to expand its vulnerable-zones boundaries at some point in the near future.

Conclusion

The EU's big five pig-producing countries have reached high pig density, but with the countervailing effect of restrictive environmental standards that often strangle further growth and development options for pig farms. There are, however, contrasting national situations.
The adoption of relatively flexible regulations appears to have proven a facilitative factor for the development of pig farming. **The growth of the German pork industry** in the 2000s was built on multiple structural economic and organizational factors. Nevertheless, the development of pig farms in zones as dense as north-west Germany was visibly only made possible by a degree of political flexibility on the application of EU directives. **Spain**, where the

Table 4: Change in intensity of environmental constraints on pig farms from 2016 to projected 2021 situation (as gauged by expert opinion)

	Germany	France	Denmark	Netherlands
Nitrogen				
Phosphorus				
Land				
Administrative				
Opposure				
Ammonia				
Odour nuisance				
Particulate matter				

Change in constraint intensity score from the 2016 situation to the projected 2021 situation : > 2,5; :]2,5 ; 02] ; < 0,2 ; No response on odour nuisance and particulate matter from the Netherlands

environmental constraints are relatively comfortable, has seen steady growth since the 1980s and surging growth since 2013. In contrast, those EU member states that opted for particularly heavy environmental constraints have gained an advance in terms of pollution control planning (nitrates in Denmark and ammonia in the Netherlands are examples), but the pork-sector economy has paid the price. The **farrow-to-wean specialization of Danish and Dutch farms**, largely dictated by environmental constraints, has led to profit opportunity losses for their sector value chains.

Of the EU's big five pig-producing countries, **Spain** stands out as a special case insofar as its market development is **structurally tied to a low-cost model** (Duflot, 2016) **in a low-intensity-constraints economy. Germany also enjoyed more comfortable standard land application values in the early 2000s**—but those conditions have now been brought back into line. On balance, whether today or in the near future, none of these four countries appears to enjoy a competitive advantage stemming from the national transposition of pan-EU environmental directives.

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