Environmental policy mixes as a necessity in a world of multiple target group motivations and decision-making rationales: Matching agri-environmental policy instruments to farmer motivations

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Much of the general environmental governance literature claims there has been either a shift from traditional government (command-and-control regulations) towards new modes of governance relying more on societal self-organisation and/or market solutions; or that traditional command-and-control regulations have become smarter (see Wurzel et al. 2013). Furthermore, for years, environmental economists have been advocating the introduction of market-based instruments to improve cost-effectiveness in environmental governance, and thereby, according to Wurzel et al. (2013), sometimes downplayed the role of contextual factors, such as institutional constraints etc., for policy instrument effectiveness. We argue that in the debate on policy instrument development and effectiveness, often target group motivation has been neglected despite the 'behavioural turn' in public policy. If assumptions about individual decision makers in policy target groups are wrong or only partially correct, policy instruments of any kind will not affect behavior as predicted. Members of a given policy target group may be driven by different motivations and each member may even act on composite motivations, which results in a multitude of decision-making rationales in a target group. E.g., some farmers respond quickly to economic incentives, while others do not. This suggests that rather than focusing on identifying and developing a single perfect policy instrument, research and environmental governance should focus on better policy mixes to match those different motivations. Policy mixes are very often necessary for reaching a high level of effectiveness in environmental governance due to different motivations in the target group (Gunningham 1999). However, the need for good policy mixes can only be fulfilled through more knowledge on target group motivation – a research field which could be considered an example of a field in the environmental policy instrument literature aspiring to the label 'under-empiricized' (see Jordan et al. 2013). We substantiate our argument by an empirical analysis of Danish pesticide taxes and, farmer motivations

Introduction

A substantial part of the general environmental governance literature claims there has been either a shift from traditional government (command-and-control regulations) towards new modes of governance relying more on societal self-organisation and/or market solutions; or that traditional command-and-control regulations have become smarter (see Wurzel et al. 2013). Furthermore, for years, environmental economists have been advocating the introduction of market-based instruments to improve cost-effectiveness in environmental governance, and thereby, according to Wurzel et al. (2013), sometimes downplayed the role of contextual factors, such as institutional constraints etc., for policy instrument effectiveness.

Jordan et al. (2013) wraps up the achievements in the policy instrument literature and points out some directions for the future research in the field – one of them they explain as: "Put very simply, in some contexts [new environmental policy instruments] do seem to work, but in many others their performance has fallen well short of expectations. Instead of adopting a rather static perspective which simply describes the presence and/or absence of particular instruments of governing, future work could usefully explore the causal relationship between policy instruments and outcomes 'on the ground', including technological innovation" (Jordan et al. 2013). More specifically, Howlett (2018) points to the need for more knowledge on the match between policy instruments/tools and their targets.

In general, textbook economics consider e.g. environmental taxes more cost-effective policy instruments than traditional regulatory instruments (see e.g. Begg et al. 1991: 272-74; Pearce et al. 1989; Svendsen et al. 2001; OECD 2008). However, the dominant behavioral assumption in macroeconomic theory of 'economic man' has increasingly been challenged by a relatively small but growing literature during particularly the 2000's (see e.g. Straßheim & Beck 2019; Howlett 2018; OECD

2016; Jordan et al. 2013; Pedersen et al. 2012; Willock et al. 1999). Primarily through qualitative studies (xxxx), but also some quantitative studies (Pedersen et al. 2012; xxxx) demonstrating that additional motivations are at play in many target groups facing environmental policy instruments. Additionally, research shows that target groups can sometimes be divided in different segments according to their motivation (see e.g. Pedersen et al.2012; xxxx; xxxx;).

To meet this challenge of (mis)match between target group motivation and policy instrument, we argue that part of the solution could be to introduce more targeted policy mixes to increase the effectiveness by targeting multiple motivations in a target group. There are many examples of existing policy mixes. However, often there is a lack of a unifying overall logic behind the mix, with mixes being the result of a 'layering' processes where policy instruments and programs are added to already existing policies to address new concerns (Thelen 2003; Howlett & Rayner 2007). Because of layering, mixes can be (too) complex, costly to administer or even contain counter-productive instruments, resulting in tense relationships between the various parts of policy, and be difficult to change (Beland 2007; Grabosky 1995; Howlett and Rayner 2007, Kay 200???, Howlett et al, 2015).

Howlett (2018) and Weaver (2014) agree that there has been a tendency to consider the target group as a relatively homogenous group. As Howlett (2018) suggests, "what is needed in the study and analysis of policy formulation, design and implementation processes is a better, more systematic and empirically robust and supportable linkage of the expected behavior of policy targets to the full range of policy tools available" (Howlett 2018). After years of experimentation with various types of instruments in the field of environmental policy with mixed outcomes, we argue in this paper that, specifically, what is needed is more knowledge on the diversity of motivations within the target group of policy and how these motivations match the policy instruments. The multitude of target group motivations and their match with environmental policy instruments is a research field that might aspire to being 'under-empiricized' (see Jordan et al. 2013). A better theoretical and empirical understanding of target group heterogeneity is crucial for designing policies that more effectively address environmental problems. We argue that there is an urgent need for more knowledge on the range and distribution of decision-making rationales within a target group. For instance, some farmers might have motivations that comes close to 'economic man' while other subgroups/clusters within the target group display behavior which reflects other motivations more distant to 'economic man'. These can originate from e.g. peer group norms or individual attitudes (Weaver 2014). Therefore, well-crafted policies often need to be composed of a mixture of instruments to address a multitude of motivations within the target group to achieve optimal impact.

We substantiate our argument on the importance of knowledge on different motivations within target groups through an analysis of the evidence on Danish agri-environmental market-based policy instruments and farmer motivations – more specifically, Danish pesticide taxes.

While in the past farming was very much seen as an activity relying on and being in harmony with nature, it has now become evident that modern farming is associated with environmentally hazardous activities, contributing significantly to climate change, water pollution, air pollution and negative impacts on biodiversity. Over the last three decades, agriculture has been a key object of environmental regulation. Most agri-environmental regulation is based on traditional command-and-control instruments and not least environmental subsides. Further, particularly in Europe, farm income subsidies have increasingly been linked to environmental behavior (dubbed cross-compliance and 'greening' in the EU). However, the environmental impact of this 'greening' of agricultural income

support is dubious (Alons 2017). Additionally, an increasing amount of countries have experience in implementing agri-environmental taxes (see e.g. Pedersen et al. 2017; XXXX).

Market-based environmental policy instruments are designed to appeal to rational economic behavior amongst individual target group members. Unlike command-and-control instruments, market-based environmental policy instruments display very visible costs, and therefore we would expect farmers to respond in an economically rational manner to them, e.g. reduce the use or emissions of environmentally harmful substances to the new economically optimal level. While market-based instruments may not always result in economically rational behavior when directed towards consumers, farmers engaged in capital intensive modern farming can be assumed to behave in a business-like manner (refs).

However, given that much pollution in the farm sector is diffuse, such as nutrition run-offs from fields or impact of pesticides on ground water, bee populations etc., it is difficult to tax actual pollution. Therefore, the strategy has been to tax environmentally harmful farm inputs like fertilizers and pesticides, assuming that an increased price on input would lead to a decline in the use of the polluting input (Gunningham & Sinclair 2005). For pesticides use, there is a relatively direct relationship between the quantities or types being applied and pollution across all farm types. Therefore, from a behavioral perspective, we would expect that fairly similar economic motivational factors are at play amongst farmers in relation to pesticide taxation as farmers can be assumed motivated to optimize their profits and that it is relatively easy to determine the economically optimal use of pesticides.

Therefore, in relation to pesticide taxation, we would expect farmers, as a target group, to be homogeneous by displaying the most uniform motivations amongst individual farmers. In other words, we argue that pesticide taxation is the environmental policy field within the farm sector where we should be most likely to find a homogenous target group. If we can identify fairly similar motivations amongst farmers, the target group can be considered homogenous, providing support for the assumption found in behavioral economics that underpin much of the thinking behind market-based environmental policy instruments. On the contrary, if we find significant diversity amongst Danish farmers in terms of their motivations, the assumptions on uniform motivation upon which behavioral economics is based can be questioned and strong support for our clustered target group hypothesis, which assumes significant heterogeneity within target groups, can be obtained. The support for the cluster hypothesis can be considered strong when found in a situation where we most likely should not expect to find support for it.

We analyse the motivation of farmers when responding to the Danish pesticide tax that was introduced in 1996 and increased in 1998 and 2013. Denmark has implemented some of the most ambitious market-based agri-environmental policy instruments and has introduced what is probably the world's highest pesticide tax (Pedersen & Nielsen 2017). Because of price inelasticity, it can be assumed that there will be very limited or no response to a pesticide tax set at a relatively low level, as is the case in some countries (Pedersen et al. 2017). With a Danish pesticide tax set at high level based on ex ante economic assumptions regarding farmer behavior, traditionally, economists would expect relatively uniform motivations and responses to the tax. Based on farm survey data we establish the extent to which farmers as a target group responded homogenous to the initial tax in 1996/1998 and the increased tax in 2013.

First, we shortly recapitulate the broader literature on the link between policy instrument and target group behavior and the literature on policy mixes and farmer heterogeneity, followed by a section on market-based agri-environmental policy instruments. Finally, we analyse drivers for farmer decision-making – with a specific focus on farmer responses to agri-environmental market-based policy instruments in Denmark and discuss our findings.

The literature on the link between policy instruments and behavior

The effectiveness of policy instruments, the degree to which they achieve the objectives of policy makers, hinges on the accuracy of the behavioural assumptions embedded in the instrument choice and design (Schneider & Ingram 1990; Nielsen 2012; Howlett 2018; Weaver 2014). Howlett (2018) notes that considerations about characteristics and behavior of policy target groups featured as important in seminal works on policy interventions such as Dahl & Lindblom (1953), Laswell (1954), and Lowi (1966). But these considerations gave way to more theoretically-based models of policy targets as utilitarian, self-interest maximizers, as economists began to dominate the policy analysis field from the 1980s onwards (Howlett 2018; refs. to policy analysis books).

This was, perhaps particularly, evident in environmental governance where environmental economists applied a welfare economic framework to advocate for a switch from command-and-control regulation to market-based instruments such as pollution charges and tradable quotas (Pearce et al. 1991; Kolstad 1999; Ekins 1999; OECD 2001). Assuming that businesses act as profit-optimizers and individuals as utility maximizers more generally, such instruments would deliver on policy objectives at the lowest cost and might even ensure ongoing environmental improvement as it would be economically optimal especially for businesses to innovate to keep down environmental costs (ibid).

The engine in this model is the rational decision maker who is 1) motivated by profit or other forms of utility of a self-interested nature and 2) cognitively able to translate economic incentives into economically optimal choices (Jones 2001; Nielsen 2010). However, behavioral economists and cognitive psychologists (Tversky and Kahneman xxx; Camerer xxx; van den Bergh et al. 2000) have amply demonstrated the empirical shortcomings of this model. At the core of this research is the recognition that much human behavior is guided by selective use of information, cognitive shortcuts and biases, leading to systematic and widespread deviations from optimized decisions. Despite recognition in the form of Nobel prizes to both Herbert Simon (1978) and Daniel Kahnemann (2002), it was not until the publication in 2008 of Thaler and Sunstein's book 'Nudge' that the behavioral approach made a significant impact on the policy instrument literature and on policy-making (Straßheim & Beck 2019; Olivier, 2017; Howlett 2018; Halpern 2015). Since then behavioral public policy has proliferated as a field, aiming to design policy instruments that guide policy targets towards rational behavior through deliberate choice architectures.

Behavioral policy research as it has evolved focuses primarily on the cognitive dimension of the behavior, i.e. the ability of decision makers to make fully rational decisions. In fact, nudging is touted as interventions that help people make decisions in line with their own interests (Battaglio et al. 2018), which may or may not be the case when it comes to environmental policies. This raises the issue of motivation – or what could be described as the objectives pursued, the values guiding action or even as the content of their utility function (Simon 1997: 282; Schneider & Ingram 1990; Weaver 2014; Howlett 2018). The question of motivation has been addressed in the socio-legal literature on regulatory

compliance. Studies of businesses' and citizens' motivation to comply (or not comply) with regulatory requirement have identified three general types of motivation: economic motives, where decisions are based on economic rewards or costs (e.g. sanctions); social motivation, where behavior is driven by the desire for social approval, and normative motivation, which indicates a morally based duty to comply (Nielsen and Parker 2012; Gunningham and Kagan 2005; May 2005). In other words, it cannot be assumed that policy target behavior is driven by self-interest or monetary calculations, and we should expect heterogeneity in motivation among targets (Gunningham and Kagan 2005; Nielsen and Parker 2012; more refs). This does not necessarily imply that policy targets segment neatly into groups driven by different motivation forms. Nielsen and Parker (2012) in a study of the 1,000 largest Australian companies found that each company was driven by multiple forms of motivation, but in various constellations, which were also context dependent.

These insights have not carried over into the literature on economic instruments for environmental policy. Yet, for MBIs to work policy targets must be motivated by economic incentives. If a sizable share of the policy targets are not or only minimally motivated by economic incentives we should not expect MBIs to work as effectively as predicted by economic models; instead it may be necessary to bring into play different or complementary policy instruments that take into account other types of motivations. Likewise, when designing economic instruments it is important to understand what it takes to activate economic motivation, i.e. the magnitude of the economic incentive (taxes or subsidies) may influence the weighting of economic motivation.

Pedersen et al. (2012) find that literature identifying typologies of farmer motivations overlap, but the specific types of motivations also vary by the framework of the study, types of farms included etc. Furthermore, they find that a similar characteristics of these typologies is the recognition that "… farmer decisions are shaped by a multitude of values and goals, including profit, but also the intrinsic value of being a skilled farmer, professional and community recognition and environmental stewardship".

Altogether, this suggests that policy instrument research and design need to pay attention to the motivational structures of policy targets and that it may be necessary to identify policy mixes which effectively address heterogeneous target groups for the policy.

We argue that much more research is needed on heterogeneity/homogeneity in target group behavior and the responsiveness to policy instruments – there is a need for the introduction of well-designed policy mixes which can handle different motivations.

The policy mix literature

Policy instruments have often been used in a single instrument strategy where policy instruments have been treated as alternatives to each other rather than as potentially complementary (Gunningham and Sinclair 1999). Though many public policies are composed of a multitude of instruments, they may not be a result of a deliberate strategy to design a coherent policy in which instruments are complementary. Rather, a multi-instrument policy may be a result of layering in which one of several layers of instruments are added to an existing policy to address new concerns emerging on the agenda (Thelen 2003; Howlett & Rayner 2007). In such situations, the policy may lack a unifying overall logic behind the instrument mix, resulting in what Kay (2007) calls tense layering. Gunningham and Sinclair (1999) analyse different types of mixes and touches on the behavioural link – for instance when stating that 'to

the extent that firms behave in less than rational ways' voluntarism might be complementary to economic instruments etc.

[to be developed a bit more]

Farmer motivations and (lack of) responses to environmental taxes

As mentioned above, it was not until Thaler and Sunstein's book 'Nudge' (2008) that the behavioral approach started having a significant impact on the policy instrument literature and on policy-making (Straßheim & Beck 2019; Olivier, 2017; Howlett 2018; Halpern 2015). There were studies on farmer motivation before Thaler and Sunsteins book, but apparently the research interest in farmer motivation increased.

In the international literature there are examples of research on the multiplicity of farmer objectives going back to the 1920's (UK) and the 1940's (US) according to Garforth & Rehman (2006). However, in the UK this literature was dormant until Mitchell's (1968) Bristol study and Gasson's (1973) ground-breaking empirical research on farmers' values and goals, where he identified four different farmer types differentiated by the values that drive their decisions (Garforth & Rehman 2006). According to Garforth & Rehman (2006: 19), this research was important since it "established [a] recognition that farmers' goals and values are complex, and that dividing [farmers] into behavioural types on the assumption of simple profit maximizing behavior is increasingly difficult to sustain". This research initiated an interest in farmer objectives where one of the common features of this literature is the 'elicitation of farmers' objectives, which are later used to derive classifications and hierarchical structures of goals' (Garforth & Rehhman 2006). During the 2000's a literature more oriented towards deriving orientations and categories of farmers as defined by their stated objectives has developed (see e.g. Garforth & Rehman 2006; Pedersen et al. 2012). For instance, studies show that the weighing of economic motivation against other types of motivations can vary among farmers (Jørgensen et al. 2007; Burton et al. 2008; Nielsen 2009; Greiner & Gregg 2011). This does not mean that large groups of farmers are not motivated by prices and expenditures at all – what it does mean is that there is a variation in the magnitude of the economic motivation. Bartkowski and Bartke (2018) find in a meta study of European studies that only two of 47 studies on economic motivations among farmers indicate that economic motivation is not having an effect at all.

There is now a substantial literature on what motivates farmers' decision-making in relation to responding to environmental policy measures. The studies cover a broad array of environmental decision making situations, but the studies only seldom analyze the role of economic optimization in relation to taxes on agricultural inputs and make the coupling to farmer motivation. A case where we from a behavioural economics perspective would expect to find the most uniform motivations and policy responses to the policy instrument. The reason for the lack of research in this subject might be that often implemented agri-environmental tax design have too low tax levels to ignite any changes at all – consequently there might be no effect to observe.

Experiences with environmental taxes on business inputs

In general, one of the environmental tax challenges across countries have been to introduce optimal tax designs. In many countries, taxes are differentiated and not uniform as the textbooks prescript – e.g. consumers are often taxed at a higher rate than producers are (see e.g. Svendsen et al. 2001). A

connected challenge has been to impose taxes on certain businesses. Strong policy networks clustered around these businesses can often successfully avoid environmental taxation or succeed in getting more favorable tax designs than other societal groups (see e.g. Daugbjerg and Pedersen 2004; Schuerhoff et al. 2013). This has also been a challenge within the agricultural sector.

Tax designs need to be carefully designed to have a behavioural effect on the target group. If they are not, there is a risk that they will be ineffective. There is evidence of successful examples of application of economic instruments (Andersen and Ekins 2009), but on the other hand there is also evidence that sometimes environmental taxes do not produce the types of responses expected from the target groups. The reason can for instance be that the policy process leading to the introduction of the environmental tax results in a flawed tax design with only very little incentive or that the text book assumptions in ex ante policy analyses based on neo-classical economic models doesn't match real-world target group behavior (see e.g. Speck et al. 2006). We argue that some individuals in a target group might come close to the neo-classical behavioural ideal while others might be influenced more by other motivations. This affects the effects of the tax and therefore also the policy recommendations.

There is not a large experience in OECD countries with introducing environmental taxes in the agricultural sector on e.g. business inputs like pesticides and fertilizers (OECD 2010) and often tax levels have been lower than the textbooks recommend what makes it difficult or impossible to analyse behavioural effects.

There is some variation in the literature on the evidence of which countries have introduced environmental taxes on pesticides and fertilizers, which might be explained by the fact that some of the taxes have been very low, with only a purpose of covering administrative costs etc. It is a fact though that the numbers of this type of taxes being implemented are relatively low.

The Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) have all introduced pesticide taxes on agriculture (Andersen et al. 2001; Danish Competition Authority 2006: 253; Pedersen et al. 2015). However, the Finnish pesticide fee was repealed in 2007 (OECD 2009). Italy, France and some North American states (e.g. British Columbia and Washington) have also introduced pesticide taxes on agriculture (Pedersen et al. 2015 based on OECD & EEA 2014; UNDP (undated)). The Danish pesticide tax is on average by far the highest of these taxes.

Fertilizer taxes have been introduced in Austria (abolished 1996 when Austria joined EU (Söderholm 2009)), Denmark (but only targeted towards small farms and other sectors (Söderholm 2009; Nielsen 2010)), Finland (abolished 1995 when Finland joined EU (Söderholm 2009)), Italy, Norway (abolished 2000 (Söderholm 2009)), Sweden and the US (Louisiana) (OECD 2012; Söderholm 2009; Speck & Paleari 2016).

Additionally, the Flanders region in Belgium has introduced a manure tax and a water pollution tax, and the Netherlands have introduced a nutrients tax (abolished 2006 because of an EC court decision (Söderholm 2009)) and a levy on water pollution (OECD 2012).

Regarding effects of the above-mentioned taxes, the literature is very sparse – partly because some of the taxes probably have not been expected to change behavior due to low tax levels – e.g. the Finnish, Icelandic and Swedish pesticide taxes, and the Norwegian fertilizer tax (see Andersen et al. 2001; Gunningham & Sinclair 2005; Söderholm 2009). Furthermore, demand for the taxed products can sometimes be inelastic (Gunningham & Sinclair 2005). However, the Danish pesticide tax has a size

where substantial behavioral changes have been predicted in ex ante economic analyses both when the tax was introduced in 1996, doubled in 1998 and reformed in 2013.

Farmer responses to the Danish pesticide taxes

Below, we discuss the main drivers for Danish farmers' decision-making, more specifically, the farmer responses – and motivations behind this - to pesticide taxes.

Denmark's first pesticide action plan was implemented in 1986 with one of the most important aims being to cut pesticide use by 50 pct. before 1997 (Pedersen & Nielsen 2017). During the period 1986-1996, this part of the plan was primarily implemented through the introduction of information tools – e.g. better information on environmental effects when farmers were taking advice from agricultural advisors – more research, better education (e.g. mandatory spray certificates), and mandatory registration of pesticide use. During the 1990's it became evident that this policy mix could not deliver the ambitious 50 pct. cut in pesticide use, and a pesticide tax based on the retail prices of pesticides was introduced in 1996 to supplement the introduced instruments (Pedersen & Nielsen 2017). Tax levels were at 15% on the retail price (excluding VAT and other taxes) for fungicides, herbicides and growth regulators and 37% for insecticides (because insecticides were often cheaper). Ex ante assessments indicated that the tax, under different assumptions, would deliver, in isolation, a reduction in pesticide use of 8 pct. assuming a price elasticity of -0.5 (Ministry of Taxation 1995). However, it soon became clear that despite adding the pesticide tax to the policy mix, a 50 pct. reduction was still not achieved (Pedersen & Nielsen 2015), what led the government to double the pesticide taxes on average from 1998. Before the introduction of the new tax levels, a new ex ante assessment assuming economic rational farmers was performed, indicating how much the new tax would decrease the pesticide use. This time a reduction of pesticide use at 8-10 pct. were calculated ex ante assuming a price elasticity at -0.75 (L44 1997/98; Ministry of Taxation 2004). The tax was never the subject of a full-size ex post evaluation, but based on the development in pesticide use, grain prices etc. the assessment in Pedersen et al. (2015) is that the tax only had a small effect on pesticide use, at best.

Continued problems in reaching the aims of the policy – in combination with a 35 pct. increase in pesticide use since 2007 – led to the implementation of a fifth pesticide action plan in 2013. A new and better pesticide use indicator – based on pesticide load – was introduced and a new aim of 40 pct. reduction in pesticide use 2011 to 2015 was introduced (later prolonged to 2016) (Danish Government 2013). The most important instrument was a comprehensive reform of the pesticide tax. The tax was reformed to become a 'true' environmental tax, since the tax base was changed from a fixed percentage on top of the retail price of the pesticide, to an individual tax rate of each and every pesticide based on that particular pesticide's human health effects, environmental fate and environmental toxicity (effects on non-target organisms) (Pedersen & Nielsen 2017). Furthermore, overall tax rates were increased substantially – corresponding to more than a doubling of the previous tax rate on average if assuming no behavioral changes (Nielsen et al. 2019). Again, ex ante expectations on effects of the tax were based on assumptions on economic rationality: "Preliminary analyses indicate that the new pesticide tax can reduce current pesticide use of fungicides, insecticides and herbicides in grain and rape with 40 to 50 pct. The reduction is primarily caused by an economically rational change of pesticide product selection, substituting pesticides with a high load, and therefore expensive, with cheaper pesticides with a lower load, secondarily a smaller reduction in overall pesticide use" (Ørum et al. 2013, our translation).

Currently, the Danish Environmental Protection Agency (2019) has two indicators for pesticide load. One is based on the sales figures for pesticides while the other is based on farmers' mandatory registration of use in individual spray journals. During the period 2011 to 2017, overall load has decreased by 44 pct. according to the sales figures, while the decrease is 27 pct. according to the farmers' registered use figures (from 2010/11 to 2016/17) or only 12 pct. if measuring from 2011/12 to 2016/17. One of the reasons behind the differences in the two statistics are that farmers hoarded many pesticides before the tax increase in 2013 (ibid). We know for a fact that some of these pesticides were still stored in 2017 (Nielsen et al. forthcoming) resulting in an 'artificial' low pesticide use based on sales figures in the years after 2013, since some farmers still use stored pesticides and consequently bought less pesticides than normal. Consequently, it is deemed more precise to rely on the actual use as registered by the farmers, which indicate that a quite impressive reduction in load has been reached at a size within the range of 12-27 pct. (depending on baseline year), and maybe even a bit more if there are still a small amount of hoarded pesticides out there, but there are no indications that Denmark reached the 40 to 50 pct. reduction which the ex-ante calculations indicated prior to the introduction of the tax.

The pesticide tax has been an important element in the Danish pesticide policy since 1996, but as demonstrated, the pesticide tax has not been able to fulfil the high expectations of ex ante calculations based purely on economic rational farming. A closer look at Danish farmers' motivations can provide some answers to this gap.

Farmer motivation as an explanation for not meeting the ex-ante expectations

Through a 2009 survey distributed to 1.740 Danish farmers (1.164 responses), Pedersen et al. (2012) demonstrate by using cluster analysis that 45 pct. of Danish farmers are more economically motivated and resemble the agent in economic models. Another cluster consists of 32 pct. of the Danish farmers – these 'production-oriented farmers' are more focused on optimizing yield and pay less attention to pesticide prices. Furthermore, they are above average attentive to having 'clean fields' completely free of weeds compared to other farmers. These farmers are more professionally oriented in the sense that they are driven by a motivation to do a good job as a farmer (see e.g. Gasson 1973) and/or maybe an orientation to demonstrate skilled performance (Burton et al. 2008; see also Nielsen 2009).

In other words, farmers are differentiated by the types of rationales they prioritize in their decisions to use pesticides. These findings have some connection to other typologies, including Gasson (1973) and Brodt et al. (2006), but compared to these, Pedersen et al. (2012) add a new element by indicating "... that attention to prices and attention to production represent two different dimensions, which are mixed as a general business orientation in other studies, e.g. in the production maximiser identified in Brodt et al. (2006)".

Furthermore, Pedersen et al. (2012) find, based on data on farmers' self-reported perceptions of policy effectiveness, that these two groups differ significantly in their response to policy instruments; farmers who focus on yield and less on prices, indicate less responsiveness to economic policy instruments than those farmers focusing very much on prices. For instance, farmers are asked about their responses to a hypothetical significant increase in the pesticide tax, and here, farmers in the more economically motivated cluster indicates a stronger inclination to respond to a significant tax increase by reducing their use of pesticides than farmers in the more production-oriented cluster. All these findings are statistical significant (Pedersen et al. 2012).

Based on these findings, it does not come as a surprise that the 1996/1998 tax apparently faced problems in delivering the results expected in ex ante calculations, since a large group of the farmers are not highly motivated by changes in pesticide prices. Based on statistics on the development in pesticide use, the assessment in Pedersen et al. (2015) is that the tax only had a small effect on pesticide use, at best. Another economic instrument in Danish pesticide policies in the 2000's, subsidies for pesticide-free-buffer zones – a voluntary policy instrument with economic incentives - experienced similar problems in living up to predictions on effect in ex ante economic analyses, since uptake of this scheme was lower than predicted in ex ante assessments (Pedersen & Nielsen 2017). To underline the point, Pedersen et al. (2012) also find when asking about other types of market-based instruments that farmers in the production-oriented cluster are less likely to reduce pesticide use through their responses to other hypothetical market-based instruments as tradable pesticide quotas and subsidy schemes.

Ørum (2003) and Ørum et al. (2008) analyse the lack of effect of the 1996/1998 tax and finds that despite the fact that it would have been economically rational for the farmers to lower their pesticide use to a level similar to the objectives in the Danish pesticide policy, the economic outcome at farm level would not have changed much and therefore a stronger price signal was probably needed through e.g. a higher pesticide tax or pesticide quotas to get substantial effects through behavioral changes. The advice on stronger price signals was followed by the Danish government in 2013, when the pesticide tax was reformed and increased substantially with more than a doubling of the tax rates on average, and multiple times for those pesticides with the highest environmental loads, since the tax design was changed and the tax on each pesticide was now dependable on that specific pesticides environmental load. As described above, the tax has led to some substantial decreases in pesticide use, but not as high decreases as calculated in ex ante economic assessments before the tax introduction. Danish farmers did not reach a 40 to 50 pct. reduction as predicted ex ante, but might have reached a 12-27 pct. reduction based on the 2017 self-reported figures from the farmers (see discussion above).

Nielsen et al. (forthcoming) analyses the motivation of farmers in an evaluation of the reformed Danish pesticide tax by using the same questions on motivation as in Pedersen et al. (2012) on a sample of 607 farmers. Again, 'ensure greatest crop yield' turns out to be a very important objective for the farmers regarding pesticide use (scores 4.3 on a scale from 1 (not important at all) to 5 (very important)). Overall, the farmers find the objective of ensuring greatest economic outcome the most important, but, as in Pedersen et al. (2012), direct economic considerations in the form of prices on crops and pesticides and costs of bringing out the pesticides scores lower than most other motivations (only 'managing work time' scores lower). Nielsen et al. (forthcoming) cannot – in contrast to Pedersen et al. (2012) – identify statistical significant clusters (one reason for this might be that the sample is substantially smaller than in Pedersen et al. 2012). What this research do show, however, supported by an increasing amount of, in particular, qualitative studies (see above), is that a number of different motivations are at play for the farmers. Farmers are very complex decision-makers and there are differences in their decision-making rationales and this is very likely the reason why it, again, also is difficult to reach the same amount of reductions in pesticide use as predicted in ex ante analyses prior to the implementation of the reformed pesticide tax. Substantial reductions have been reached, but there still seems to be a gap to the ex-ante estimations based on economic rational behavior and it is most likely due to one-dimensional behavioral ex ante assumptions.

Discussion and conclusion

More than two decades of evidence on the effects of what is probably the world's highest pesticide tax demonstrates that even when analyzing farmers engaged in capital intensive modern farming, which very often are assumed to behave in a business-like manner, we find that ex ante expectations based on economic man are not met for the farmer community as a whole. Many farmers do behave according to economic man expectations, but there is also a large group of farmers with weaker responses to market-based instruments and a more production-oriented motivation. In other words, the target group is not homogenous and it cannot be assumed that policy target behavior is only driven by self-interest or monetary calculations. Consequently, it comes as no surprise that the Danish pesticide tax, despite some large reductions in pesticide use (or more precisely pesticide load), has not reached the reductions predicted in ex ante economic calculations based on rational economic behavior. These findings support Jordan et als (2013) suggestion to focus more on the causal relationship between policy instruments and outcomes 'on the ground' in the policy instrument literature. More specifically, as we have demonstrated, more research is needed on the development of well-crafted policy mixes that match different motivations in a target group. The research on different types of motivations has been growing since Thaler and Sunstein (2008) published their study, but there is still a need to couple it more explicitly to the policy instrument literature.

Market-based policy instruments like agri-environmental taxes are still often a cost-effective alternative when aiming to change the behavior of a large group of the farmers, but it need supplement with other policy instrument(s). Needless to say, it is not a possibility not to tax those farmers who are less motivated by prices, since this would be deemed unequal treatment of the farmers, and still, from a polluter-pays-perspective, it can be considered fair that these farmers also pay for those negative externalities (pollution) they impose on society, through a so-called Pigouvian tax (xxx) (see also Pedersen et al. 2012). These farmers who to a lesser degree are motivated by prices need motivation for behavioral change through other policy instruments to reduce their pollution though. However, if it comes through introduction of general command-and-control instruments it might be considered unfair by the group of farmers acting more like economic man, since they already changed their behavior. As Gunningham & Sinclair (1999) suggest, it might be a possibility to add voluntary instruments to the policy mix. This type of policy instrument can have a low reliability when used in isolation (Gunningham & Sinclair 1999) and therefore it is essential to obtain knowledge about target group motivation before including this type of instrument in a policy mix. E.g., voluntary agri-environmental subsidy schemes are used widely across the EU, but if there are no other incentives as part of the design than the economic, these types of instruments are not likely not to appeal to those farmers that are less responsive to economic instruments. To target these farmers, which e.g. are more production-oriented, it might be important to include voluntary policy instruments in the mix that allows them to exhibit their farmer skills (Burton et al. 2008; Nielsen 2009). E.g. if farm land is taken out of production farmers can't exhibit their skills on this land, but if they can maintain the land and some production on it, where they can demonstrate farmer skills while using lesser amounts of e.g. pesticides, there might be a potential for policy effects, but still it has to compete with the strong motivation to maximize the crop. Affecting social motivation, where behavior is driven by the desire for social approval, and normative motivation – the morally based duty to comply is not an easy task. Affecting peer group norms in the farming community or individual attitudes is a possibility, e.g. through agricultural advisors, is possible, but can also be very challenging. In Denmark, like in many other countries, many farmers rely on advice from agricultural advisors. However, it is important to be aware that advisors are often not heterogeneous

either and might e.g. be giving different advices regarding pesticide use based on whether they are independent or supplier-affiliated (Pedersen et al. 2019). Additionally, most farmers (Pedersen et al. 2012) and most agricultural advisors (Pedersen 2019) find that approved pesticides are innocuous for the environment if the label recommendations on the pesticide are not exceeded, what might be a barrier for voluntary instruments to decrease use. There seem to be no obvious solutions, what again underlines the need for more research in this field.

In general, what is needed is more research and focus on developing policy mixes that match multiple motivations in target groups. The discussion above suggests that not only are there different motivations within the primary target, i.e. those whose immediate change of behavior is need to reach the policy objective. To address these different groups, the policy instrument mix literature suggests that at package of complementary instruments is directed towards the primary target group. While this sounds obviously and rather straightforward, our discussion points to the difficulties of designing such a package and there may be a risk that to reach the different clusters within the target group, policy may be counter-productive, that is one instrument may neutralize the effect of the other. Our discussion also suggests that when designing policy mixes, policy makers should broaden their perspective to include what can be called secondary target groups, which are those groups whose behavior needs to change to create conditions for the primary target group to respond optimally to the policy instruments (Daugbjerg, forthcoming). As we argued above, farm advisors can play an important role in persuading farmers to respond optimally to pesticide taxes. A single policy instrument may not work optimally on its own, but may need other instruments to support it. These secondary policy instruments may be directed at other groups who can change the conditions for the primary group to respond optimally. Hence, even when environmental regulation relies on mainly single instrument, there may be a need to support it by secondary instruments [to be expanded and further elaborated].

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