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This is an Accepted Manuscript version of the following article, accepted for publication in Environmental Policy & Planning. Anders Branth Pedersen, Helle Ørsted Nielsen & Carsten Daugbjerg (2020) Environmental policy mixes and target group heterogeneity: analysing Danish farmers' responses to the pesticide taxes, Journal of Environmental Policy & Planning, 22:5, 608-619, DOI: [10.1080/1523908X.2020.1806047](https://doi.org/10.1080/1523908X.2020.1806047). It is deposited under the terms of the Creative Commons Attribution-NonCommercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited."

How to cite this publication

Please cite the final published version:

Anders Branth Pedersen, Helle Ørsted Nielsen & Carsten Daugbjerg (2020) Environmental policy mixes and target group heterogeneity: analysing Danish farmers' responses to the pesticide taxes, Journal of Environmental Policy & Planning, 22:5, 608-619, DOI: [10.1080/1523908X.2020.1806047](https://doi.org/10.1080/1523908X.2020.1806047)

Publication metadata

Title:	Environmental policy mixes and target group heterogeneity: analysing Danish farmers' responses to the pesticide taxes
Author(s):	A. B. Pedersen, H. Ø. Nielsen & C. Daugbjerg
Journal:	Environmental Policy & Planning
DOI/Link:	https://doi.org/10.1080/1523908X.2020.1806047
Document version:	Accepted manuscript (post-print)

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Environmental policy mixes and target group heterogeneity: analysing Danish farmers' responses to the pesticide taxes

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Abstract

In this article, we challenge two assumptions embedded in many ex-ante analyses of environmental policy instruments. Firstly, it is often assumed that target groups in environmental policy are homogeneous and thus can be expected to respond to policy instruments in a similar manner. Secondly, individual target group members are expected to respond to policy instruments like 'economic man', particularly in relation to MBIs applied in environmental policy. We argue that despite the 'behavioural turn' in public policy, the debate on policy instrument development and effectiveness has often neglected target group heterogeneity. E.g. members of a given policy target group may be driven by different motivations and each member may even act based on a combination of motivations. Target group heterogeneity suggests that rather than chasing a single perfect policy instrument, research and environmental governance should focus more on better policy mixes to match those differences in decision-making rationales. We argue that a focus on instrument combinations designed to effectively address policy problems where target groups are heterogeneous would mark a new and innovative stage in the research on policy instruments. We substantiate our argument by an empirical analysis of farmer responses to Danish agricultural pesticide taxes.

Keywords: target groups; motivation; environmental taxation; behaviour; farmer decision-making; policy instruments

Introduction

A substantial part of the general environmental governance literature claims there has been either a shift from traditional government (command-and-control regulation) towards new modes of governance relying more on societal self-organisation and/or market solutions (see Wurzel, Zito & Jordan 2013). Furthermore, for years, environmental economists have been advocating the introduction of market-based instruments (MBIs) to improve cost-effectiveness and efficiency in environmental governance (e.g. Pearce, Markandya & Barbier 1989; Perman, Ma & McGilvray 1996). However, this blanket recommendation, according to Wurzel et al. (2013) sometimes downplayed the role of contextual factors, such as institutional constraints that affected the effectiveness of policy instruments.

In their assessment of the policy instrument literature, Jordan, Wurzel & Zito (2013) suggest that future research in the field might pay more attention to the contextual conditions for policy effectiveness: “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, p.238). Pedersen, Nielsen, Christensen & Hasler (2012) and Howlett (2018) point specifically to the need for more knowledge on the match between policy instruments and their targets.

In general, textbook economics consider MBIs, such as environmental taxes, more cost-effective policy instruments than traditional regulatory instruments because economically optimizing agents will respond to price incentives to different degrees. Those who can reduce the use of polluting practices at the lowest cost will reduce the

most, thereby ensuring that environmental abatement is undertaken where it is least costly (see e.g. Begg, Fischer & Dornbusch 1991: 272-74; Pearce et al. 1989; Perman et al. 1996). Mainstream economics is to a large extent dominated by different extensions of neoclassical economics, which is also reflected in the field of economics education (Ruiz-Villaverde 2019) – as well as in most modelling and forecasting of the behaviour of agricultural businesses (Schwarze, Holst & Mußhoff 2014; Bartkowski & Bartke 2018). The dominant behavioural assumption in neoclassical economic theory is that policy targets act as ‘economic man’, but this assumption has increasingly been challenged by a relatively small, but growing literature particularly during the last decade (see e.g. Howlett 2018; Jordan et al. 2013; Nielsen 2010; OECD 2016a; Pedersen et al. 2012; Straßheim & Beck 2019; Willock et al. 1999; Angner 2019; Schwarze et al. 2014). Primarily through qualitative studies (e.g. Burton, Kuczera & Schwarz 2008), but also some quantitative studies (Davies & Hodge 2007; Gasson 1973; Pedersen et al. 2012), it has been demonstrated that a range of motivations are at play in many target groups with actors facing environmental policy instruments

Despite the challenge from behavioural economics, a vast amount of public policies still rely on assumptions rooted in traditional neoclassical economy (see e.g. Schwarze et al. 2014), because they apply economic theory or are based on ex-ante analyses using business or sector economic models (Ørum et al. 2008 and 2013; Winsten & Hunter 2011; OECD 2016b, 2019). While the neo-classical notion of utility is theoretically open and neo-classical economists acknowledge that motivation can be multifaceted, when it comes to the empirical application of theory in policy analytical models, behaviour is typically modelled through a profit optimisation function (Nielsen 2010, p. 19-22.) For instance, in the modelling underpinning the Danish pesticide taxes, Ørum et al. (2013) applied heterogeneous optimization functions for crops and soil

types, but a uniform profit optimization function across farmers, when estimating the impact of the tax. Furthermore, Howlett (2018) points out that there has been a tendency also in the policy instrument literature, to consider policy target actors as a relatively homogenous group: “These ‘policy targets’ are often assumed to act as simple rational utility maximizers who can be manipulated by incentives and disincentives” (Howlett 2018, p.101). This leads to a risk of policy failure. Thus, 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 behaviour of policy targets to the full range of policy tools available” (Howlett 2018, p.108).

After years of experimentation with various types of instruments in the field of environmental policy and with mixed outcomes, we argue in this article that specifically what is needed is more knowledge on the diversity of motivations within the target group of policy and how these motivations can be matched by policy mixes. 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 and sustainable development. We see an urgent need for more knowledge on the range and distribution of decision-making rationales within target groups of environmental policy. Thus, parts of a target group might be primarily driven by economic motivation, while other clusters within the target group primarily display behaviour that reflects other motivations and to a lesser degree economic motivations. These other motivations can originate from e.g. peer group norms or individual attitudes (Weaver 2014), for instance environmental values.

In this article, we use the Danish case of pesticide taxation to demonstrate the need to take target group heterogeneity into account when designing environmental policy. Taxes on environmentally harmful business inputs are assumed to lead to a decline in the use of such input (Gunningham & Sinclair 2005). The Danish pesticide tax was introduced in 1996 and increased in 1998 and 2013. It is probably the world's highest pesticide tax (Danish Competition Authority 2006; Pedersen & Nielsen 2017). As argued above, neoclassical economics and most studies, models and forecasts analysing agricultural businesses (Schwarze et al. 2014) assume that fairly similar economic motivational factors are at play amongst farmers in relation to pesticide taxation, as farmers - generally – are modelled as profit optimizers.

Based on farm-level data from farmer surveys conducted in 2009 and 2016-2017 by two of the authors, and data on Danish farmers' pesticide use before and after the tax raise in 2013, we examine this assumption. We explore the extent to which farmers as a target group responded to the initial tax in 1996/1998 and the increased tax in 2013 and how this links to farmers' motivation. We show that farmers do in fact differ in the motivations that drive decisions on pesticide use and that these differences to some extent are reflected in different responses to the taxes. Hence, the assumption on uniform preferences within a target group can be questioned and, consequently, should lead to reflection on the utility of the single instrument approach in environmental policy.

Based on these findings, we suggest that the nature of target groups should have a more prominent position in policy design processes. Target group heterogeneity suggests that policy mixes rather than a single instrument should be applied. However, the existing policy mix literature is mainly concerned with instrument complementarity and coherence as a key dimension in designing mixes. Our case study findings suggest

that policy effectiveness can be improved by adding target group nature as a key design principle in policy mixes.

Covering an agri-environmental issue, this article contributes to the series of studies on agricultural issues that JEPP has published over the last 21 years. 27 articles have listed 'agriculture' or 'farm(er)' as one of the key words to indicate the empirical focus of the article. In relation to regulating the use of pesticides, which is an area of major concern not least in relation to biodiversity and water quality, only one article lists the keyword 'pesticides' to indicate the focus on this issue (Guthman & Brown 2016). With a focus on policy instruments and environmental taxation, our article contributes to research fields where JEPP has been less active. Over the last 21 years, only six articles have listed 'policy instruments' as a key word (for the most recent articles see: Juerges, Hagemann & Bartke 2018; Wolff, Schönherr & Heyen 2017). Judged by the use of key words only four articles list 'tax/taxation' as a key word (Andersen & Massa 2000; Bachaus, van Ootegem & Verhofstadt 2019; Ekins & Speck 2000; Gago & Labandeira 2000). Searching for articles using the concept of Pigouvian environmental taxes, only one article discusses this type of environmental tax (Juerges et al. 2018). Focusing on these issues, this article contributes to research fields where there is potential for JEPP to increase its coverage and contribute to the policy debate.

First, we recap the broader literature on the link between policy instrument and target group behaviour, followed by a section on farmer motivations and responses to environmental taxes. Finally, through a case study we analyse farmer responses to Danish pesticide taxes and discuss farmer motivation as an explanation for the findings. In the discussion and conclusion, we suggest a research focus on how instrument combinations can be designed to effectively address policy problems where target

groups are heterogeneous. This would mark a new and innovative stage in the research on policy instruments and design.

The link between policy instruments and behaviour

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 (Howlett 2018; Nielsen 2013; Schneider & Ingram 1990; Weaver 2014). Howlett (2018) notes that considerations about characteristics and behaviour of policy target groups featured as important in seminal works on policy interventions such as Dahl & Lindblom (1953), Lasswell (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).

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 (Ekins 1999; OECD 2001; Pearce 1991).

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, behavioural economists and cognitive psychologists (Camerer 2003; Tversky and Kahneman 1974; van den Bergh, Ferrer-i-Carbonell & Munda 2000) have amply demonstrated the empirical shortcomings of this model. At the core of this research is the recognition that much human behaviour is guided by selective use of information, cognitive short cuts, and biases, leading to systematic and widespread deviations from optimized decisions. Despite recognition in the form of Nobel prizes to

both Herbert Simon (in 1978) and Daniel Kahnemann (in 2002), it was not until the publication in 2008 of Thaler and Sunstein's book 'Nudge' that the behavioural approach made a significant impact on the policy instrument literature and on policy-making (Halpern 2015; Howlett 2018; Straßheim & Beck 2019). Since then, behavioural public policy has proliferated as a field, aiming to design policy instruments that guide policy targets towards rational behaviour through deliberate choice architectures.

Behavioural policy research as it has evolved focuses primarily on the cognitive dimension of behaviour, 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, Bellé, Cantarelli 2019), 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 utility functions (Howlett 2018; Schneider & Ingram 1990; Simon 1997; Weaver 2014). 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 requirements have identified three general types of motivation: economic motives, where decisions are based on economic rewards or costs (e.g. sanctions); social motivation, where behaviour is driven by the desire for social approval; and normative motivation, which indicates a morally based duty to comply (Nielsen & Parker 2012; Winter & May 2001). In other words, it cannot be assumed that policy target behaviour is driven solely by self-interest or monetary calculations, and we should expect heterogeneity in motivation among target group members (Nielsen & Parker 2012; Pedersen et al. 2012). As stated in the introduction, neo-classical economics are theoretically open to such heterogeneity, but

models applied to policy analysis tend to assume economic motivation (Nielsen 2010). This does not necessarily imply that policy targets segment neatly into groups driven by different motivation forms. In a study of the 1,000 largest Australian companies, Nielsen & Parker (2012) found that each company exhibited 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 *ex-ante* calculations using 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.

Altogether, this suggests that policy instrument research and design need to pay attention to the motivational structures of policy targets groups and that it may be necessary to identify policy mixes which effectively address heterogeneous target groups for the policy. The Tinbergen (1952) rule states that for each policy objective there must be at least one policy tool. We argue for an addition to this rule: very often, more policy tools than one will be needed to achieve one policy objective due to differences in target group motivation.

Farmer motivation

Mitchell's (1968) and Gasson's (1973) studies became ground-breaking empirical research on farmers' values and goals (Garforth & Rehman, 2006). They "...

established [a] recognition that farmers' goals and values are complex, and that dividing [farmers] into behavioural types on the assumption of simple profit maximizing behaviour is increasingly difficult to sustain" (OECD 2012 p.16 referring to DEFRA 2006).

During the 2000s a literature has developed oriented towards deriving typologies of farmers as defined by their stated objectives in relation to farming in general and to specific decision domains (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 (Burton et al. 2008; Greiner & Gregg 2011; Jørgensen et al. 2007; Nielsen 2010). This does not mean that large groups of farmers do not consider prices and expenditures at all – in fact, a meta-analysis of 47 European studies finds that economic motivation plays a role in farmer decisions in all but two studies (Bartkowski & Bartke, 2018). What the typology-based studies do show is that there is a variation among farmers, decision domains, farm types etc. in the degree to which decisions are driven by economic objectives (Nielsen 2010; Pedersen et al. 2012). Indeed, "... 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" (Pedersen et al. 2012, p.1097).

While the studies of farmers' motivation cover a broad array of environmental decision-making situations, they do not consider how different clusters of farmers sharing similar values and motivations may respond to different types of policy instruments. Mapping clusters within the policy target group and generating knowledge on how members of the clusters might respond to various policy instruments can be used to design policy mixes which take into account diverse target groups. In this

article, we take a first step in this endeavour by identifying different clusters of Danish farmers and explore their responses to pesticide taxes.

Given that much pollution in the farm sector is diffuse, such as nutrition and pesticide run-offs from fields, it is difficult to tax actual pollution. Therefore, the strategy among the small group of countries that have introduced this type of taxes, has been to tax environmentally harmful farm inputs such as 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). Schwarze et al. (2014, p.11) points out that “Most studies, models, and forecasts dealing with the economic management of agricultural businesses are based on the underlying assumption of the homo oeconomicus (Camerer and Fehr, 2006; Fehr and Gächter, 2001; Gintis, 2000)”, in other words of farmers being perfectly rational profit maximizers. Consequently, from a traditional economic 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.

On the contrary, if we find significant diversity amongst Danish farmers in terms of their economic and non-economic motivations, this will point towards a need for a broader set of policy instruments to address those different motivations.

Case study: farmer responses to Danish pesticide taxes

After struggling for a decade to reduce farmer pesticide use substantially, Denmark introduced a pesticide tax in 1996 (Pedersen & Nielsen 2017). Tax levels were set 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 itself (with some uncertainty), would reduce, pesticide use by 8 percent assuming a price elasticity of -0.5 (Minister of Taxation

1995). However, it soon became clear that despite adding the pesticide tax to the policy mix, the Danish governments aim of a 50 percent reduction of pesticide use was still not achieved (Pedersen, Nielsen & Andersen 2015). This 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 to estimate how much the new tax would decrease the pesticide use. Ex-ante assessments indicated a reduction of pesticide use in the region of 8-10 percent, assuming a price elasticity of -0.75 (L44 1997/98). The tax was never subject to a comprehensive ex post evaluation, but based on the development in pesticide use, grain prices etc. (Ørum, Boesen, Jørgensen & Kudsk 2008) the assessment in Pedersen et al. (2015) is that the tax, at best, had only a small effect on pesticide use 1998-2012.

Continued problems in reaching the objectives of the policy – in combination with a 35 pct. increase in pesticide use since 2007 – led to the implementation of a new pesticide action plan in 2013 (Danish Government 2013). The most important instrument was a comprehensive reform of the pesticide tax and the introduction of a new and better pesticide use indicator, based on pesticide load; the tax was re-designed to become a ‘true’ environmental tax. Hence, the tax base was changed from the retail price of the pesticide (with a fixed tax rate on top of sales price) to the impact on health and environment of the pesticide, applying an individual tax rate to each and every pesticide based on that particular pesticide’s effects as measured by three main types of indicators: human health, environmental toxicity (effects on non-target organisms), and environmental behaviour (Ministry of Environment and Food of Denmark, 2017). Furthermore, overall tax rates were increased substantially – corresponding to more than a doubling of the previous tax rate on average if there were no behavioural changes (Danish Environmental Protection Agency 2018). Again, ex-ante expectations on

effects of the tax were based on assumptions of economic rationality: “Preliminary analyses indicate that the new pesticide tax can reduce current pesticide use of fungicides, insecticides and herbicides in grain and rapeseed by 40 to 50 percent. 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, Jørgensen & Kudsk 2013, p.16, our translation). Based on these ex-ante calculations, a new policy aim in the government’s pesticide action plan of 40 pct. reduction in pesticide load from 2011 to 2015 was introduced (later extended to 2016) (Danish Government 2013). The aim was later changed to reaching a pesticide load of 1,96 (Danish Environmental Protection Agency 2018), which corresponds to a 35 pct. reduction 2011-2015.

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 electronic spray journals. From 2011 to 2017, the overall load has decreased by 44 percent 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 (ibid). One of the reasons behind the differences in the two statistics is that farmers hoarded many pesticides before the tax increase in 2013 (ibid). We know that some of these pesticides were still stored in 2017 (Nielsen, Pedersen, Konrad & Gyldenkærne 2020) resulting in an ‘artificially’ low pesticide use based on sales figures in the years after 2013, since some farmers still use stored pesticides and consequently have bought less pesticides than they would normally do. Consequently, it is deemed more accurate to rely on the actual use as registered by the farmers. These data indicate that a

substantial reduction in load has been reached within the range of 12-27 percent (depending on baseline year). However, there are no indications of a 40 to 50 percent reduction as the ex-ante estimations suggested prior to the introduction of the tax and no indications of reaching the policy aim of a pesticide load at 1,96, when actual use data are analysed. In 2016/17 (the most recent year calculated), recorded at pesticide load at 2,14, which was very close to the two preceding years (Danish Environmental Protection Agency 2019).

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

Through a 2009 survey distributed to 1.740 Danish farmers (1.164 respondents), Pedersen et al. (2012) demonstrate through a 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, who tend to be production-oriented. They are more focused on optimizing yield and pay less attention to pesticide prices. Furthermore, they pay more attention to having 'clean fields' completely free of weeds compared to other farmers. These farmers are more professionally oriented in the sense that they are to a large extent driven by a motivation to do a good job as a farmer as they see it (see also Gasson 1973) and/or maybe an orientation to demonstrate skilled performance (Burton et al. 2008; see also Nielsen 2010).

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, Klonsky & Tourte (2006), but

compared to these, Pedersen et al. (2012, p.1103) 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)”.

Based on data on farmers’ self-reported perceptions of policy effectiveness, Pedersen et al. (2012) find that these two groups differ significantly in their response to policy instruments. Farmers in the production oriented cluster, indicate less responsiveness to economic policy instruments than do farmers focusing very much on prices. Since a large group of the farmers are not highly motivated by changes in pesticide prices, it therefore does not come as a surprise that the 1996/1998 tax faced difficulties in delivering the outcomes expected in ex-ante estimations based on assumptions of farmer profit maximization. Based on statistics on the development in pesticide use, Pedersen et al. (2015) find that the tax only had a small effect on pesticide use, at best. To underline the point, Pedersen et al. (2012) also find that farmers in the production-oriented cluster are less likely to reduce pesticide use through their responses to other hypothetical market-based instruments such as tradable pesticide quotas and subsidy schemes.

As part of a new study on the reformed Danish pesticide tax (survey conducted in 2017 on a sample of 607 respondents), we asked farmers the same questions on motivation as we did in Pedersen et al. (2012) (see table 1).

Table 1. To what extent is each of the following objectives important for your use of plant protection products? Please rate on a scale from 1 (no importance) to 5 (very great importance). Mean score ('don't know' not included)

Objective	Mean score
Maximizing net economic outcome	4.6
Prevent resistance	4.4
Ensure greatest crop yield	4.3
Forestall problems	4.3
Clean fields	4.1
Professional ambition to use as fewest possible pesticides	4.1
Price of crop	4.0
Environmental protection	4.0
Price of herbicides	3.8
Price of fungicides	3.8
Price of insecticides	3.7
Price of growth inhibitors	3.2
Costs of bringing out pesticides	3.1
Work time and planning	3.0

N=547

Again, 'ensure greatest crop yield' turns out to be a very important objective for the farmers regarding pesticide use in general (average score 4.3 on a scale from 1 (not important at all) to 5 (very important)). Overall, the objective of ensuring greatest economic outcome receives the highest average score, but, as in our previous study (Pedersen et al. 2012), direct economic considerations in the form of prices on crops and pesticides and costs of bringing out the pesticides score lower than most other objectives. The recent survey study did not identify statistically significant clusters (perhaps due to a smaller sample size than the 2009 study). However, we do find a statistically significant correlation between a high score on price motivation and farmers' propensity to have made considerable changes in their choice of pesticides due to price changes, while this is not the case for farmers who rate crop yield as important.

What this research does show, most importantly, is that a number of different motivations are at play for a substantial part of the farm community. There are significant differences in farmers' decision-making rationales. This is most likely the reason why it is difficult to reach the level of reductions in pesticide use as predicted in ex-ante analyses. Substantial reductions have been reached, but there is still a gap between the ex-ante estimations based on economic rational behaviour and actual behaviour. As we suggest, this is most likely due to one-dimensional behavioural assumptions on farmer motivations.

Conclusion and Directions for Policy Mix Research

In this article, we have challenged two related assumptions underpinning much ex-ante evaluation of environmental policy instruments. Firstly, it is assumed that target groups in environmental policy are homogeneous and thus can be expected to respond to policy instruments in a similar manner. Secondly, individual target group members are expected to respond to policy instruments in an economically rational way, particular in relation to MBIs applied in environmental policy. Based on surveys on farmers' motivations and rationales in their response to the Danish pesticide tax, we find that ex-ante expectations grounded in economic man are not met for the farmer community as a whole. Many farmers do behave like economic man, but there is also a large group with a more production-oriented motivation who show a weaker response to market-based instruments. Consequently, it comes as no surprise that the Danish pesticide tax, despite some large reductions in pesticide use (or more precisely pesticide load) after the tax reform in 2013, has not reached the reductions predicted in ex-ante economic calculations based on rational economic behaviour.

These findings support Howlett's (2018) suggestion that more knowledge on the match between policy instruments and their targets is needed. The findings also suggest that the design principles of policy mixes should be revisited to better take into account target group heterogeneity when designing policy mixes consisting of a set of policy instruments. Many public policies are indeed composed of a multitude of instruments. However, such instrument packages are often not 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. In such situations, the policy may lack a unifying overall logic behind the policy mix (Howlett & Rayner 2007; 2013; Kern & Howlett 2009). Hence, there is a need to develop methods to improve the design of policy mixes.

While it is now widely accepted that addressing a problem by implementing policy mixes tends to be more effective than a single instrument approach, our findings suggest that the principles for designing policy mixes need also to include diversity within the target group of a policy. Gunningham and Sinclair's (1999) work was ground-breaking and still is highly relevant for thinking about design principles for policy mixes. They highlighted complementarity as the key principle for combining instruments. The argument is that all instruments have weaknesses and strengths in addressing a problem and by combining instruments, the weaknesses of some instruments can be compensated for by including other instruments that address such weaknesses. The concept of complementarity has been translated into the concept of consistency in more recent studies, but essentially scholars are talking about the same thing. As suggested by Rogge and Reichardt (2016, p.1626), "... consistency captures how well the elements of the policy mix are aligned with each [other], ... It may range

from the absence of contradictions to the existence of synergies within and between the elements of the policy mix” (see e.g. also Howlett & Rayner 2007; Kern & Howlett 2009; May & Jochim 2013; Lindberg, Markard & Andersen 2019). If policy designers lose sight of complementarity (or consistency), there is a risk that policy mixes may become counter-productive where one or more instruments neutralize or diminish the effectiveness of other instruments. Gunningham and Sinclair’s (1999) focus was on how combining policy instruments in a package could improve effectiveness in terms of addressing a problem. This is particularly important when addressing complex and multifaceted problems. Different instruments can be targeted at different aspects of the problem (Daugbjerg & Sønderkov 2012).

As we have indicated in the case study, where the target group is heterogeneous, individual members respond differently to the behavioural mechanisms of the instruments. While Gunningham and Sinclair would probably not disagree that this is an important motivation for using policy mixes, their work is based on an implicit assumption that target groups are more or less homogeneous. As the recent scholarly debate and our data on Danish farmers’ motivations show, target group homogeneity cannot be assumed. Therefore, to achieve maximum impact, policy mixes should be designed to target various clusters within the target group. Complementarity remains an important concern, but if the potential of policy mixes to address complex policy problems is to be fully realized, more analytical and practical emphasis must be put on establishing how policy mixes can be designed to better address the heterogeneity within target groups. This can be considered the second dimension of designing policy mixes. An indication that Howlett’s (2018, 101) assertion that the assumption on target group homogeneity is underpinning policy instrument design is that even the most recent research on policy mixes does not pay attention to target group diversity and how

this should and can be reflected in policy instrument combinations. While instrument research does distinguish between different target groups in situations where achieving a policy objective requires that different groups are targeted (see e.g. Mavrot, Hadorn & Sager's (2019) study of tobacco control policy), diversity within a target group, for instance within the farming community, has not been paid sufficient attention.

Though taking target group heterogeneity into account when designing policy mixes appears appealing, it can be difficult in practice. From a purely technocratic perspective, government could design a policy in which each cluster is targeted by a single, or a set of, instrument(s) designed specifically to speak to the motivation and decision-making rationales within a specific cluster of individuals within the target group. However, this raises two concerns. First, it would cause legal concern about equal treatment and raise issues of fairness (see Gunningham and Sinclair 2005). Second, it would require that the target group can be clearly subdivided in clusters. This may not be possible when data are not available or when many individuals have mixed motives.

With the growing scholarly appreciation that target groups cannot be assumed to be homogenous when designing policy measures, more research is needed on how policy mixes can match different motivations within a target group. The research on different types of motivations within target groups has been growing since the publication of Thaler and Sunstein's 2008-book, *Nudge*, but there is still a need to link the findings of such research more explicitly to research on policy mixes. A focus on how instrument combinations can be designed to effectively address policy problems where target groups are heterogeneous would mark a new and innovative stage in the research on policy instruments and design (see Howlett, Mukherjee, Woo (2015) for an overview of the three stages of instrument research). A better understanding of the

diversity of motivations found within target groups and how instrument packages can be designed to achieve a higher policy impact would be welcomed by policy makers. This would in particular be true for environmental policy makers who often find themselves confronted with recurrently under-achieving policies and politicians who are reluctant to introduce tough measures to achieve the stated objective.

Acknowledgement

We gratefully acknowledge the financial funding from the Danish Environmental Protection Agency's 'Bekæmpelsesmiddelforskningsprogram' for the research on pesticide policies referred to in in this article through the grants MST-667-00073 and MST-667-00120; and the Aarhus University 'AU Tapwater' project for funding part of the time used on writing this article. We thank the participants of the JEPP@21 Workshop in Berlin September 2019 for very helpful comments on a draft version of the paper. Finally, yet importantly, we thank farmers and advisors who took the time to participate in those surveys and qualitative interviews referred to.

References

- Andersen, M.S. & Massa, I. (2000). Ecological modernization — origins, dilemmas and future directions. *Journal of Environmental Policy & Planning* 2, 337-345.
- Angner, E. (2019). We're all behavioral economists now. *Journal of Economic Methodology* 26(3), 195-207.
- Bachaus, K., van Ootegem, L. & Verhofstadt, E. (2019). 'No taxation without hypothecation': towards an improved understanding of the acceptability of an environmental tax reform. *Journal of Environmental Policy & Planning* 21, 321-332.

- Bartkowski, B. & Bartke, S. 2018. Leverage Points for Governing Agricultural Soils: A Review of Empirical Studies of European Farmers' Decision-Making. *Sustainability* 2018 10(9).
- Battaglio, R.P., Bellé, N. & Cantarelli, P. (2019). Behavioral Public Administration ad fontes: A Synthesis of Research on Bounded Rationality, Cognitive Biases, and Nudging in Public Organizations. *Public Administration Review* 79(3), 304–320.
- Begg, D., Fischer, S., & Dornbusch, R., (1991), *Economics (3rd edition)*. London et al.: McGraw-Hill.
- Brodts, S., Klonsky, K. & Tourte, L., 2006. Farmers' goals and management styles: implications for advancing biologically based agriculture. *Agricultural Systems* 89, 90–105.
- Burton, R.J.F., Kuczera, C. & Schwarz, G., (2008). Exploring Farmers' Cultural Resistance to Voluntary Agri-environmental Schemes. *Sociologia Ruralis* 48(1), 16-37.
- Camerer, C. F., (2003). Strategizing in the Brain. *Science* 300(5626), 1673-1675.
- Camerer, C.F., & Fehr, E., (2006). When Does “Economic Man” Dominate Social Behavior? *Science* 311:5757.
- Dahl, R.A. & Lindblom, C.E., (1953). *Politics, economics and welfare: Planning and politico-economic systems resolved into basic social processes*. New York: Harper and Row.
- Danish Competition Authority, (2006). *Konkurrenceredegørelse 2006*. Copenhagen. <https://www.kfst.dk/media/3092/konkurrenceredegoerelse-2006-analyse-20060522.pdf> (at 04.12.2019).
- Danish Environmental Protection Agency (2018). *Evaluering af den differentierede pesticidafgift (Orientering fra Miljøstyrelsen nr. 26)*. Danish Environmental Protection Agency.
- Danish Environmental Protection Agency, (2019). *Bekæmpelsesmiddelstatistik 2019 - Behandlingshyppighed og pesticidbelastning baseret på salg og forbrug (Orientering fra Miljøstyrelsen nr. 31 2019)*. Copenhagen: Ministry of Environment and Food, Environmental Protection Agency. <https://www2.mst.dk/Udgiv/publikationer/2019/03/978-87-7038-053-9.pdf> (at 23.07.2019).
- Danish Government, (2013). *Beskyt Vand, Natur og Sundhed – Sprøjtemiddelstrategi 2013-2015*. Copenhagen.

- Daugbjerg, C. & Sønderkov, K.M., (2012). Environmental Policy Performance Revisited: Designing Effective Policies for Green Markets. *Political Studies* 60(29), 399-418.
- Davies, B.B. & Hodge, I.D., (2007). Exploring environmental perspectives in lowland agriculture: A Q methodology study in East Anglia, UK. *Ecological Economics* 61(1-2), 323-333.
- DEFRA, 2006. *Behaviour and Motivations of Farmers in Responding to Policy Changes in England, Research project EPES 0405/17, Final Report by University of Reading, Commissioned by DEFRA.*
- Ekins, P., (1999). European environmental taxes and charges: recent experience, issues and trends. *Ecological Economics* 31, 39–62.
- Ekins, P. & Speck, S. (2000). Proposals of environmental fiscal reforms and the obstacles to their implementation. *Journal of Environmental Policy & Planning* 2, 93-114.
- Fehr, E. & Gächter, S, (2001). Fairness and Retaliation: The Economics of Reciprocity. *Journal of Economic Perspectives*, Summer 2000, 14(3), pp.159-81.
- Gago, A. & Labandeira, X. (2000). Towards a green tax reform model. *Journal of Environmental Policy & Planning* 2, 25-37.
- Gasson, R., (1973). Goals and values of farmers. *Journal of Agricultural Economics* 24, 521-542.
- Garforth, C. & Rehman, T., (2006). *Research to Understand and Model the Behaviour and Motivations of Farmers in Responding to Policy Changes (England). Annex A to the final report: Research methodology (Research project EPES 0405/17), University of Reading.*
- Gintis, H., (2000). Beyond Homo Oeconomicus: Evidence from Experimental Economics. *Ecological Economics* 35(3), 311-322.
- Greiner, R. & Gregg, D., (2011). Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from northern Australia. *Land Use Policy* 28(1), 257-265.
- Gunningham, N. & Sinclair, D., (1999). Regulatory Pluralism: Designing Policy Mixes for Environmental Protection. *Law & Policy* 21(1), 49-76.
- Gunningham, N. & Sinclair, D., (2005). Policy Instrument Choice and Diffuse Source Pollution. *Journal of Environmental Law* 17(1), 51-81.

- Guthman, J. & Brown, S. (2016). Midas' Not-So-Golden Touch: On the Demise of Methyl Iodide as a Soil Fumigant in California. *Journal of Environmental Policy & Planning* 18, 324-341.
- Halpern, D., (2015). *Inside the Nudge Unit. How small changes make a big difference.* London: WH Allen, Penguin Random House.
- Howlett, M., (2018). Matching policy tools and their targets: beyond nudges and utility maximization in policy design. *Policy & Politics* 46(1), 101-124.
- Howlett, M., Mukherjee, I. & Woo, J. J., (2015). From tools to toolkits in policy design studies: the new design orientation towards policy formulation research. *Policy & Politics* 43(2), 291-311.
- Howlett, M. & Rayner, J., (2007). Design Principles for Policy Mixes: Cohesion and Coherence in 'New Governance Arrangements'. *Policy and Society* 26(4), 1-18.
- Howlett, M., & Rayner, J., (2013). Patching vs Packaging in Policy Formulation: Assessing Policy Portfolio Design. *Politics and Governance* 1(2), 170-182.
- Jones, B. D., (2001). *Politics and the Architecture of Choice. Bounded rationality and Governance.* Chicago: The University of Chicago Press.
- Jordan, A., Wurzel, R.K.W. & Zito, A.R., (2013). Still the century of 'new' environmental policy instruments? Exploring patterns of innovation and continuity. *Environmental Politics* 22(1), 155-173.
- Juerges, N., Hagemann, N. & Bartke, S. (2018). A Tool to Analyse Instruments for Soil Governance: the REEL-Framework. *Journal of Environmental Policy & Planning* 20, 617-631.
- Jørgensen, L.N., Noe, E., Langvad, A.-M., Rydahl, P., Jensen, J.E., Ørum, J.E., Pinnschmidt, H. & Bjørn, O.Q., (2007). *Vurdering af Planteværn Onlines økonomiske og miljømæssige effekt (Bekæmpelsesmiddelforskning fra Miljøstyrelsen nr. 115).* Copenhagen: Danish Environmental Protection Agency.
- Kern, F. & Howlett, M., (2009). Implementing transition management as policy reforms: a case study of the Dutch energy sector. *Policy Sciences* 42, 391-408.
- L44 1997/1998. L 44 (som fremsat): *Forslag til lov om ændring af lov om afgift af bekæmpelsesmidler og lov om ændring af forskellige punktafgiftslove (Afgiftsforhøjelse m.v.).*
- Lasswell, H., (1954). Key symbols, signs and icons. In L. Bryson, L. Finkelstein, R.M. MacIver, R. McKean (eds), *Symbols and values: An initial study*, (pp.77-94). New York: Harper and Brothers.

- Lindberg, M. B., Markard, J. & Andersen, A. D., (2019). Policies, actors and sustainability transition pathways: A study of the EU's energy policy mix. *Research Policy* 48(10).
- Lowi, T.J., (1966). Distribution, regulation, redistribution: The functions of government. In R.B. Ripley (ed.) *Public policies and their politics: Techniques of government control*, (pp.27-40). New York: WW Norton.
- Mavrot C., Hadorn, S. & Sager, F., (2019). Mapping the Mix: Linking Instruments, Settings and Target Groups in the Study of Policy Mixes. *Research Policy* 48(10).
- May, P. J. & Jochim, A.E., (2013). Policy Regime Perspectives: Policies, Politics, and Governing. *Policy Studies Journal* 41(3), 426–452.
- Minister of Taxation, (1995). *Forslag til lov om bekæmpelsesmidler. Lovforslag nr. L186. Fremsat den 7. marts 1995 af skatteministeren (Carsten Koch)*.
- Ministry of Environment and Food of Denmark, (2017). *Danish National Actionplan on Pesticides 2017-2021. Facts, caution and consideration*. Ministry of Environment and Food of Denmark.
- Mitchell, G.F.C., (1968). *Application of a Likert-type Scale to the Measurement of the Degree of Farmers' Subscriptions to Certain Goals or Values*. Bristol: University of Bristol, Department of Economics.
- Nielsen, H. Ø., (2010). *Bounded rationality in decision-making*. Manchester University Press.
- Nielsen, H. Ø. (2013). “Bounded Rationality in an Imperfect World of Regulations: What If Individuals are Not Optimizing?”. In Milne, J., Andersen, M.S. (red.) *Handbook of Research on Environmental Taxation*, (pp.439-455). Edward Elgar Publishing.
- Nielsen, V.L. & Parker, C., (2012). Mixed Motives: Economic, Social, and Normative Motivations in Business Compliance. *Journal of International Law and Policy* 34(4), 428-462.
- Nielsen, H.Ø., Pedersen, A.B., Konrad, M.T. & Gyldenkærne, S., (2020). *Evaluering af den omlagte pesticidafgift – Betydningen af beslutningsadfærd for pesticidanvendelsen* (Bekæmpelsesmiddelforskning nr. 183). Danish Environmental Protection Agency.

- OECD, (2001). *Environmentally related taxes in OECD countries. Issues and strategies*. Paris: OECD. <https://www.cbd.int/financial/fiscalenviron/g-fiscaltaxes-oecd.pdf>
- OECD (2012). *Farmer Behaviour, Agricultural Management and Climate Change*. Paris: OECD. <https://www.oecd-ilibrary.org/docserver/9789264167650-en.pdf?expires=1575553133&id=id&acname=ocid177114&checksum=E8BC13AC08BC4C28AF54F9AA0019D352>
- OECD (2016a). *Debate the Issues: New Approaches to Economic Challenges, OECD Insights*. Paris: OECD. <http://dx.doi.org/10.1787/9789264264687-en>
- OECD (2016b). *Farm Management Practices to Foster Green Growth, OECD Green Growth Studies*. Paris: OECD. <http://dx.doi.org/10.1787/9789264238657-en>
- OECD (2019). *Taxing Energy Use 2019: Using Taxes for Climate Action*. Paris: OECD <https://doi.org/10.1787/058ca239-en>.
- Pearce, D., Markandya, A. & Barbier, E.B., (1989). *Blueprint for a Green Economy*. London: Earthscan Publications Ltd.
- Pearce, D. W., (1991). The Role of Carbon Taxes in Adjusting to Global Warming. *Economic Journal* 101, 938–948.
- Pedersen, A.B., Nielsen, H.Ø., Christensen, T. & Hasler, B., (2012). Optimising the effect of policy instruments: a study of farmers' decision rationales and how they match the incentives in Danish pesticide policy. *Journal of Environmental Planning and Management* 55(8), 1094-1110.
- Pedersen, A.B., Nielsen, H.Ø. & Andersen, M.S. (2015). The Danish Pesticide Tax. In M.Lago, J. Mysiak, C.M.Gómez, G.Delacámara, A.Maziotis, *Use of Economic Instruments in Water Policy: Insights from International Experience (Global Issues in Water Policy 14)*, (pp.73-88). Springer.
- Pedersen, A.B. & Nielsen, H.Ø., (2017). Effectiveness of pesticide policies: Experiences from Danish pesticide regulation 1986-2015. In Coll, M & Wajnberg, E. (eds.), *Environmental Pest Management – Challenges for Agronomists, Ecologists, Economists and Policymakers*, (pp.299-324). Wiley.
- Perman, R., Ma, Y. & McGilvray, J., (1996). *Natural Resource and Environmental Economics*. London & New York: Longman.
- Rogge, K.S., Reichardt, K., (2016). Policy mixes for sustainability transitions: an extended concept and framework for analysis. *Research Policy* 45(8), 1620-1635.

- Ruiz-Villaverde, A., (2019). Editor's Introduction: The Growing Failure of the Neoclassical Paradigm in Economics. *The American Journal of Economics and Sociology* 78(1), 13-34.
- Schneider, A. & Ingram, H., (1990). Behavioural Assumptions of Policy Tools. *The Journal of Politics* 52(2), 510-529.
- Schwarze, J., Holst, G.S., Mußhoff, O., (2014). Do farmers act like perfectly rational profit maximisers? Results of an extra-laboratory experiment. *International Journal of Agricultural Management* 4:1.
- Simon, H.A., (1997). *Models of Bounded Rationality: Empirically Grounded Economic Reason*. Cambridge: MIT Press.
- Straßheim, H. & Beck, S. (eds.), (2019). *Handbook of Behavioural Change and Public Policy*. Edward Elgar.
- Thaler, R.H. & Sunstein, C.R., (2008). *Nudge: Improving Decisions about Health, Wealth and Happiness*. New Haven: Yale University Press.
- Tinbergen, J., (1952). *On the theory of economic policy*. Amsterdam: North Holland.
- Tversky, A. & Kahneman, D., (1974). Judgment under Uncertainty: Heuristics and Biases. *Science* 185, 1124-1131.
- van den Bergh, J.C.J.M., Ferrer-i-Carbonell, A. & Munda, G. (2000). Alternative models of individual behaviour and implications for environmental policy. *Ecological Economics* 32, 43-61.
- Weaver, R. K. (2014). Compliance Regimes and Barriers to Behavioural Change. *Governance* 27(2), 243-265
- Willock, J., Deary, I.J., Edwards-Jones, G., Gibson, G.J., McGregor, M.J., Sutherland, A., Dent, J.B., Morgan, O. & Grieve, R., (1999). The role of attitudes and objectives in farmer decision making: business and environmentally-oriented behaviour in Scotland. *Journal of Agricultural Economics* 50(2), 286–303.
- Winsten, J. & Hunter, M. (2011). Using pay-for-performance conservation to address the challenges of the next farm bill. *Journal of Soil and Water Conservation* 66:4, 111A-117A.
- Winter, S. & May, P. J., (2001). Motivation for Compliance with Environmental Regulations. *Journal of Policy Analysis and Management* 20, 675–98.
- Wolff, F., Schönherr, N. & Heyen, D.A. (2017). Effects and success factors of sustainable consumption policy instruments: a comparative assessment across Europe. *Journal of Environmental Policy & Planning* 19, 457-472.

- Wurzel, R.K.W., Zito, A.R. & Jordan, A.J. (eds.), 2013. *Environmental Governance in Europe. A Comparative Analysis of New Environmental Policy Instruments*. Cheltenham (UK), Northampton (MA): Edward Elgar.
- Ørum, J. E., Boesen, M. V., Jørgensen, L. N., & Kudsk, P., 2008. *Opdateret analyse af de driftsøkonomiske muligheder for en reduceret pesticidanvendelse i dansk landbrug – en beskrivelse af udviklingen fra 2003–2008*. Copenhagen: University of Copenhagen.
- Ørum, J.E., Jørgensen, L.N. & Kudsk, P., 2013. *Potentiel reduktion i pesticidbelastning ved substitution af midler og anvendelse af IPM (IFRO Udredning Nr. 2013/17)*. Copenhagen: University of Copenhagen.