The effects of risk based pesticide taxation in Denmark

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INTRODUCTION

Denmark – a 30 year-long history of taxing pesticides
Until recent redesign, not great effect
New pesticide tax appears to deliver on promises

Outline:
• Brief introduction to Danish agriculture
• Why tax pesticides – and how
• Design of Danish pesticide tax 1996-2013
• Effects of the tax 1996-2013
• Design of Danish pesticide tax 2013-
• Effects of the tax 2013- (limitations on how much we can go in detail, unpublished work in progress)
• A few concerns
• Transferability?
DENMARK

Pop. 5.7 million
Area 43,000 km²
GDP per capita: 48,400 EUR

- Farmland 61%, cereals, fodder, potatoes ....
- World Bank: 1.1% of GDP 2017

Source: Ministry of taxation 2017
Copyright: NOAA, TV2 vejret
Why tax pesticides?

- Prices should reflect externalities caused by use of pesticides
- Higher prices offer incentive to reduce use of pesticides or switch to less harmful products
  - Theoretically, tax every farm according to emissions and negative effects on the farm’s surroundings.
  - However – challenge when diffuse emissions. Administration costs huge etc etc
- Plan B: Tax business inputs like fertilizers and pesticides since they are good proxies for negative effects
- Needless to say - tax design is very important for the effects
1996-2013 Ad valorem pesticide tax

- Background: failure to reach aims of 1986 Pesticide Action Plan + subsequent plans: 50% reduction of pesticide use (broad political agreements)
- A ‘true’ environmental tax was debated in 1996 but the different ministries couldn’t provide the necessary data to assess the negative effects of pesticides
- Consequently, an ad valorem pesticide tax was introduced
- Aim: Treatment frequency index at 1.7 = economically optimal
- 37% on insecticides, 15% on fungicides, herbicides and growth regulators
- Lack of effect lead to doubling of tax (on average) 1998. 54% on insecticides, 33% on fungicides, herbicides and growth regulators
- Reimbursement of revenue to the sector. Primarily through reduced land tax
Effects 1985-2012.
Aim: Treatment frequency index 1.7
Cause lack of effect- farmers not 100% economic man

• Not all farmers respond like ‘economic man’
• Danish survey with responses from more than 1100 farmers. Cluster analysis showed that half of the farmers are very economically motivated (Pedersen et al. 2012)
• However, one third of the farmers are primarily focused on maximizing physical yield and less on prices on crops and pesticides. Not primarily motivated by prices. Motivated by e.g. strong sense of professionalism
• It affects their response to economic policy instruments
Table 1. How important are the following objectives for your usage of plant protection chemicals. Please mark a number between 1 and 5 where 1 equals not important at all and 5 equals very important (%), N varies.*

<table>
<thead>
<tr>
<th>Rationale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Do not know</th>
<th>Mean score*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure greatest crop yield</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>40</td>
<td>41</td>
<td>0</td>
<td>4.2</td>
</tr>
<tr>
<td>Forestall future problems</td>
<td>1</td>
<td>5</td>
<td>20</td>
<td>44</td>
<td>29</td>
<td>0</td>
<td>3.9</td>
</tr>
<tr>
<td>Professional ambition to use few chemicals</td>
<td>2</td>
<td>7</td>
<td>26</td>
<td>37</td>
<td>28</td>
<td>0</td>
<td>3.8</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>3</td>
<td>6</td>
<td>29</td>
<td>40</td>
<td>21</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>Price of crop</td>
<td>3</td>
<td>7</td>
<td>27</td>
<td>38</td>
<td>24</td>
<td>1</td>
<td>3.7</td>
</tr>
<tr>
<td>Clean fields</td>
<td>1</td>
<td>12</td>
<td>33</td>
<td>38</td>
<td>16</td>
<td>1</td>
<td>3.6</td>
</tr>
<tr>
<td>Price, herbicides</td>
<td>3</td>
<td>9</td>
<td>33</td>
<td>35</td>
<td>20</td>
<td>1</td>
<td>3.6</td>
</tr>
<tr>
<td>Price, fungicides</td>
<td>3</td>
<td>9</td>
<td>31</td>
<td>35</td>
<td>20</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>Price, insecticides</td>
<td>6</td>
<td>12</td>
<td>34</td>
<td>28</td>
<td>16</td>
<td>4</td>
<td>3.4</td>
</tr>
<tr>
<td>Costs of bringing out</td>
<td>11</td>
<td>24</td>
<td>30</td>
<td>25</td>
<td>10</td>
<td>1</td>
<td>3.0</td>
</tr>
<tr>
<td>Work time, planning</td>
<td>15</td>
<td>20</td>
<td>32</td>
<td>25</td>
<td>8</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Price, growth inhibitors</td>
<td>24</td>
<td>14</td>
<td>20</td>
<td>14</td>
<td>11</td>
<td>16</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Note: *The mean score for each item was calculated excluding ‘do not know’ answers. N is approximately 1150 on most items, except for the item ‘price of insecticides’ which drew 1117 responses and the item ‘price of growth inhibitors’ which drew 975 responses.
Table 2. How do you assess the risk of the use of plant protection chemicals with regard to the following issues? Please rate on a scale from 1 to 5 where 1 indicates ‘no risk’ and 5 indicates ‘very great risk’ (%), N varies.*

<table>
<thead>
<tr>
<th>Risk of ...</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Don’t know</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of reduced yield from reducing the use of PPCs</td>
<td>3</td>
<td>6</td>
<td>22</td>
<td>37</td>
<td>31</td>
<td>1</td>
<td>3.9</td>
</tr>
<tr>
<td>Risk to farmer’s health from application</td>
<td>15</td>
<td>33</td>
<td>27</td>
<td>16</td>
<td>9</td>
<td>1</td>
<td>2.7</td>
</tr>
<tr>
<td>Risk of pollution of water courses and lakes</td>
<td>13</td>
<td>36</td>
<td>26</td>
<td>14</td>
<td>9</td>
<td>1</td>
<td>2.7</td>
</tr>
<tr>
<td>Risk of damage to wildlife and wild plants</td>
<td>11</td>
<td>37</td>
<td>31</td>
<td>13</td>
<td>6</td>
<td>1</td>
<td>2.7</td>
</tr>
<tr>
<td>Risk of damage to crop</td>
<td>17</td>
<td>39</td>
<td>24</td>
<td>14</td>
<td>5</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Risk of pollution of groundwater/drinking water</td>
<td>19</td>
<td>37</td>
<td>21</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Risk of pesticide residues in food</td>
<td>26</td>
<td>36</td>
<td>20</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Note: N* is approximately 1150 respondents for all items.
More on farmer heterogeneity

• Size and type of farm etc influences decision-making. E.g.:
  • Difficult to know your weed spots in detail if you have >200 ha.
  • If you have livestock or an extra job it demands extra attention
• But also variations in decision rationale across the farmers as demonstrated above (rules of thumb etc etc)
Why difficult to reach aims?

- TFI 1.7 might be economically optimal, but not all farmers are acting 100% like economic man
- Denmark was already low?
- Climate effects, crop changes etc.? Can’t explain lack of effect
- Low price elasticity. Risk averse
Some of the farmers might not always get the best advice from their agri advisors

• Two results from research we did on Danish agricultural consultants:
  • 69% of Danish agricultural consultants partly (27%) or very much (42%) agree that approved pesticides are innocuous for the environment if the label recommendations are not exceeded
  • Advisors employed by chemical companies and agricultural companies selling pesticides are less likely to recommend lower doses than advisors employed at companies not selling pesticides (differences significant but not very large)
New pesticide plan, 2013-2016 (cont. 2017-2021)

- Adopted in June 2012
- Most important policy instrument: Revised pesticide tax.
  - Tax differentiated according to impact on environment and health of each product, based on a newly developed indicator (PL)
    - Increased tax rates in general
    - Revenue returned to farmers through reduced taxes on land
- Main objective: Reduction in pesticide load by 40 pct. by 2015/16 compared with 2011. Based on the Pesticide Load Indicator (PLI) to be reduced to 1.96
The pesticide Load indicator

- For all commercial products, a pesticide load (PL) is calculated and expressed as the PL per unit commercial product (kg, litre or tablet).

- Three elements:
  - Human health indicator
  - Ecotoxicology indicator
  - Environmental fate indicator

(see e.g. Kudsk et al. 2018)
New pesticide tax – design

• **TAX BASES**

• Basic tax 50 kr./kg active substance (6.5 EUR)
• Health 107 kr./kg pesticide pr. unit load index (13.9 EUR)
• Environmental effect 107 kr./kg active substance pr. unit load index
• Environmental behaviour 107 kr./kg active substance pr. unit load index

(1 DKK = 0.13 EURO)

• Average tax rate increased by 125 pct.
• Revenue: ≈10 pct from basic tax and 30 pct. from each of load taxes
• Huge differences in price levels – some pesticides became very expensive, some not
• Assessment based on the EU approval of the active substance
“The differences in maximum PL points reflect that the major concerns in Denmark regarding the current use of pesticides are adverse effects on bees/pollinators, aquatic organisms and leaching to the groundwater. The higher maximum number of PL points implies that pesticides adversely affecting bees/pollinators and aquatic organisms or presenting a high risk to the groundwater will score higher and be imposed a higher tax.”

Source: Kudsk et al. 2018

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### Table 1

Input parameters included in the calculation of PL\textsubscript{ECO} and PL\textsubscript{FATE}, maximum values and reference active ingredients for each input parameter.

#### Ecotoxicology

<table>
<thead>
<tr>
<th>Input parameters</th>
<th>Unit</th>
<th>Maximum value</th>
<th>Reference active ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds – acute LD\textsubscript{50}</td>
<td>mg/kg body weight</td>
<td>49</td>
<td>Thiacloprid</td>
</tr>
<tr>
<td>Mammals – acute oral LD\textsubscript{50}</td>
<td>mg/kg body weight</td>
<td>20</td>
<td>Lambda-cyhalothrin</td>
</tr>
<tr>
<td>Fish – acute 96 h LC\textsubscript{50}</td>
<td>mg/L water</td>
<td>0.00021</td>
<td>Lambda-cyhalothrin</td>
</tr>
<tr>
<td>Daphnia – acute 48 h EC\textsubscript{50}</td>
<td>mg/L water</td>
<td>0.0003</td>
<td>Alpha-cypermethrin</td>
</tr>
<tr>
<td>Algae – acute 72 h EC\textsubscript{50}</td>
<td>mg/L water</td>
<td>0.000025</td>
<td>Picolinafen</td>
</tr>
<tr>
<td>Aquatic plants – 7d EC\textsubscript{50}</td>
<td>mg/L water</td>
<td>0.00036</td>
<td>Metsulfuron-methyl</td>
</tr>
<tr>
<td>Earthworms – acute 14d LC\textsubscript{50}</td>
<td>mg/kg soil</td>
<td>3.4</td>
<td>Picoxystrobin</td>
</tr>
<tr>
<td>Honeybees – acute 48 h LD\textsubscript{50}</td>
<td>mg/bee</td>
<td>0.02</td>
<td>Cypermethrin</td>
</tr>
<tr>
<td>Fish – chronic 21d NOEC</td>
<td>mg/L water</td>
<td>0.000115</td>
<td>Alpha-cypermethrin</td>
</tr>
<tr>
<td>Daphnia – chronic 21d NOEC</td>
<td>mg/L water</td>
<td>0.000115</td>
<td>Alpha-cypermethrin</td>
</tr>
<tr>
<td>Earthworms – chronic 14d NOEC</td>
<td>mg/kg soil</td>
<td>0.2</td>
<td>Epoxiconazole</td>
</tr>
</tbody>
</table>

#### Environmental fate

<table>
<thead>
<tr>
<th>Input parameters</th>
<th>Unit</th>
<th>Maximum value</th>
<th>Reference active ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil degradation – DT\textsubscript{50}</td>
<td>Days</td>
<td>354</td>
<td>Epoxiconazole</td>
</tr>
<tr>
<td>Bioaccumulation</td>
<td>Bio-concentration factor</td>
<td>5100</td>
<td>Pendimethalin</td>
</tr>
<tr>
<td>Mobility</td>
<td>SCI-GROW index</td>
<td>10.91</td>
<td>Thifensulfuron-methyl</td>
</tr>
</tbody>
</table>
Kudsk et al. 2018

• “PL for human health (PLHH) is based on the risk phrases on the product label, while PL for ecotoxicology (PLECO) is calculated on basis of the LC/LD/EC50 values of the active ingredients for acute toxicity to mammals, birds, fish, daphnia, algae, aquatic plants, earthworms and bees and NOEC values for chronic toxicity to fish, daphnia and earthworms. PL for environmental fate (PLFATE) is calculated on basis of the half-life in soil (DT50), the bioaccumulation factor (BCF) and the SCI-GROW index. PL does not consider the actual exposure, i.e. it reflects the relative risks associated with the use of pesticides”
Effects of new tax – sales statistics + individual farmer spray registrations

- Sales:
  - 40% reduction load

- USE (spray journals)
  - Overall use (TF) +24 pct.
  - Load (P load/ha) –15 pct.

- I.e. substitution towards less harmful substances

- Conclusion: tax appears to be working…… enough?

![Graph showing development, pesticide use from 2011 to 2016](image)
Revenues

- Before 2013: 500M DKK (67M EUR) annually (most of it reimbursed through lower land tax)

- Expected new revenue size after 2013:
  - 1.1 B DKK *without behavioural effect*
  - 650 M with a 40 pct. reduction in sales
  - 150 M reimbursed to farmers through lower land taxes, i.e. a redistribution

- Revenue, realized: about 550 mill. DKK (but difficult to assess finally yet)
Survey with 600 farmer responses
(work in progress – publication date autumn 2019. Therefore I can’t go into detail)

• Indications so far:
• Farm size and farm type matters again
• We see some clusters again. Some similar motivations
• Some differences across crops
Potential aber dabei’s

• DISTRIBUTIONAL EFFECTS?
  • High value crops – increased crop sales prices have outpaced pesticide prices
  • A few crops – production area decreased due to production cost increases, but minor

• PESTICIDE RESISTENCE
  • Use of narrower portfolio of products? Resistance? Danish EPA 2018:
    • Herbicides – there is a risk of increased resistance among some grass weeds if substitution towards ‘minimidler’ continues. However, can be solved by following IPM principles etc.
    • Fungicides – increased resistance, but not due to tax (in general small supply of active substances for fungi)
    • Insecticides – no change

• ILLEGAL IMPORTS?
  • If prices increase, the incentive to cross the border increases….’
  • Unconfirmed numbers: 2016 – in 2 pct. of 762 farm inspections found illegal substances never allowed in DK

(Source: The Danish Society for Nature Conservation, based on preliminary EPA reports, 2017)
Experiences other countries

- UK, Germany, Sweden: pesticide registration fees
- Some countries - Cyprus, Poland, Portugal, Slovenia, and Spain - charge reduced VAT rates for pesticides! France abandoned reduced VAT on pesticides (only on organic now)
- Finland abolished their registration/administration tax on pesticides in 2007
- Source: Böcker and Finger (2016)

- Many countries use development in sales of active ingredients as indicator – but it doesn’t tell us much
Comparison
(better Eurostat data would help….)

Table 13.4. Treatment frequency index (TFI) in wheat and yield in wheat (2006/2007)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TFI in wheat</td>
<td>6.74</td>
<td>4.1</td>
<td>5.8*</td>
<td>2.62</td>
</tr>
<tr>
<td>Wheat yield, tonnes per ha.</td>
<td>8.0</td>
<td>6.9</td>
<td>7.3</td>
<td>7.3</td>
</tr>
</tbody>
</table>

Source: Jørgensen and Jensen 2011. Note: *Snail pesticides not included.
Transferability

• Generally, higher use of pesticides in most comparable countries, so possibly low hanging fruits?

• But issues to consider:
  • Tax design
  • Need data and expertise to devise proper tax base
  • Need tax rate high enough – political will?
  • Know your farmers: what drives their decisions and what obstacles to price adjustment
  • Other policy instruments necessary, possibly financed by tax revenue

Process
• Involve stakeholders in process - provide input and increase acceptance
Policy recommendation

- Pesticide tax
- Strict approval systems
- Schemes to support e.g. new pesticide reduction smart technologies
- Information (e.g. through independent consultants)
- Accompanied by strong economic incentives reductions are possible
- Better European pesticide indicators needed
- Challenge: political support to make an effective policy design?
  - In DK lobbying for abolishing tax
REFERENCES


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, p. 1094-1110


Pedersen, A.B., Nielsen, H.Ø., Christensen, T., Ørum, J.E., Martinsen, L., (forthcoming), Are independent agricultural advisors more oriented towards recommending reduced pesticide use than supplier-affiliated advisors? *Journal of Environmental Management*.
Projects that have contributed to the research results

- Danish Ministry of Environment’s Pesticide Research Programme: A number of different projects – e.g. on farmer and advisor behavior etc. + Evaluation of the new tax (2015-2019) for the Danish MoE
- EU FP7 (2011-14): EPI-WATER - Evaluating economic policy instruments for sustainable water management in Europe
- EU DG Environment (2016-17): Capacity building, programmatic development and communication in the field of environmental taxation and budgetary reform

Thank you!

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