



Fertilizer and Pesticide Taxes for Controlling Non-point Agricultural Pollution

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Agriculture contributes negative and positive externalities to society. A particular feature of the negative externalities is the damage done by nutrient pollution and by pesticides. Nutrient pollution refers to water pollution mainly from nitrates and phosphorus, concentrations being elevated by leaching from soils of fertilizers and animal manure and slurry. A similar leaching process occurs with pesticides. Significant repositories for these leached pollutants are surface waters and groundwater. Eutrophication of water results from excess nutrient loading. Eutrophication contributes to losses of biological diversity, while nitrate concentrations in drinking water may be a health hazard.

A notable characteristic of these sources of pollution is that they are dispersed or 'non-point', which raises a complex policy issue, namely how to design a system of controls for pollutants the sources of which are hard to identify. Our contribution is concerned with the extent to which market-based economic instruments, such as taxes, could be used to control non-point pollution.

There is fairly extensive experience with pesticide and fertilizer taxes in OECD countries. The problems with designing these taxes are several. The experience of those countries that have introduced these taxes is that they appear to have played some role in reducing pesticide and fertilizer use. However, their price elasticity estimates are low and this suggests comparatively little effect in terms of quantity reductions, unless they are set at very high rates (relative to price). There is some suggestion that revenue recycling may have been more effective, with revenues redirected to research and information. In terms of environmental effectiveness, there is a problem both with pesticide and fertilizer taxes, in terms of being proportional to damage done. However, whereas pesticides vary in their toxicity by design and also according to the conditions in the receiving environment, fertilizer damage tends to vary mainly because of the receiving environment conditions.

Moreover, pesticides and fertilizers can be expected to be over-used due to risk aversion among farmers. This means that farmers will prefer to over-use them rather than under-use them, the latter option being associated with risks of unacceptable increases in the variance of the profit from crop yield. Hence a tax should reduce pesticide and fertilizer use without giving rise to profit reductions. This can be achieved in the case of fertilizers, when other technologies are available for replacing artificial fertilizers (e.g. leguminous crops). However, even if fertilizers and pesticides are used optimally from the standpoint of the farmer's interests, profit reductions may be justified as the price to be paid for reducing environmental externalities.

Both Norwegian and Swedish official reviews on the effectiveness of pesticide and fertilizer taxes, reached the conclusion that they will do little to reduce their use, although both also agreed that it is difficult to disentangle tax effects from other policy effects. This suggests that, as mentioned above, the effectiveness of these taxes rests on the uses of the tax revenues. The Danish experience suggests that recycling revenues back into agriculture severely reduces the effectiveness of the

tax. Using revenues to further research or encourage changes in farming practice would appear to make more sense. Damage from pesticides and fertilizers, is cumulative so that current damage is partly a function of their past releases. This will be especially true of water contamination by pesticides and fertilizers. If revenues can be hypothecated, they can be used for groundwater clean-up programmes, so that revenue-raising taxes nonetheless have an externality reducing function.

Moreover, most taxes have been designed as percentage of pesticide and fertilizer prices. The risk here is that technological progress in pesticide and fertilizer manufacturing can give rise to price falls, and consequently absolute tax reductions, encouraging more pesticide and fertilizer use. Taxes per unit of active ingredient can also fail to approximate differential environmental and health impacts. The theoretical solution here is to express the tax as an absolute sum per unit of toxicity-weighted ingredient.¹ Securing the toxicity weights is potentially feasible through the use of health-risk coefficients and health or ecological risk coefficients. In practice, capturing the 'true' marginal damage from different forms of pesticide and fertilizers is complex due to other factors affecting damage - e.g. ground and weather conditions, ecosystem variation, and so on. As already noted above, fertilizer damage in particular, tends to vary mainly because of the receiving environment conditions rather than toxicity.

Unfortunately, there are few examples of *actual* taxes being differentiated by toxicity. The Norwegian reforms of 1999 appear to come closest to this. Even though the overall demand for pesticides is not reduced significantly by a tax, a toxicity-differentiated tax may be effective if substitution between pesticides will occur in such a way that the overall toxic impact of pesticides will be reduced. In short,

¹ However, as pointed out by an anonymous referee, the real value of an absolute tax will decline if prices increase due to inflationary pressures.

pesticide use and toxicity could be 'decoupled' by a pesticide tax. The problem with pesticide tax studies is that few of them simulate the 'cross price effects' of such a policy, i.e. they do not look closely at substitution between types of pesticides (or between pesticides and other inputs such as fertilizers and land). Simulations of such toxicity-weighted taxes for the UK in the period 1992-1998 show that overall price elasticity of demand for pesticides was consistently low and never greater than -0.39 . However, cross price elasticities between the 'banded' pesticides (banded according to toxicity) were greater than the 'own' price elasticities, suggesting that farmers might switch between types of pesticide.

As far as fertilizer taxes are concerned, it is important to note that the Netherlands and Denmark are developing detailed 'mineral accounts' for each farm in the country. A mineral account records the application of nitrogen to soils through fertilizers and animal manure, the net take-up of nitrogen by crops, and hence the net excess balance. The net balance is effectively the run-off of nitrates from the farm. To some extent, then, the underlying problem of non-point pollution - namely the difficulty of allocating ambient pollution to sources - is overcome. In the case of Austria, the levy is thought to have had a significant 'signalling' effect through raising awareness that fertilizers are environmentally damaging. In Sweden, it is estimated that the tax reduced demand for fertilizers in 1991-2 by 15-20% and also reduced financially optimal dosages by about 10 per cent. Indirect effects through the use of recycled revenues to fund research etc. were more significant. However, recycling of revenues ended in 1994 when the charge became an official 'tax'. The Finnish experience is limited to a period of just two years since before 1992 the tax was set at a very low level and it was abolished altogether in 1994. The effect in 1992 was significant but there was a growth in set-aside land at the same time. It is suggested that the resulting net price elasticity was low at -0.11 . However, this needs to be interpreted as a very short-run elasticity and long run elasticities would certainly have been higher. The Danish

experience suggests that the nitrogen tax (which covers fertilizers and manure) will help to solve regional nitrate problems, but that local problems will require more careful controls on animal stocking rates.

The findings, interpretations, and conclusions of this note are the authors' own and should not be attributed to the World Bank, its management, its Board of Executive Directors, or the countries they represent.

Additional Reading

Pearce, D., and Koundouri, P. (2003). Diffusion Pollution and the Role of Agriculture, in "Water Sustainability and Regulation: The Next Periodic Review and Beyond" (ed. D. Helm), OXERA Press, (forthcoming).