Welfare Impacts of Agri-Environmental Policies in an Open Economy: A Numerical General Equilibrium Framework

by:
Farzad Taheripour
Madhu Khanna
Carl Nelson

Department of Agricultural and Consumer Economics
College of Agricultural, Consumer and Environmental Science
University of Illinois at Urbana-Champaign

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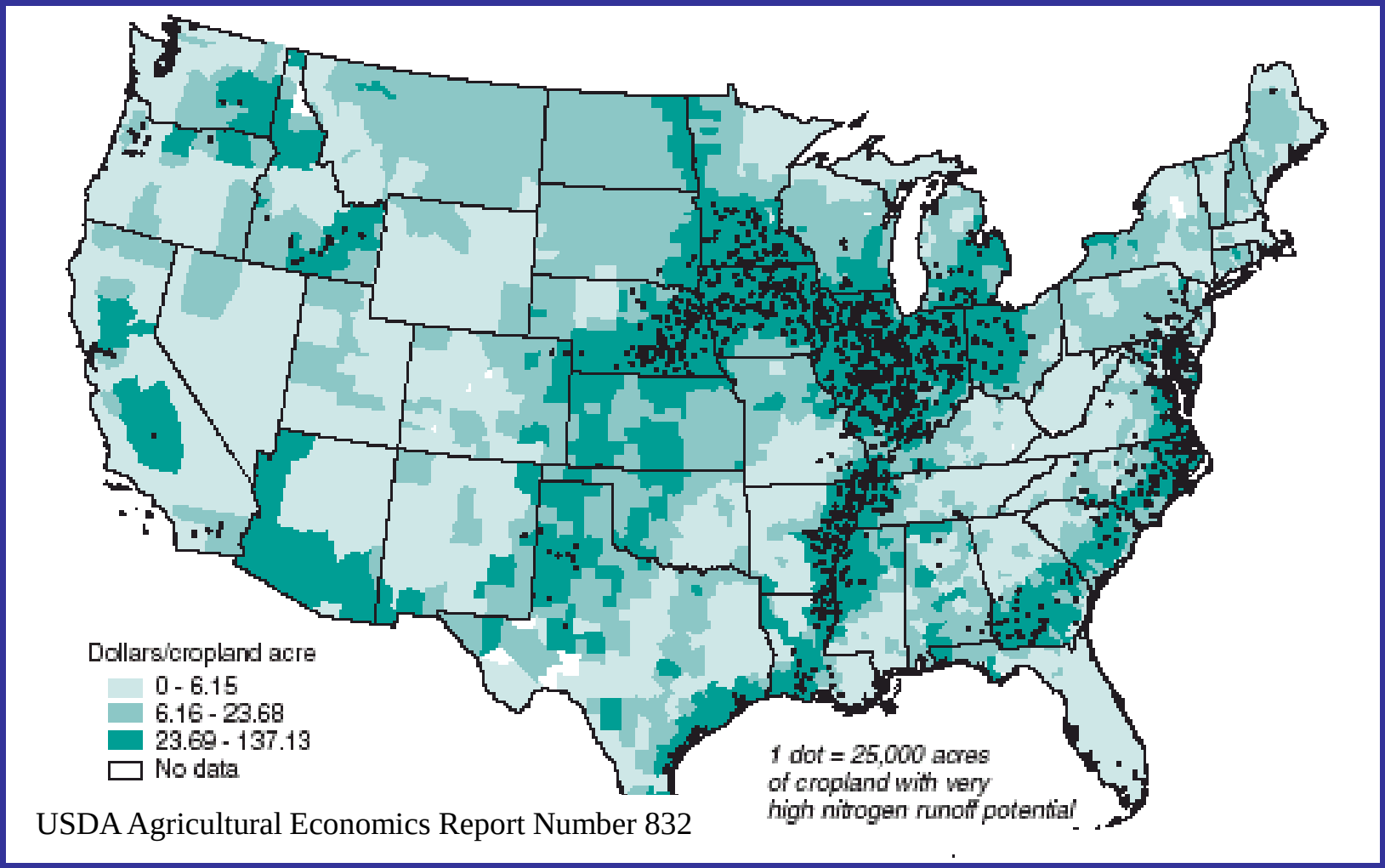
- Outline:
  - Introduction
    - Agricultural Exports
    - Agricultural Subsidies
      - Domestic Concerns
      - WTO Limits
    - Agricultural Budget Reforms
  - Research Objectives
  - Theoretical Background
  - A Numerical General Equilibrium Model
  - Data and Calibration Process
  - Numerical Results
  - Conclusion

- Introduction
  - US is a large exporter of agricultural products:
    - In 2002, more than half of all US wheat production, 18 percent of corn production, 37.9 percent of soy production, 58.5 percent of rice production and more than half of cotton production were exported to the world market.
    - In this year, the shares of US in total exports of these commodities were about 21 percent, 52.8 percent, 45.8 percent, 13.7 percent and 38 percent, respectively
  - Since the US is a main exporter of agricultural products in the world, its domestic agri-environmental policies have the potential to affect prices of these commodities in the world market.

- Introduction (Continue)
  - Traditionally, the US government supports agricultural production through support subsidies
    - USDA has paid about $114 billion subsides to farmers during 1995-2002
    - Based on the WTO definitions a large portion of US agricultural subsidies falls in amber box
    - In 2000, about 73 percent of the US agricultural subsidies were classified under the amber box

- Introduction (continue)
  - Agricultural subsidies and domestic issues
    - Agricultural pollution
    - Burden of tax
    - Distortionary impacts on agricultural products

Distribution of Commodity Program Payments and Very High Nitrogen Runoff Potential - 1998



USDA Agricultural Economics Report Number 832

- Introduction (Continue)
  - According to Uruguay and Doha negotiations, WTO members must reduce their domestic agricultural support subsidies
  - Direction of agri-environmental policies (US Farm Bills)
    - Reduce distortionary agricultural support subsidies
    - Increase decoupled support payments to farmers
    - Allocate more funds for environmental protection programs in agriculture

- Research Objectives
  - To explore and quantify welfare impacts of agri-environmental policies in the context of an open economy in the presence of income taxes and agricultural support subsidies

Alternative Policies

- A full subsidy cut policy
- A nitrogen run-off tax
- A nitrogen reduction subsidy
- A tax on output
- A two-part instrument

Theoretical Background and Literature Review

- Environmental taxes in the presence of labor tax
  - Revenue recycling effect (the double-dividend hypothesis)
  - Tax interaction effect
- Deficiencies
  - Labor is the only primary input
  - There is only one pre-existing distortion in the economy - either a tax on labor or a commodity tax
  - The abatement technology is separable from the production technology, also known as the “end-of-pipe” abatement technology assumption
  - The economy is closed

Components of the numerical model

- A Consumer
  - Consumes two goods
    - A dirty good (crop products)
    - A Clean Good (other goods and services)
  - Enjoys leisure
  - Suffers from nitrogen run-off and deficit from trade
  - Supplies labor, land and capital
- Two producers
  - A farmer which uses labor, land, capital, and nitrogen fertilizer to produce crop
  - A firm which uses labor, land, capital to produce other goods and services (including agricultural clean good)
- Trade
  - The farmer imports nitrogen fertilizer and exports crop products
- Government
  - Raises revenue from income taxes
  - Pays agricultural subsidies
  - Regulate nitrogen run-off
- Production and utility functions
  - CES utility function
  - Two-level CES production function

The Numerical Model: Main Structure

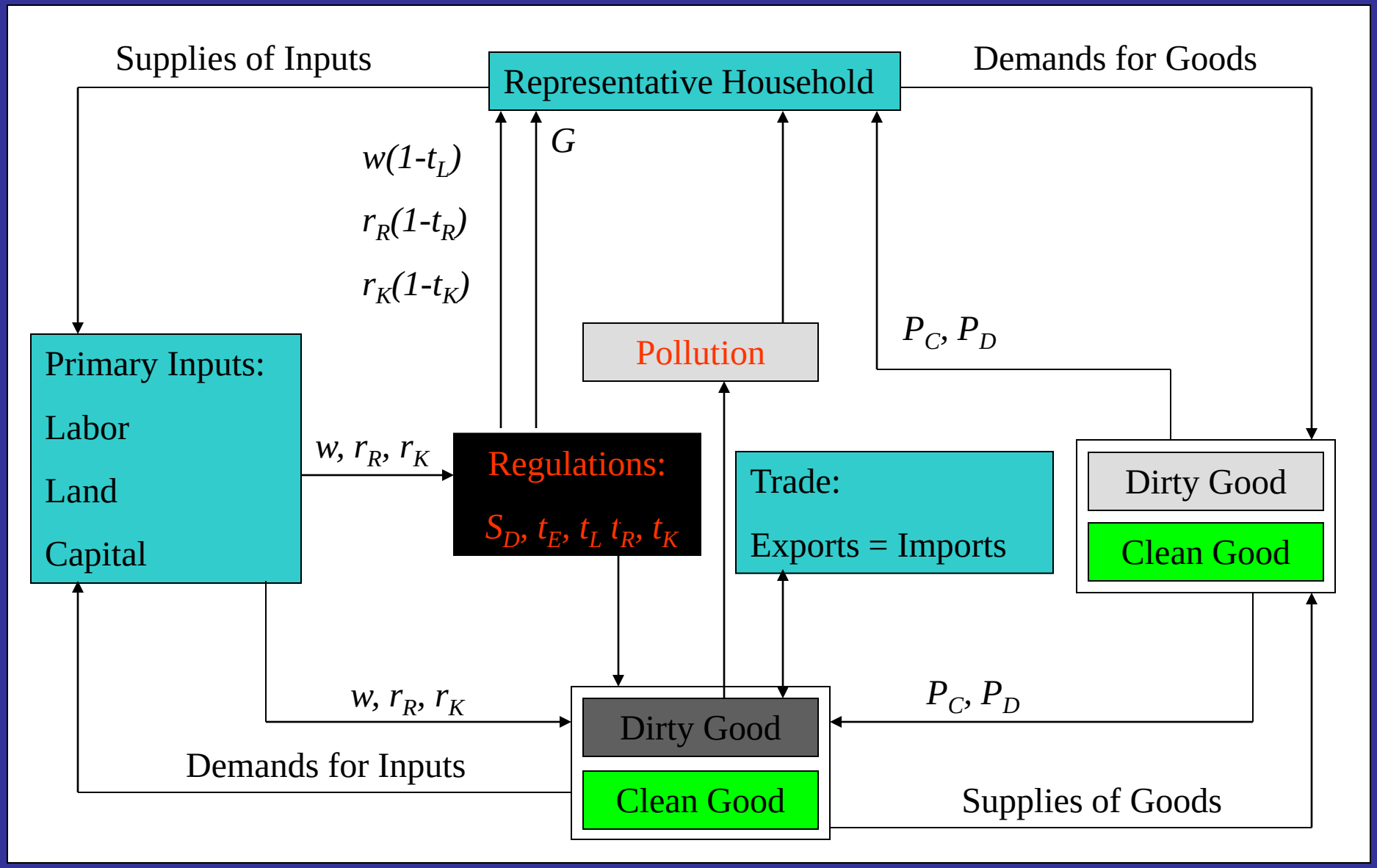


Table 1. Benchmark data (in millions of 2002 dollars except as otherwise noted)

Description	*Dirty Good*	*Clean Good*	*Total*
Value added at the producer price	87718	8908190	8995908
Subsidy (the price support)	9513	0	9513
Value added at the consumer price	78205	8908190	8986395
Export (payments for fertilizer)	15168	0	15168
Consumption at the consumer price	63037	8908190	8971228
Consumption at the producer price	70705	8908190	8978896
Leisure	0	0	2871434
Labor income	20894	5139655	5160549
Land income	27462	9912	37373
Capital income	24194	3758624	3782818
Land (million acres)	341	1222	1563
Homogenized land (million acres)	1148	415	1563
Capital stock	585325	22827675	23413000
Homogenized capital	149744	23263256	23413000
Fertilizer (nitrogen content in million metric tons)	12		12
Mechanical inputs	45089	8898279	8943367
Biological inputs	42629	9912	52541
Marginal income tax rate (percent)			40
Government expenditures (G)			1595427

Table 2. Selected Parameters

Description of Parameter	*Value*	*Source*
Uncompensated labor supply elasticity	0.15	Goulder (1999)
Uncompensated price elasticity of demand for the dirty good	0.5	Steven et al. (2003)
Uncompensated price elasticity of demand for the clean good	1.0	Kyer and Maggs (1997)
Elasticity of substitution between the biological and the mechanical inputs in production of X	0.5	Horan et al. (2002)
Elasticity of substitution between land and nitrogen fertilizer in production of X	1.25	Horan et al. (2002)
Elasticity of substitution between labor and capital in production of X	0.585	Balisteri et al. (2002)
Elasticity of substitution between the biological and the mechanical inputs in production of Y	0.5	Horan et al. (2002)
Elasticity of substitution between labor and capital in production of Y	0.951	Balisteri et al. (2002)

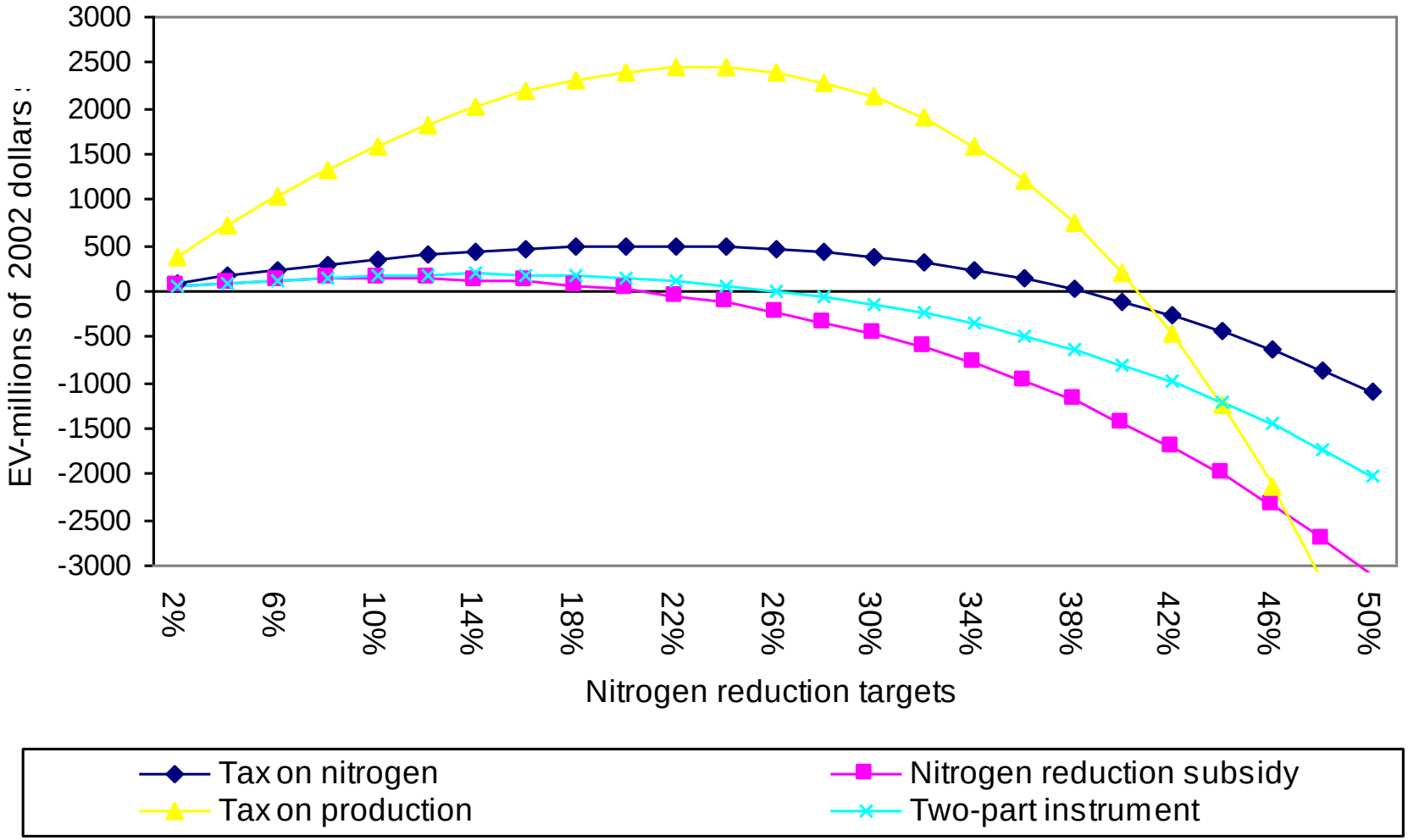
Table 3. Impacts of the full subsidy-cut (in percentage except as otherwise noted)

Description	*Change in the variable due to subsidy cut*
Price of the dirty good	9.49
Price of the clean good	-0.02
Price of land	-5.94
Price of capital	-0.03
Production of the dirty good	-4.83
Domestic consumption of the dirty good	-4.23
Exports of the dirty good	-7.84
Production of the clean good	0.02
Applied nitrogen	-8.47
Land in production of the dirty good	-1.19
Land in production of the clean good	3.12
The equivalent variation (EV) in millions of 2002 dollars	1175.00

Table 4. Impacts of alternative policies to reduce nitrogen run-off (in percentage except as otherwise noted)

Variable	*Target: 10 percent reduction in nitrogen run-off*			
	Change in variable under alternative policies			
	Tax on nitrogen run-off	*Nitrogen run-off reduction subsidy*	*Tax on production of the dirty good*	*Two-part instrument*
Price of the dirty good	3.39	3.38	11.43	3.52
Price of the clean good	0.00	0.00	-0.02	0.00
Price of land	3.01	3.00	-7.02	2.81
Price of capital	0.00	-0.01	-0.02	-0.01
Production of the dirty good	-1.81	-1.81	-5.72	-1.88
Domestic consumption of the dirty good	-1.58	-1.59	-5.02	-1.65
Exports of the dirty good	-2.96	-2.95	-9.28	-3.06
Production of the clean good	0.00	-0.01	0.03	-0.01
Index of applied nitrogen per unit of output	-8.43	-8.43	-4.55	-8.28
Tax on income	0.00	0.06	-0.06	0.06
Land in production of the dirty good	0.56	0.56	-1.42	0.53
Land in production of the clean good	-1.47	-1.47	3.73	-1.38
Welfare (EV in millions of 2002 dollars)	354.88	140.27	1584.27	170.74
Rank based on EV	2	4	1	3

Figure 1. Welfare Impacts of Alternative Policies in the Second-Best



Conclusion:

- A revenue-neutral budget reform, which cuts all distortionary agricultural support subsidies and pays released funds as a lump-sum transfer payment to the land owner, increases welfare and reduces nitrogen run-off
- Environmental regulation in agriculture can generate a double dividend
- The relative efficiency of alternative policies depends on the level of pollution reduction target
- At low levels of pollution reduction targets, the tax on production is the most efficient policy
- At high levels of pollution reduction target, the tax on nitrogen run-off