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Environmental Bads

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The Issue

- Since the 1970s, economists have relied heavily on Weitzman (1976) to measure how environmental problems affect our well-being.
- This welfare-based approach provides a powerful conceptual lens, linking environmental change to consumer welfare and overall economic performance.
- But consumers do not choose the level of pollution they experience.
 - You can decide whether to buy a new car or take a vacation, but you cannot decide how much smog is in your city's air or how contaminated your local river is.

The Issue

- The framework can't capture the full welfare effects of pollution because consumers are making choices conditional on a pollution level they don't control.
- If pollution affects your utility but you can't choose its level, then we can't observe how you would trade off market goods for cleaner air or water.
- The data needed to measure these preferences simply does not exist in consumer purchasing patterns.

Contributions of the Paper

We show that the consumer perspective is the “wrong” perspective to measure the welfare effects of bads:

- it is impossible to measure completely the welfare effects of externalities using a consumer framework.

In contrast, production-based approaches are shown to be useful in this context.

Details of the Consumer Approach

- Weitzman (1976) provided a welfare interpretation for net national product.
- Used extensively in the growing literature on environmental economic accounting to measure the negative welfare effects of pollution, environmental degradation, and other environmental bads.
- Previously established problems with the framework:
 - Closed economy, no government, no technical progress, no tax distortions
 - Lack of general discrete time counterparts to his results from continuous time optimization (Diewert and Schreyer 2006).

Details of the Consumer Approach

- Weitzman's justification of **net national product** from a welfare perspective is that it is **a proxy for the present discounted value of future consumption**, and that this can be obtained by capitalizing current consumption and net investment (using a constant real interest rate).
- Subsequent interpretations of this relate to net investment including environmental depletion and degradation.
- Weitzman's results depend on the levels of consumption and net investment being choices made by consumers.
- **If the net investments include externalities** (e.g. environmental degradation) that are not chosen by the consumers yet affect the consumption choices that consumers make, **then Weitzman's results will not hold**.

Details of the Consumer Approach

Suppose consumer utility u is a function of:

- N dimensional vector x of market goods and services
- K dimensional vector of environmental “bads” b

$$u = f(x, b)$$

p = positive vector of prices for market goods and services

e = expenditure on market products in a given period.

The consumer's utility maximization problem is:

$$\max_x \{f(x, b) : p \cdot x = e\}$$

Details of the Consumer Approach

The maximization is by the choice of the vector x , b taken as given.

First order necessary conditions:

$$\nabla_x f(x, b) = \lambda p$$

$$p \cdot x = e$$

System of estimating equations for the consumer's system of inverse demand functions:

$$p = e \nabla_x f(x, b) / x^T \nabla_x f(x, b)$$

Suppose that $f(x, b)$ is a linear function of x and b , the marginal utility parameters of the linear function for the components of b do not enter these estimating equations

So, it is not possible to recover the underlying preferences over combinations of goods and bads using a consumer framework

Details of the Consumer Approach

A consequence of this is that Weitzman's connection between welfare and net national product is lost in the presence of externalities.

Producer Perspective: Baseline Approach – No taxes on Bads

y = outputs

x = inputs

$S(y)$ = set of feasible inputs that can produce the vector y

Use x to produce y , a vector of bads is also produced: b

$$b = G(x) \equiv [g_1(x), g_2(x), \dots, g_K(x)]^T$$

where the bads production functions $g_k(x)$ are in principle observable

Producer Perspective: Baseline Approach – No taxes on Bads

If bads are not taxed or regulated, with w a vector of positive input prices, the producer's cost minimization problem is

$$\min_x (w \cdot x : x \in S(y)) \equiv C(y, w)$$

Apply Shephard's Lemma:

$$x(y, w) = \nabla_w C(y, w)$$

With competition, output prices, p , should be approximately equal to marginal costs.

$$p(y, w) = \nabla_y C(y, w).$$

These last two equations become a system of estimating equations for the competitive case after a functional form for the joint cost function $C(y, w)$ has been specified.

Producer Perspective: Baseline Approach – No taxes on Bads

Substitute the optimal $x(y,w)$ into $b = G(x)$ to get the vector of bads produced:

$$b(y,w) \equiv G[x(y,w)]$$

Producer Perspective: Bads are Taxed

τ = vector of tax rates on the production of bads

The new cost minimization problem is:

$$\min_{x,b}\{w \cdot x + \tau \cdot b : x \in S(y) ; b = G(x)\} = \min_x\{w \cdot x + \tau \cdot G(x) : x \in S(y)\}$$

The new joint cost function minimization problem has a potentially nonlinear objective function, so the usual duality results don't go through.

We show that if the production of bads functions are linear functions of x , then the estimating equations are the same as in the baseline approach, but with tax adjusted input prices.

Producer Perspective: Comprehensive Cost Function

Combine the constraints $x \in S(y)$ and $b = G(x)$ into a comprehensive set of x and b combinations that can produce the output vector y . Call this comprehensive set of (x, b) combinations the set $S^*(y)$

Cost minimization problem:

$$\min_{x, b} (w \cdot x + \tau \cdot b : (x, b) \in S^*(y)) = C^*(y, w, \tau)$$

Shephard's Lemma can be applied to obtain the cost minimizing demands for inputs x and “supplies” of bads b :

$$x(y, w, \tau) = \nabla_w C^*(y, w, \tau)$$

$$b(y, w, \tau) = \nabla_\tau C^*(y, w, \tau)$$

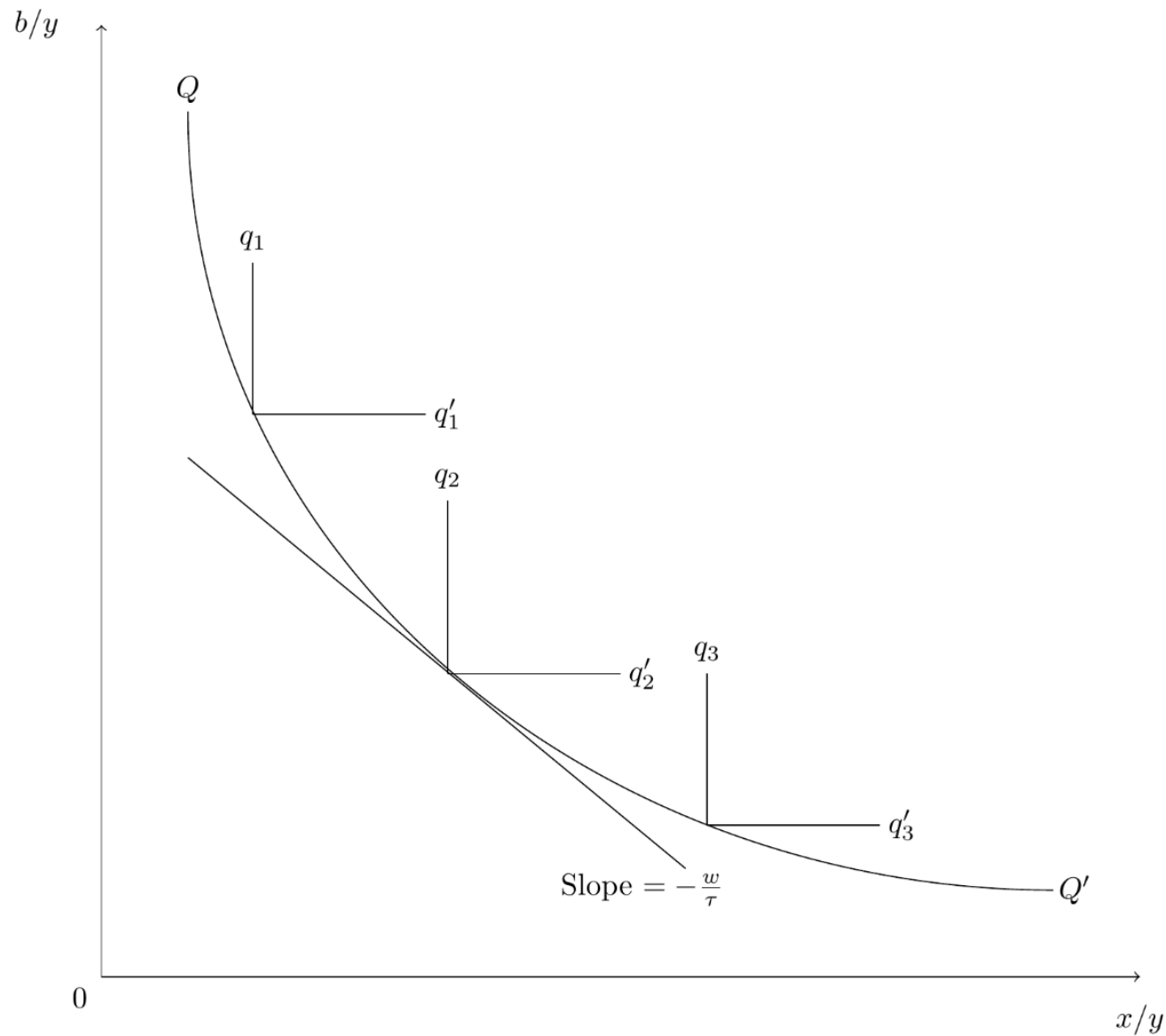
Hence bads can be treated in the same way as inputs in an econometric study that estimates input demand equations.

Producer Perspective: Comprehensive Cost Function

The Comprehensive Cost Function approach just requires information on the firm's production of bads and the corresponding tax rates.

The previous approach ("Bads are Taxed") required additional information on the bads production functions.

Producer Perspective: Comprehensive Cost Function



Summary

The Weitzman (1976) approach to justifying net national product as a measure of welfare fails in the presence of externalities

Presented three alternative ways of modelling bads from the producer perspective.

Our conclusion is that treating bads as inputs into production is probably not the best way to organise the data.

It may be better to treat bads as intermediate inputs: make the output aggregate an aggregate of the prices (p, τ) and quantities ($y, -b$)

This recognizes that the vector of bads is actually produced by the production sector.

Summary

Creates an aggregate output variable from which environmental bads have been netted out, consistent with the idea of net product, but without Weitzman's consumer-based approach as a justification.

The net product approach is consistent with e.g. Pittman (1981)(1983) and Brandt, Schreyer and Zipperer (2014)

For a full economic accounting of the welfare effects of environmental bads, need to take into account that the tax revenue which is raised by taxing bads can be used by the government to either reduce other taxes or to provide public goods; McKittrick (1997) and Jorgenson, Goettle, Ho and Wilcoxon (2013).

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