



Control engineering the economy with dividend-bearing pollutant surcharges.

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What is control engineering?

Control engineering adds a control layer to a device through which the operator sets the expected performance of the device. The device functions are controlled in turn by **actuators**. These actuators are connected via the control layer to **sensors**. Control is achieved by the digital control layer receiving feedback from the sensors, input from the operator and through a set of rules which at close intervals, controls the actuators.

This is where the term “fly by wire” comes from as for example the driver of the vehicle is not in direct mechanical control, but sends the command to the control layer which in turn interprets the signal depending on a range of factors including the information coming from the sensors.

The benefit of control engineering is that controls can be simplified yet the control more precise whilst the workings of the device can be highly sophisticated. Once dirty technology, like the diesel engine, can be run cleanly as optimum combustion (and thereby clean burning) can be obtained with each piston stroke and combustion cycle.

How do you apply control engineering to the economy?

The diagram on the right shows a simple way to see the real economy. If we represent citizens at the top, with their money to spend as a stock in a bath-tub, money flows to the other three classes of actors in the economy; enterprises including banks, the state and the municipality. Every month, the stock of money is replenished by transfer of money between the actors, and up to the citizens. Much of what goes back to citizens is then redistributed back to the other three classes and so the cycle begins again.

Transactions with pollutants are surcharged,(actuators) and the charge raised until the economy responds measures (sensors) as reduction in imports, reduction in emissions and increase in recycling.

Controls on phosphorus

PROPERTY TAX SURCHARGE

- The more degraded the land is (i.e. levels of phosphorus leakage) or the more the property performs like degraded land, the higher the surcharge
- A Dividend Board raises charges at regular levels until level of restoration acceptable
- Dividend is returned to taxpayers

WASTE WATER CONNECTION SURCHARGE

- Depends on P (and N) in waste water
- Performs like Surcharge

IMPORT SURCHARGE

- On all imports of fertilizer
- Levied on food and chemicals too

Modern digital technology controlling surcharges on pollutants promises to move extractive, polluting, disparative culture into circular, equitable prosperity.

Sensors

Most modern economies are highly digitalized and this provides opportunities to measure the performance of the economy. For instance, sales of phosphorus in fertilizers can be monitored almost in real time, and many environmental authorities regularly monitor water quality. Each product has its own number and barcode, and knowing the ingredients in each product it is possible to collect vast amounts of data on the flow of substances through the economy as they pass through the supply chain.

Based on the premise that the economy exists to provide for citizens, suitable measurements comprise unemployment figures, homelessness, reports on food insecurity etc. Consumer price index can form part of the measurements package too, as well as home affordability reflected in average house prices.

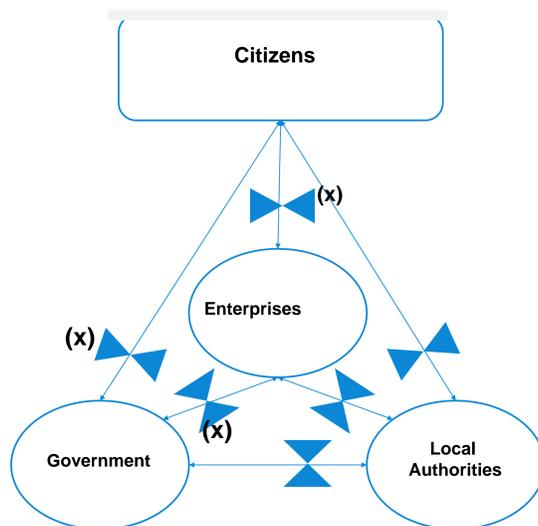
An **actuator** is a type of mechanism that is responsible for moving or controlling a system. Fiscal actuators that could affect P flows in society include surcharges, levies, subsidies and dividends.

Actuators

Most tax and fee systems are rather complex. Adding more would only add to the complexity. The Foundation proposes putting surcharges on already existing instruments in order to simplify administration. These surcharges (which can be negative) can be put on VAT, import fees, interest rates, and property deed transfers. The surcharges act as actuators. For example, putting a surcharge on import of oil would make oil products more expensive and encourage the purchase of alternatives. If at the same time the fee levied were to be paid back to citizens, they would retain their purchasing power.

A **sensor** is a device or mechanism that detects and responds to some type of input from the environment. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

For phosphorus we envisage a mechanism that collects data on things like imports, technology, emissions and land statues into a *Decision Support System* that informs the government surcharge-setting body's decision on rate adjustments.



Surcharges at (x) control polluting behaviour in the system

How do control instruments work on phosphorus?

Land that leaks becomes more expensive to own

By making it more expensive to own land that leaks P, products from that land become relatively more expensive. As the fee collected from the surcharges goes back to citizens, they have the same amount of money to spend. So the demand for “cleaner” products increases.

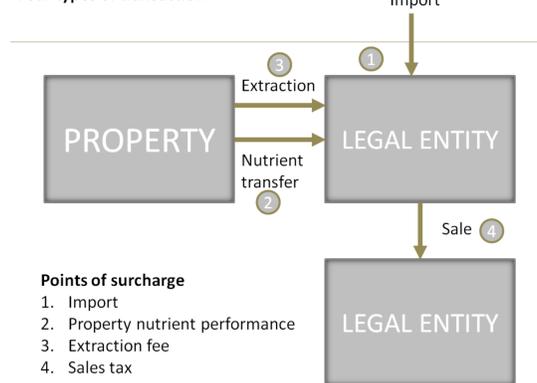
The freedom to buy more expensive “polluting” products is still there, making this kind of market-based instrument more appealing to liberal democracies.

Cleaning waste water becomes more lucrative

As waste water charges are raised, options to retain nutrients (in for example urine-separating toilets) become more viable.

Thanks to the dividend collected, consumers have the same amount of money to spend. This ensures the economy remains stable whilst phosphorus emitting system behavior decreases.

Four types of transaction



Points of surcharge

1. Import
2. Property nutrient performance
3. Extraction fee
4. Sales tax

PHOSPHORUS SURCHARGES

Point of control:

- Surcharge on import and extraction of P.
- Surcharge on waste water management.
- Surcharge on property tax for those properties that perform poorly in P retention.

Purpose:

- Raise comparative price of products and services driving phosphate rock demand.
- Render sustainable alternatives cheaper.
- Raise price of waste, encourages recycling.

Effects:

- Encourages investment in alternatives.

Revenue distribution:

- Revenues go directly to taxpayers' accounts.

Mechanism:

- Surcharges levied on existing taxes and raised until phosphate rock import starts to follow reasonable phase-out trajectory and recycling practices expand.

Psychological effects:

- Consumers know they are charged extra for environment-affecting services, and that the revenue goes to promoting alternatives.
- Regular adjustment of fees tells enterprises that the government is serious about finding the point where alternatives are cheaper.

Works with:

- Full employment mechanisms to ensure green job transition, land maturity taxes to ensure circular economy for major nutrients. House loan interest rate surcharges/discount mechanism to ensure affordable housing.

Levying a fee on activities that pollute, and paying it back to tax payers ensures the economy is stable, advantages the poor, and sends a strong signal to the investment community on where their money should go.

BENEFITS

Modern Information technology allows dynamic control of the economy: all actors benefit in the long run.

Redistribution of fees increases security for poorest citizens.

By making import more expensive, the mechanism encourages green consumption and green jobs. It also encourages new investment in recycling technology, ushering in the circular economy.

Progress so far

REPORTS

Dividend-bearing pollutant fees have been investigated in several reports from Sweden and the Nordic Council of Ministers.



Flexible emission fees – An incentive for driving sustainable production and consumption

Two approaches to pricing pollution (TN2014:512), compares the efficacy of Cap and Trade with a Flexible Fee approach.

A Flexible Pollution Tax is an theoretical investigation into the viability of dividend-bearing pollution instruments.

IMPLEMENTATION

Along the lines of the fee mechanism, a recent project to remove phosphorus from the floor of the Baltic Sea proposed raising waste water charges along with a dividend in the form of biogas from the organic sediment.

SIMULATIONS

The Foundation has developed a simulation in the form of a business–game that teaches the basics of the mechanism and brings awareness of the factors affecting successful implementation.

Literature Cited

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Breugel, C. V., Enggaard, M., Jessen, J. E., Stavlöt, U., Sköld, C., & Berghäll, E. (2014). *Two approaches to pricing pollution*.

Sanctuary, M., & Høglund, A. (2005). *A Flexible Pollution Tax. A report written on behalf of Nutek-the Swedish Agency for Economic and Regional Growth*.

Next steps

The Foundation is looking to adapt the World 3 model (the Limits to Growth analysis) to see if changing the fiscal framework can stave off collapse of carrying capacity.

Several new instruments are being released. The Foundation believes it can match all of the sustainability criteria for example those that have been put forward on planetary boundaries and system conditions. This needs further analysis.

The Foundation is interested in collaborating with partners addressing the Baltic Sea challenge as well as introducing and increasing EFR at national and municipal level to encourage a circular economy for P, N and the phase-out of C from fossil sources.