Economic Modelling in Forestry: Avoiding the Lucas Critique

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1. Modelling is an important part of Forest Economics
2. Modelling is also an important part of Economics
3. The late 1960,s and the 1970,s was an "era" of macroeconomic modelling in Economics
4. The Link model was one of the most ambitious of them!
5. The idea was to use them for (counterfactual) policy comparisons

- In 1976 Robert Lucas pointed out that when policy changes, economic behaviour changes and the (parameters of) the model!
- The Lucas critique: To naive to predict the effects of a change in economic policy on the basis of relationships observed in existing empirical data.
- He suggested modelling based on deeper parameters (preferences, technology and resource constraints)

- Edward Phelps (1966), and Milton Friedman (1967) and Lucas (1972) had already shown why the "Phillips curve" failed.

1. Main Problem: Data is typically not enough; you cannot typically construct future historical data in order to conduct counterfactual comparisons.

2. Forestry has an advantage in this respect. *There exist good inventory data and growth functions are relatively precise, i.e. the technology is there and the (initial) resource constraints are there*

3. *Preferences can be handled by alluding to Irving Fisher's separation theorem. Forecasting may work!*

- Without having heard anything about the Lucas critique Peichen Gong (1994, 1995) used these advantages to develop a method for counterfactual comparisons.
- The method avoids (most of) the Lucas critique.
- The trick parameterizes the harvest behaviour functions (the supply function), plugs them into the expected present value function which is optimized with respect to the parameters

A simple numerical example:

$\underset{x}{Max}[y-\omega x]$ Subject to $y = 2\sqrt{x}$

$\pi(\omega) = \underset{x}{Max}[2\sqrt{x} - \omega x]$

Solution $x^* = \frac{1}{\omega^2}, y^* = \frac{2}{\omega}$

Now put $x = \frac{1}{\omega^a}$ $x = \frac{1}{\omega^a}$ and solve

$\pi(\omega) = \underset{a}{Max}[2e^{-\frac{a}{2}\ln\omega} - e^{-(a-1)\ln\omega}]$

From $\frac{d\pi}{da} = a\ln\omega[e^{-(a-1)\ln\omega} - e^{-\frac{a}{2}\ln\omega}] = 0$,

we get $-(a-1) = -a/2 \Leftrightarrow a^* = 2$

Large scale application to the Swedish forestry sector, built on Gong (1994,1995) of a 40% increase in biotechnological progress Gong, Löfgren and Roswall (2010)].

1. Data 20 million ha (all productive forests below age 120 years)
2. Maximizing the expected present value of the total economic surplus (consumer+producer surplus)
3. Both in the presence and absence of genetic progress

We choose a functional form of the timber supply function $S(X_t, p_t; A)$ and determine the parameters A of the supply function by solving the following maximization problem:

$$\max_A \quad E[TS(A)] =$$

$$= E\left[\sum_{t=1}^{\infty} \int_0^{Q_t} P(q; B_t)dq - C(X_t, Q_t)\ e^{-rt}\right]$$

$$\begin{aligned} p_t &= P(Q_t; B_t) \\ Q_t &= S(X_t,\ p_t; A) \end{aligned} \qquad (2)$$

$$X_{t+1} = g(X_t, Q_t),\ X_1 = X_0 \quad (3)$$

$P(Q_t, B_t) =$inverse demand function

$B_t =$random demand curve parameters

$Q_t =$market supply at t

$X_t =$state of forest at time t

$C(X_t, Q_t) =$cost function

- Constraints (2) market clearing condition
- Constraint (3) the dynamics of the forest
- Total harvest cannot exceed the stock of timber. Included in the supply function
- Given a parametric timber supply function
- Determine the Expected Present Value (EPV) by taking the average of a large number of optimized demand scenarios

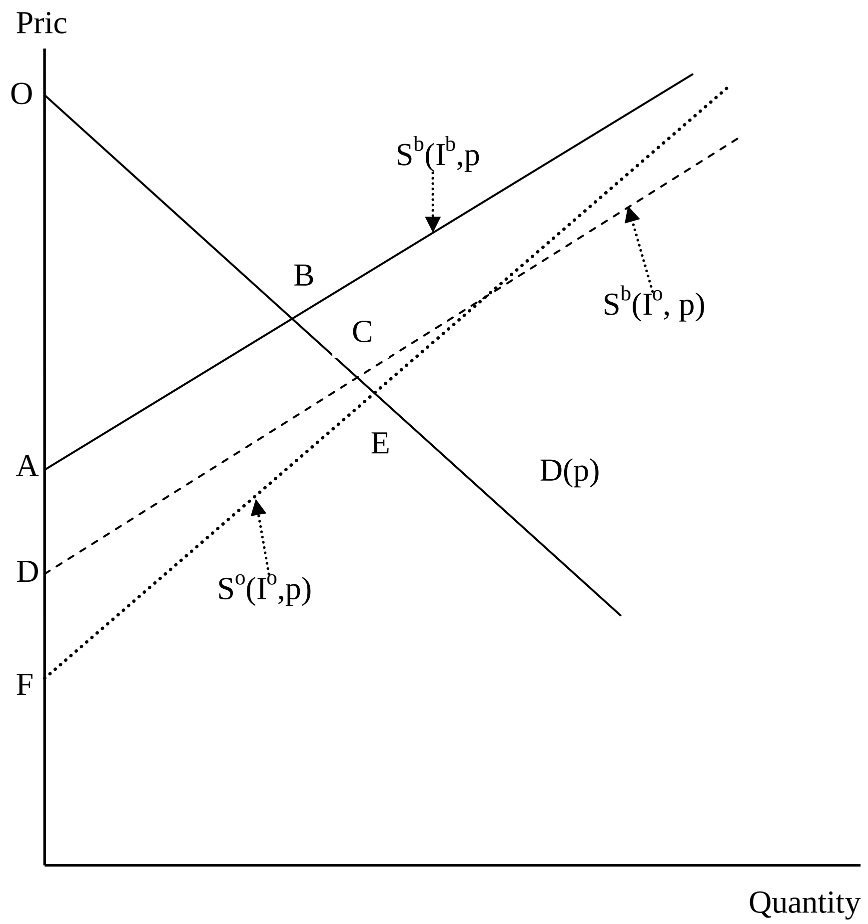
$$E[TS^n(A^n)] = \frac{1}{N}\sum_{k=1}^{N}\left[\begin{array}{l}\sum_{t=1}^{T} \int_0^{Q_t^k} P(q; B_t^k)dq - C(X_t^k, Q_t^k)\ e^{-rt} \\ +R(X_{T+1}^k)e^{-r(T+1)}\end{array}\right]$$

N= number of scenarios

$R(X_{T+1}^k)e^{-r(T+1)}$=present value of endpoint value of the forest.

The two cases (absence and presence of improved genetic material, IRM) differ only with respect to the growth function

A schematic description of the welfare effects of tree improvements



ABEF=total gain
ABCD=direct gain
DCEF=gain from changing behaviour

Relating the estimation of EPV to Figure 1

$E[TS^n(A^n)]$=FOE=total surplus with IRM

$E[TS^b(A^b)]=$AOB=total surplus in base case

$E[TS^n(A^b)]=$DOC=total surplus with IRM with baseline supply curve

$E[TS^n(A^n)]$-$E[TS^b(A^b)]=$ABEF=Total gain from IRM

$E[TS^n(A^n)]$-$E[TS^n(A^b)]=$DCEF=the net gain from changing the harvest behaviour (The Lucas effect)

The Results from Gong, Löfgren and Roswall (2010)

1. Total surplus with IRM but baseline parameters=DOC=22505 billion Swedish Crowns. Direct Gain=ABCD=27.41billion Swedish Crowns

2. Total surplus with IRM and optimized parameters=FOE=22511 billion Swedish Crowns. Optimal gain=ABEF=33.61

3. Gain from changing harvest behaviour=DCEF=6.2 billion Swedish Crowns or 18% of the total effect

Producer and consumer surpluses in the presence of IRM,s

Table 9. The expected present values of producer surplus and consumer surplus in the presence of IRMs (unit: billion SEK).

	Producer surplus	change[a]	Consumer surplus	change[a]
Benchmark supply function	596.72	-30.10	21908.75	57.50
Optimal supply function	583.35	-43.45	21928.31	77.06

[a] Compared with the case where IRMs are not available.

Note that the producer surplus decreases. The reason is that IRM,s increases supply while the expected demand curve is assumed fixed

Another counterfactual large scale comparison is contained in Gong and Löfgren (2003)

- Monopoly versus Perfect Competition among Swedish private forest owners

- In the baseline case expected welfare is 24% higher under perfect competition

- Prices are 22% lower and timber supply 43% higher

- In this case we compare we estimate the coefficients of a *pseudo supply curve* under monopoly and the coefficients of the supply function under perfect competition.

- The supply function are generated by coefficients from a second order Taylor expansion

Conclusions

1. Counterfactual comparisons can be improved by the “approximation idea” introduced by Gong (1994,1995)

2. The results depend on the precision numerical assumptions but …..

3. We believe that modelling that neglect the impact of the management behaviour on the structure of the model typically result in substantially biased results

4. The counterfactual approach is worth trying