



Green
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Theoretical developments of the comprehensive (or “green”) national accounting literature

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University of Oslo

**Expert meeting on Ecosystem Valuation
in the context of Natural Capital Accounting**
German Federal Agency for Nature Conservation – BfN
Bonn 24–26 April 2018



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- Many practical applications use wealth-based measures



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- Many practical applications use wealth-based measures
 - ◇ Income: Interest on wealth



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- Many practical applications use wealth-based measures
 - ◇ Income: Interest on wealth
 - ◇ Savings: Change in wealth



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- Many practical applications use wealth-based measures
 - ◇ Income: Interest on wealth
 - ◇ Savings: Change in wealth

- Theoretical developments from [Hicks \(1946, Ch. 14\)](#), via [Samuelson \(1961\)](#) og [Weitzman \(1976\)](#), to [Sefton & Weale \(2006\)](#) support . . .



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- Theoretical developments from [Hicks \(1946, Ch. 14\)](#), via [Samuelson \(1961\)](#) og [Weitzman \(1976\)](#), to [Sefton & Weale \(2006\)](#) support ...
 - ◇ Income: PV of future interest on consumption



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- Theoretical developments from [Hicks \(1946, Ch. 14\)](#), via [Samuelson \(1961\)](#) og [Weitzman \(1976\)](#), to [Sefton & Weale \(2006\)](#) support ...
 - ◇ Income: PV of future interest on consumption
 - ◇ Savings: PV of future changes in consumption



Income as interest on wealth

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Income in the tradition of

Fisher (1906) and Lindahl (1933, Sect. II)

is associated with interest on wealth,

where wealth is PV of future consumption



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Problems:



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Problems:

- Non-constant interest rates



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Problems:

- Non-constant interest rates
- Capital gains



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Fisher (1906) and Lindahl (1933, Sect. II)
is associated with interest on wealth,
where wealth is PV of future consumption

Problems:

- Non-constant interest rates
- Capital gains

Illustration:

Models of capital accumulation and resource depletion
where the interest rate decreases & the resource appreciates



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 1

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Indicator of impoverishment:
Stationary equivalent of future consumption



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 1

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Indicator of impoverishment:

Stationary equivalent of future consumption

Income (Hicks, 1946, “income no. 3”)

is associated with the stationary equivalent



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 1

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is associated with the stationary equivalent

Problems:

- Income does not equal net product,
even in a closed economy with stationary technology



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 1

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Indicator of impoverishment:

Stationary equivalent of future consumption

Income (Hicks, 1946, “income no. 3”)

is associated with the stationary equivalent

Problems:

- Income does not equal net product,
even in a closed economy with stationary technology
- Hard to define in the case of multiple consumption goods



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 2

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Hicks (1946, p. 172): “It seems that we ought to define a man’s income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning.”



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 2

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Hicks (1946, p. 172): “It seems that we ought to define a man’s income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning.”

Indicator of impoverishment: Dynamic welfare



Income: “The amount which [one] can consume without impoverish [oneself]” (Hick, 1946), v. 2

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Indicator of impoverishment: Dynamic welfare

Measurement of change in dynamic welfare (Samuelson, 1961):
PV of future changes in consumption



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PV of future changes in consumption = savings



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Income = value of consumption + savings



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Income = value of consumption + savings
= value of consumpt. + PV of future changes in consumpt.



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Present & future consumpt. (changes) are valued in welfare terms



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Present & future consumpt. (changes) are valued in welfare terms

In an optimum: Observable prices; otherwise: calculated prices



Definition of income (Sefton & Weale, 2006)

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$$\mathbf{p}_c(t)\mathbf{c}(t)$$



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$$\frac{d}{dt}(\mathbf{p}_c(t)\mathbf{c}(t))$$



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$$\frac{d}{dt}(\mathbf{p}_c(t)\mathbf{c}(t)) = \dot{\mathbf{p}}_c(t)\mathbf{c}(t) + \mathbf{p}_c(t)\dot{\mathbf{c}}(t)$$



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$$-\mathbf{p}_c(t)\mathbf{c}(t) = \int_t^\infty \dot{\mathbf{p}}_c(\tau)\mathbf{c}(\tau)d\tau + \int_t^\infty \mathbf{p}_c(\tau)\dot{\mathbf{c}}(\tau)d\tau$$



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$$\underbrace{\int_t^{\infty} \mathbf{p}_c(\tau)\dot{\mathbf{c}}(\tau)d\tau}_{\text{Savings}}$$



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$$\mathbf{p}_c(t)\mathbf{c}(t) + \underbrace{\int_t^\infty \mathbf{p}_c(\tau)\dot{\mathbf{c}}(\tau)d\tau}_{\text{Savings}}$$



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$$\mathbf{P}_c(t)\mathbf{c}(t)$$



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$$\mathbf{P}_c(t)\mathbf{c}(t) + \int_t^{\infty} \frac{\pi(\tau)}{\pi(t)} \mathbf{P}_c(\tau)\dot{\mathbf{c}}(\tau)d\tau$$



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$$\int_t^\infty \frac{\pi(\tau)}{\pi(t)} R(\tau) \mathbf{P}_c(\tau) \mathbf{c}(\tau) d\tau = \mathbf{P}_c(t) \mathbf{c}(t) + \int_t^\infty \frac{\pi(\tau)}{\pi(t)} \mathbf{P}_c(\tau) \dot{\mathbf{c}}(\tau) d\tau$$



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$$Y(t) = \int_t^{\infty} \frac{\pi(\tau)}{\pi(t)} R(\tau) \mathbf{P}_c(\tau) \mathbf{c}(\tau) d\tau = \mathbf{P}_c(t) \mathbf{c}(t) + \int_t^{\infty} \frac{\pi(\tau)}{\pi(t)} \mathbf{P}_c(\tau) \dot{\mathbf{c}}(\tau) d\tau$$



Definition of income (Sefton & Weale, 2006)

- Real income: PV of future real interest on consumption

$$\frac{d}{dt}(\mathbf{p}_c(t)\mathbf{c}(t)) = \dot{\mathbf{p}}_c(t)\mathbf{c}(t) + \mathbf{p}_c(t)\dot{\mathbf{c}}(t)$$

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$$Y(t) = \int_t^\infty \frac{\pi(\tau)}{\pi(t)} R(\tau) \mathbf{P}_c(\tau) \mathbf{c}(\tau) d\tau = \mathbf{P}_c(t) \mathbf{c}(t) + \int_t^\infty \frac{\pi(\tau)}{\pi(t)} \mathbf{P}_c(\tau) \dot{\mathbf{c}}(\tau) d\tau$$



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If a Divisia CPI is used



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If a Divisia CPI is used

- Change in the real value of consumption
= real value of consumption changes



Results (including Asheim & Weitzman, 2001)

If a Divisia CPI is used and the real interest rate is positive:

- Change in the real value of consumption
= real value of consumption changes

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If a Divisia CPI is used and the real interest rate is positive:

- Change in the real value of consumption
= real value of consumption changes
- Real income grows if and only if savings are positive



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If a Divisia CPI is used and the real interest rate is positive:

- Change in the real value of consumption
= real value of consumption changes
- Real income grows if and only if savings are positive

In a closed economy with stationary technology:



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If a Divisia CPI is used and the real interest rate is positive:

- Change in the real value of consumption
= real value of consumption changes
- Real income grows if and only if savings are positive

In a closed economy with stationary technology:

- Savings = value of net investments



Results (including Asheim & Weitzman, 2001)

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If a Divisia CPI is used and the real interest rate is positive:

- Change in the real value of consumption
= real value of consumption changes
- Real income grows if and only if savings are positive

In a closed economy with stationary technology:

- Savings = value of net investments
- Income = consumpt. + value of net investm. = net product



Results (including Asheim & Weitzman, 2001)

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If a Divisia CPI is used and the real interest rate is positive
in a closed economy with stationary technology:

- Increase in real net product indicates welfare improvement



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by:

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For local-in-time comparisons within an economy:
Does dynamic welfare increase?



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by:

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- consumption not exceeding income
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For local-in-time comparisons within an economy:
Does dynamic welfare increase?

Not for global-in-space comparisons between economies:
Are people in one economy better off than in another?



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For local-in-time comparisons within an economy:



Role of consumers' surplus

For local-in-time comparisons within an economy:
No role! Only the value of consumption changes matters

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For global-in-time comparisons within an economy:

Is dynamic welfare higher now than it was n periods ago?



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Global-in-time comparisons using a Divisia CPI

hold if preferences are quasi-homothetic



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If some goods are environmental amenities,

then linear Engel curves impose requirements on

the scale used to measure such amenities



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For a different scale, consumers' surplus might have a role



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