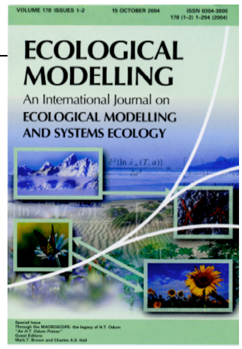
LECTURE 8 | EXTERNALITIES VS. EMTERNALITIES



LECTURE OBJECTIVES
The purpose of this lecture is to show how ideas in Systems Ecology first diverged from economics and how they are now supplementing environmental economics, especially through the new concept of emternalities.

EMTERNALITIES AS COUNTERPART TO ECONOMIC EXTERNALITIES…!
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INTRODUCTION

Emternalities, using emergy (alternatively, using dollars based on willingness-to-pay), enhance and contribute to quantifying the established theory of externalities while supplementing it by expanding definition and quantification to environmental non-commodity inputs. As an example, a sandy beach is an emternality to the tourism sector. Fertile soils are emternalities to agriculture. Environmental services from either beaches or fertile soils are not accounted for in the marketplace. Tourists have in mind they are renting 1.5 m2 of beach while they are consuming it through housing, the degradation of dunes, the building of peers, and so on. Agriculture is using up soils through overgrazing and fertilizers, the latter mobilizing extensive environmental services in order to render them inert. In both cases, however, valuing emternalities led to input natural values into economic accounting, to enlarge total economic value and, consequently, to make alternative economic decisions such as (at the beginning) in incorporating the value of the sandy beaches into the overall environment-economic profile of Agadir (Morocco) or (at the end) in anchoring direct ecological payments to Swiss farmers (2.3 billion US$ per year).

H.T. Odum's contribution prevailed in the designing of the concept of emternality. The most important publications that support this work include parts of Systems Ecology (Odum, 1983) and further environment-economic bridges tentatively derived for various countries and economic sectors including Switzerland in overview (Pillet and Odum 1984), Swiss agriculture (Ecosys 2000), Italian agriculture (Ulgiati et al. 1992), and ecology-economy theoretical settings (Pillet and Odum 1987). Ideas found in Environmental Accounting (Odum 1996) are also included as well as those developed in several seminal papers on emternalities (Pillet et al. 2001, Brandt-Williams and Pillet 2003).

1 | LINKING THE ENVIRONMENT TO THE ECONOMY

H.T. Odum devised a key ratio that allows us to put even economic values on a common basis, and that is the emergy to dollar ratio. Based on the fundamental principle that all human activities, particularly the economy, are based on natural resources, there is an intrinsic link between environmental services and economic measures such as gross national product. Translating all resources and labor used in any year within a governmental unit into emergy and dividing by the currency in circulation for the same year, same region, provides a quantitative link between the environment and the economy for that region in that year.

Calculation of this ratio is explained fully in Environmental Accounting (Odum 1996), using the U.S. as the example. Briefly, we have two values describing economic activity in any given year: one is the emergy value of the natural resources in circulation being used to support the economy, and the other, the gross national or state product, is the dollars circulating in the opposite direction processing or purchasing those resources in one form or another. This ratio of emergy to dollars can be used to convert dollar data for a given year into solar emjoules or it can used to convert solar emjoules into a value – emdollars (em$) – that is comparable to dollars. This ratio was an important milestone in ecological economics, providing the first physically derived quantitative metric for the interface between ecology and economics, as opposed to preference derived values.

2 | EXTERNALITIES AND EMTERNALITES

Externalities are a component of welfare economics and have evolved from "fringe" ideas to essentially central aspects of most economic thought. Meade (1973) defines externalities as consequences that arise from situations where actions of one agent or group of agents affect the production or well being of others in the economy, especially the welfare of people who are external to that decision. In other words, people who are not fully consenting parties in production decisions, as they are in sales and purchases, are impacted by outputs of production. Thus externalities constitute economic "spillovers", normally of an adverse sort.

A classic example would be the downstream loss of fish to a fisherman due to economic actions upstream, such as the operation of a factory. For most economists a legitimate aspect of determining what prices should be (as opposed to what they are in unregulated markets where the value of the externality is not considered) is to "internalize the externality", that is assign a dollar value to that externality through various scientific or survey methods, then enforce its inclusion in the price through government regulation. Thus the factory owner might be required to pay the fisherman or clean up his effluent. This "complete" cost of the factory's product is then assigned to the sales price.

This externality concept initially seemed bizarre and unnecessary to H. T. Odum. Indeed, within a system of man and nature, such "spillovers" simply did not need to be internalized to the system as it was obvious that they were internal from the start. If externalities had to do with pollutants, for example, why not coin some more appropriate name for dealing with the pollution as such, rather than with " added to the market" welfare effects?

Yet, with time and the maturing of emergy synthesis, Odum improved ecological systems analysis to consider the generation of human welfare-increasing actions within systems of nature and society. Reciprocally, as man-made pollution threatened ecosystems it did indeed cause decreased welfare within the larger system of nature and society. As a consequence, the externality concept again was given an important role to play. However, why should one take account of such non-commodity outputs (pollutants) without accounting for the positive environmental non-commodity inputs (current environmental goods and services) that were flowing in at the same time and scale?

As a result, the standard economic picture was considered incomplete even after accounting for externalities. From this logic the emternality concept was born. It is a deliberate attempt to directly link Odum's emergy theory to a conceptual framework familiar to economists. Hence, emternalities come into view as the quasi counterpart of established economic externalities, except that they designate unassessed inflowing environmental contributions instead of unpriced, outflowing impacts of economic processes on the environment (see Fig. 1).

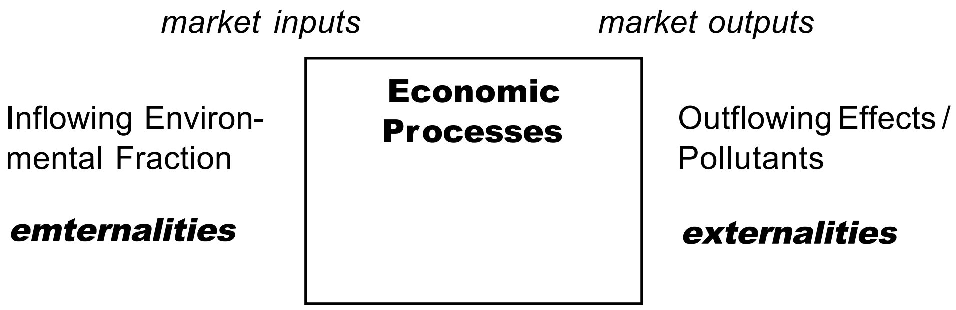


Figure 1 – Emternalities can be viewed as the quasi counterpart of economic externalities.

Emternalities constitute a counterpart to externalities on a metaphoric basis. In both cases, private ownership is unclear. Both constitute unpriced inflows or outflows, and examples include the input of rain to agro-ecosystems or rivers, and the resilience of the physical milieu upon which all life is dependant by the Earth's ecosystems collectively. One basic difference is that externalities are internalized according to preference-related methods whereas emternalities are accounted for according to non-preference related approaches (though not exclusively). Indeed, they primarily occur independently of whatever any person or group of people thinks in terms of their values. The particular prefix aims at emphasizing this "into" attribute (as a variant of the Latin "en-", em- refers to "put into").

In the case of emternalities, there is no market by which they might enter into standard economic evaluation or exchange—and therefore no "joint decision" as buyers and sellers do not exist as consenting parties to the environmental transaction, for it occurs independent of any of their thoughts or actions. Notwithstanding, the production possibilities of the economy as well as the welfare of people are very much dependant upon, and sometimes constrained by, these flows. Thus the flow of goods and services that economic activities generate and individuals enjoy is linked to the "environmental fraction" in a way that is not reflected in the marketplace. They can, however, be appreciated in real, non-economic terms as a basis for further economic conversion (Pillet, 1986).

3 | ADVANCES IN THEORY AND PROCEDURES

Advances have been made in the theory and valuation of externalities using two related approaches: understanding and valuation procedures. On the one hand, the economic concept of externality evolved from incidental non-marketed externalities to that of energy externalities, with energy used to quantify the external, energy-ecology basis of any economy. (Cf. the role of environment as an energy externality in national economies or agricultures; Pillet and Odum 1984, Pillet and Murota 1988, Ulgiati et al. 1992, Pasquier 1999, Brandt-Williams 2001, 1999.) On the other hand, the appraisal of externalities evolved from welfare measurements—by means of individual preferences—to the ecological assessment of more pervasive and structural effects applying input-output based materials and/or environmental accounting procedures (see Table I). This entered conventional economic analysis.

Accordingly, in the general emergy literature economic externalities have been supplemented by new concepts used to designate comprehensive and pervasive materials-based externalities such as waste outputs (called environmental externalities in Table I), and structural systems ecology-based emternalities such as resource inputs (formerly called energy externalities). In parallel, stages of the methodology evolved from established welfare and net energy measurements to exergy, eMergy, and even eXtropy valuation procedures. For example, whereas formerly the inputs to generate a ton of grain or an automobile might have been limited to inputs that were on the marketplace, now it is clearly understood that the full suite of inputs required include such unpaid environmental services as rain, soil, sandy beaches, and clean air…

Methods for assessing nonmarket effects, therefore, differ amongst investigators, with methodological choices constituting another difference between the assessment of externalities and emternalities. Economic valuation methods, at best, put an emphasis on the environmental consequences of economic actions on individual preferences (which are evaluated by way of direct, indirect or hypothetical markets) and economic costs. Constant resource availability is usually assumed in conventional economic analysis. In turn, the concept of emternalities is much more important and inclusive by assigning a value, even if that value does not enter into market transactions, to the essential contributions of the environment to routine economic goods and services. In this case (emternalities are primarily evaluated in eMergy and GDP$-value terms), environmental and economic systems are interfaced. The economic system might be considered itself as an ecosystem using free environmental flows as nonmarket inputs into economic production and use.

4 | DEFINITION AND MEASUREMENT OF EMTERNALITIES

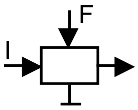
Emternalities are expressed as the environmental fraction inflowing into economic processes as nonmarket, unpriced inputs from across the commercial boundary. Some environmental flows (e.g., amenities) can be captured directly by individuals by means of exploiting their utility function, and can consequently be assessed according to the user's preferences. Emternalities inflowing into economic processes and products cannot be measured this way. They first need to be environmentally dimensioned (using nonpreference-related metrics), and then appraised in relative monetary terms. Once environmentally dimensioned, emternalities might also be assessed further according to preference-related methods.

An emternality ratio can be calculated for making comparisons. This ratio is defined as the proportion (%) of the environmental fraction (I) relative to the entire set of inputs (I + F). F denotes the market based inputs (see Table I). Recycled organic matter produced within the process (I') might increase the environmental fraction, and with it the emternality ratio (emt). In contrast, soil used up might be taken into account as negative emternalities in as far as soil is a non-renewable—or slowly renewable—resource relative to the system. As a consequence, there are two ways to calculate emternality ratios: one is by using a composite ratio, summing up renewable (R) and non renewable (N) flows entering the economic process (R + N = I); the other one is called "renewable only" and takes into account only the renewable flows of nature (R). Differences in the two ratios denote the importance or unimportance of soil losses in the process under review. Emergy synthesis is the metric used for assessing components of this system so that emternalities can be expressed in absolute as well as in relative terms.

Emergy analysis allows all system parameters, economic and environmental, to be calculated on a common energy basis using embodied solar joules, or emjoules (seJ or emJ).

Assessments of emternalities can be found in Ecosys (2000), Pillet et al. (2001), and Brandt-Williams and Pillet (2003).

Table I: Progression in the Theory and Assessment of Externalities

Concept & Origin	Theory	Definition	Modelling	Viewpoint	Principles	Assessment
Economic Externalities 1920	Welfare Economics	$\left.\frac{1}{\lambda_j}\frac{\partial U_j}{\partial x_{ik}}\right\| \neq 0$	Functional	Individual Preferences *Incidental Effects*	Pareto Optimality	Contingent Valuation and other Methods; Damage Costs
Environmental Externalities 1972	General Equilibrium; I-O Analysis	[R] Resource Input; [W] Waste Output	I-O	Including Environmental Links *Pervasive Effects*	Application of Physical Principles	I-O Based Materials Accounting; Energy Metrics
Emternalities 2000	Systems Ecology; Interfaced Environment-Economic Systems		Auto-catalytic Design	Ecological Economics *Environmental Fraction*	Energy Laws; Maximum Power Principle	EMergy Synthesis; Monergy Based $ Value Terms

Source: Pillet et al. (2001), after Pillet (1986) and Pasquier (1999);

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