

Some Comments on Ragnar Frisch's Ecocirc-system.

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1. Introduction

The "Ecocirc-system" is a system of basic concepts describing the circulation of economic flows. Its general purpose is to contribute towards:

a) Standardization of definitions, terminology, and notations which can be (1) used in a fruitful way in the economic analysis of any economic sector, e.g., a nation, a firm, etc., and (2) accepted and used as widely as possible by the economists.

b) Mechanization of the aggregation and the displaying of the degrees of freedom.

c) Establishment of conformity between different ways of presenting systems of identities, particularly between the algebraic presentation, the graphic presentation, and the presentation by means of a double-entry bookkeeping system.

The Ecocirc-system is in the main a contribution of Ragnar Frisch. He started the work on these problems in the early 1930's, and ever since it has been carried on by Frisch and his associates at the Oslo Institute of Economics. Unfortunately most of the results are either unpublished or only mimeographed in Norwegian.

2. Publications

Ragnar Frisch: Et generelt monetært begreps og symbolsystem. Mimeographed Oslo, 1935. In English: "A General Monetary Concept and Symbol-system."

Ragnar Frisch: Noen inføringsmerknader om Økosirkssystemet (Det Økonomiske sirkulasjonssystem). Mimeographed, Oslo, 1942. In English: "Some Introductory Remarks on the Ecocirc-system (The Economic Circulation System)."

Ragnar Frisch: Økosirkssystemet (Det Økonomiske sirkulasjonssystem). Økonomisk Tidsskrift, 1943. In English: "The Ecocirc-system (The Economic Circulation System)."

Ragnar Frisch, with the assistance of Odd Aulkrust and Petter Jakob Bjerve: A System of Concepts Describing the Economic Circulation and Production Process. University Institute of Economics, Oslo. Stencil-memo, 8 March 1943.--The comments in the present paper are by and large a summary of this Stencil-memo, and the attached Figure 1 and Lists 1-3 are parts of it.

Petter Jakob Bjerve: Økosirkssystemet og realsirkulasjonen i The General Theory of Employment, Interest and Money. Statsøkonomisk Tidsskrift. Oslo, 1944. In English: "The Ecocirc-system and the Real Circulation in The General Theory of Employment, Interest, and Money."

### 3. Notations.

List No. 1 indicates the philological basis for the choice of symbols. Among other notational rules applied may be mentioned:

(1) A letter with a sub-bar indicates a transaction between a sector and all other sectors. Without a sub-bar it indicates something taking place within the sector. A double bar is everywhere equal to a nonbar plus a single bar.

(2) The superscript 0 indicates "the Government," the superscript 1 "the Private Sector." A super-0 plus a super-1 is everywhere equal to a non-super.

(3) The superscripts + and - indicate the respective positive and negative parts of a net quantity, e.g.,  $\underline{K} = \underline{K}^+ - \underline{K}^-$ .

#### 4. The Graphic Presentation.

So-called "Ecocirc-graphs" are used as a means of presenting definitional relations, see the attached Figure 1. The main geometrical principles, according to which such a graph is constructed, are:

(1) A flow is indicated by a curve with the same direction/<sup>of</sup>curvature throughout its entire length, i.e., between its two endpoints. The direction of curvature defines the direction of the flow. Internal flows are indicated by continuous, external flows by dotted, curves.

(2) A stock is indicated by a circular area. Intercepting a flow of the graph and letting it accumulate in the form of a positive stock at one side of the point of interception and in a corresponding negative stock at the other side, we get a representation of the connection between a stock, the balancing entry corresponding to this stock, and the flow that alimnts the stock.

(3) Each junction point defines an equation. The sum of all clockwise (counter-clockwise) flows moving into a junction point is by definition equal to the sum of all clockwise (counter-clockwise) flows passing out of it. This means that the graph is closed. More generally, draw any closed contour-line on the graph. The sum of the flows that enter clockwise (counter-clockwise) into the area defined by the contour, must be equal to the sum of those passing out of it clockwise (counter-clockwise), provided that the net stocks within this area are equal to zero. If the sum of the stocks are different from zero, the sum of in-flows must be equal to the sum of outflows plus the net increase (positive or negative) of the stocks represented by the circled areas within

the contour.

(4) The graph for one economic sector may be connected with that for another by intercepting any of the dotted lines depicting a connection with the other sector, doing the same for the other sector and connecting the free ends thus obtained in a common junction point in such a way that both flows lead either into or out of this point. Thus we get for example  $R_{1,2} + R_{2,1} = 0$ , where the subscripts 1,2 indicate a flow from sector 1 to sector 2, and 2,1 indicate a flow from sector 2 to sector 1.

### 5. The Bookkeeping Presentation.

The identities of the Ecocirc-system may also be presented by means of a double-entry bookkeeping system. The Ecocirc-graph is mechanically transformed into this form of presentation in the following way:

(1) Conceive of each junction point (or each pair of + and - areas) as an account, the flows moving clockwise into the point as debit entries on this account, and the flows passing clockwise out of the point as credit entries. The Ecocirc-graph presents a balanced (closed) system of such accounts.

(2) Several accounts of this system may be consolidated mechanically by drawing a contour on the Ecocirc-graph enclosing all junction points corresponding to these accounts, and no others. The flows into the contour (clockwise) are debit entries and the flows passing out of it are credit entries on the consolidated account.

### 6. Real and Financial Flows.

"Real" flows are flows of real objects (goods and services), "financial" flows are flows of financial objects (economic claims and counter-claims, in a wide sense).

By convention the direction of "net" is everywhere chosen in the opposite sense for the real and the financial flows. For the Ecocirc-graph (Figure 1) the convention is adopted that the positive direction of the net real flows is clockwise, and consequently that the positive direction of the net financial flows is counter-clockwise. All flows may be described either as "real" or as "financial." The attached lists Nos. 2 and 3 give a real as well as a financial interpretation of most flows of the Ecocirc-graph. The translation of the Norwegian terminology into English was done rather in a hurry and can obviously be much improved.

When describing reality either real or financial concepts may be used according to which is regarded as most fruitful. The distinction is, however, important particularly as a means to avoid "counting the same thing twice."

#### 7. Concrete Description of the Ecocirc-graph.

It is convenient to describe one part of the graph by referring to the way in which the flows appear when considered from the real point of view, and to describe the remaining part from the financial view.

First the real interpretation. The input flows into the process of production are (a) the net services of the real factors of production (11, 12, and 14), the sum of which is the net national product [ $10 = 11 + 12 + 14$ ], (b) the depreciation of real capital (7), which added to the net national product gives gross national product [ $9 = 10 + 7$ ], (c) the imports of goods and services (6), and (d) the reinput of goods and services produced in the same period (5). The total output (1) is classified according to its utilization in: (a) the reinput (5) already mentioned, (b) the exports of goods and services

(2), the domestic consumption of goods and services (4), and gross domestic investment in real capital (3) [ $1 = 2 + 3 + 4 + 5$ ].

Subtracting depreciation from gross investment we get net investment in domestic real capital [ $52 = 3 - 7$ ]. Other additions to this capital are certain occasional gains (losses) which one doesn't want to take into consideration when calculating national income (55 and 56). Thus, the total increase in the domestic real capital equals the sum [ $52 + 55 + 56$ ].

Subtracting imports from exports we get the export surplus [ $69 = 2 - 6$ ]. From this surplus transfer of gifts, etc., in kind to foreign countries (65) is deducted and such gifts, etc., from other countries (66) are added, and we get the export surplus to be paid for [ $70 = 69 - 65 + 66$ ].

The financial interpretation of (11), (12), and (14) is the payment received by the factors of production. This factorial income [ $10 = 11 + 12 + 14$ ] together with the net income (interests and dividends) from abroad (72) gives the accruing national income [ $15 = 10 + 72$ ]. Another way of classifying this income is indicated by the equation [ $15 = 16 + 17 + 72$ ].

Proceeding counter-clockwise around the graph we see that the aggregate income accruing to the private sector (25), both from its activity at home (21) and from abroad (23), i.e., [ $25 = 21 + 23$ ], is partly transferred to the government (28). On the other hand, the private sector receives transfers from abroad (27). The balance is the private disposable income [ $36 = 25 + 27 - 28$ ]. Correspondingly, the aggregate income accruing to the government (24), both from its activity at home (20) and from abroad (22), i.e., [ $24 = 20 + 22$ ] together with transfers to the government from abroad (26) and from the private sector (28) add

up to the governmental disposable income [35 = 24 + 26 + 28]. As indicated on the top of the graph the sum of private and governmental disposable income is the disposable national income [37 = 35 + 36 = 15 + 64].

The upper lefthand part of the graph illustrates the way in which, respectively, private and governmental disposable income is disposed: Partly it is saved, viz. (41) and (40), and partly it is used up, viz. (39) and (38). What is used up is again partly spent for consumption at home, viz. (60) and (59), and partly spent for gifts, etc., to foreign countries, viz. (62) and (61). The sum of private and government spending on consumption at home equals total domestic consumption expenditure [4 = 59 + 60], and the sum of private and government spending on gifts, etc., to foreign countries equals the national expenditure on gifts, etc., [63 = 61 + 62], of which a part may be transferred abroad in kind (65) and a part in the form of financial objects (67). In the latter case only the balance of payments towards other countries is affected.

The private saving (41) may be invested in claims against the government (42), in goods and services for investment in real capital at home (48), and in foreign assets (50), i.e., [41 = 42 + 48 + 50]. Correspondingly, the government saving (40) together with the government net borrowing at home (42) may be invested either in real capital at home (47) or in foreign assets (49), i.e., [42 + 40 = 47 + 49]. The sum of private and government investment in real capital at home is the national expenditure on goods and services on capital account [51 = 47 + 48 = 52], and the sum of private investment in foreign assets is the net national expenditure on foreign assets [53 = 49 + 50 = 54]. Finally, the sum of the net national expenditure on foreign assets (54) and the net national expenditure on gifts, etc., in the form of financial objects (67)

equals the sum of the net national receipts of foreign assets as gifts, etc., (68), the net receipts in payment for the export surplus (70), and the net income of interests and dividends from abroad (72), i.e., [54 + 67 = 68 + 70 + 72]. This completes the description from the financial viewpoint.

8. Application in Comparisons Between Different Systems.

Examples will be given at the staff meeting.

9. Application in Model Building.

Some comments will be made at the staff meeting on

- (a) the use of a standard system of the Ecocirc-type as a basis and reference when selecting the identities for alternative models,
- (b) the display of the degrees of freedom when a particular selection is made, and
- (c) the Ecocirc-system as a means of securing consistency of aggregation.