CIRCULAR FLOW

A. The Concept of Circular Flow

I. THE MEANING OF THE TERM

The term "circular flow" is associated in economic science with the idea that the economic and — more generally — the social activities of individuals or groups are mutually related. These interactions consist primarily in transfers of goods and services on the one hand and of money or monetary claims on the other. Such transactions between individual economic entities are frequently purchases of goods and services (flow of goods or services from vendor to purchaser) in return for a sum of money dependent upon the price of a transaction unit (money flow from purchaser to vendor). All transactions in economically relevant objects during a particular period of time within a specified economic sphere (e.g. a national economy) — the external sphere as a whole being regarded as a separate economic entity — may be seen as a circular-flow pattern.

There are usually too many economic entities operating at once for the construction of a clear and, above all, computable model of circular flow to be possible without combining several similar entities through aggregation into higher entities (sectors or poles). Moreover, the lack of suitable statistical material (e.g. on the transactions of a single household) or the particular purpose of an investigation (e.g. economic trend analysis) frequently entails a high degree of aggregation of economic entitites into a few sectors (poles). Economic entities with as many common features as possible are combined into sectors according to the criterion of similarity in each particular case — e.g. according to functions (recipients of wages and salaries, profits, pensions, etc.), institutions (private households, manufacturing enterprises, public corporations, etc.) and regions (economic entities in regions A, B, C, etc.). A more detailed grouping is arrived at by combining these or other criteria (e.g. the private households of wage-earners in region A).

II. FORMS OF PRESENTATION OF ECONOMIC CIRCULAR FLOW

There are various ways of covering and representing circular-flow relationships within a given sphere. In order to illustrate the specific nature of the different forms of presentation and their similarities, we shall take as a basis the Marxian model of the growing capitalist economy — i.e. of expanding reproduction — omitting foreign relations and government, but including saving undertaken by workers.

First, we shall distinguish between three (aggregated) economic entities, viz. the production sector (P), non-entrepreneurial households (W) and entrepreneurial households (U). The following relationships exist between these economic entities:

1. Production enterprises obtain labour services from non-entrepreneurial households and the use of capital from entrepreneurial households. To these real inputs correspond monetary payments in the form of wages, salaries and profits.

2. The production sector produces consumer goods and capital goods, and for the supply of consumer goods there exists a corresponding monetary demand by households.

3. The payments of wages, salaries and profits over a period amount to more than the purchases of consumer goods within this period by entrepreneurial and non-entrepreneurial households; also, within a given period, the value of the capital goods produced exceeds the replacement demand due to depreciation.

These relations can be expressed in a system of linear equations, for which we shall introduce the following symbols and abbrevations:

L — wages and salaries (the monetary equivalent of work done)
G — profits (the monetary equivalent of the yield of capital)
C_w — purchases of consumer goods by non-entrepreneurial households
C_u — purchases of consumer goods by entrepreneurial households
C — total consumption
S_w — savings of non-entrepreneurial households
S_u — savings of entrepreneurial households
S — total savings
D — depreciation
I_e — replacement of capital assets
I_n — net investment
I — total investment
Y — national income (net value added net national product)
Y_b — gross national product (GNP total final output)

The following definitional equations can thus be formed:

$$C_w + C_u + I_e + I_n = Y_b \qquad \text{(i)}$$
$$G + L + D = Y_b \qquad \text{(ii)}$$
$$C_w + S_w = L \qquad \text{(iii)}$$
$$C_u + S_u = G \qquad \text{(iv)}$$
$$S_w + S_u = I_n \qquad \text{(v)}$$

Equation (i) defines the GNP from the production side: it equals the total of consumer goods and capital goods produced. Equation (ii) shows the distribution side. The GNP is divided between entrepreneurs' and workers' incomes and depreciation charges for the period. The division of wages, salaries and profits for purposes of consumption and saving is shown by equations (iii) and (iv), while equation (v) shows the *ex post* identity between national savings and net investment for the period (but not necessarily any correspondence between savings and investment plans at the beginning of the period). From these definitional equations further identical equations can be derived but these likewise do not suggest any conclusions about any kind of equilibrium; they only confirm the accounting equality — following from the definitions — of certain circulation parameters at the end of a period.

From equations (ii), (iii) and (iv) the third definition of the GNP, from the utilization side, is obtained:

$$C_w + S_w + C_u + S_u + D = Y_b \qquad \text{(vi)}$$

It states that the GNP — conceived as gross national income — is used to cover depreciation charges, for the purchases of consumer goods by households and for their savings. From equations (i), (v) and (vi) we obtain the identity between the replacement of capital assets and the wear and tear on capital goods for the period, recorded in depreciation charges in monetary terms. Finally, if the GNP Y_b is adjusted by the value of the sums set aside for depreciation, a definition of the net national product is arrived at which in our model must exactly equal the total of wages, salaries and profits, i.e. the national income.

The equation form of presentation can now be easily translated into a circular-flow matrix in which the supplies of the different sectors to one another are expressed in such a way that, for example, only the monetary values corresponding to the actual flows are recorded (thus wages and salaries are to be understood as the value of work included in budgets, for instance):

to from	P	W	U	E	F	Total
P	—	C_w	C_u	I_e	I_n	Y_b
W	L	—	—	—	—	L
U	G	—	—	—	—	G
E	D	—	—	—	—	D
F	—	S_w	S_u	—	—	I_n'
Total	Y_b'	L'	G'	I_e	I_n	

This example also shows that it was not possible to make do with the original number of sectors (P, W, U) with the circular flow closed, i.e. if the total of the goods and services supplied by a sector is supposed to equal the total of the goods and services received by it. In the matrix this means that the total of each row of the square matrix must equal the corresponding column total (i.e. $Y_b = Y_b'$, etc.). Without the additional sectors introduced into the above table (the replacement sector E and the expansion sector F), the total of the goods and services (represented by the monetary quantities L and G) received by the production sector would have been greater than the goods and services supplied to households (consumer goods), and the circular flow would not have been closed. The above example thus shows that any given open circular flow can easily be transformed into a closed circular flow through the introduction of one or more fictitious sectors (poles). The necessary equality in a closed circular flow between the value of the flows of goods and services received by a sector (also called "pole-width") and the value of the flows supplied by that sector is frequently called the "circular-flow axiom".

In the above example it would also of course have been possible to have introduced only one additional sector in order to cover the changes in net assets (V); then the number of sectors (rows and columns) would also have been one less, and investments would have been summed up in aggregate form according to the equation $I_e + I_n = I$. Partial aggregation of this kind adds to the simplicity and clarity of presentation, of course, but it involves at the same time a considerable loss of information, since we are now no longer told anything about the value of net investments, which is relevant in the long term. In practical applications of circular-flow analysis it is therefore generally very important to maintain a proper balance between clarity of presentation on the one hand and information content on the other.

The situation is different if — as in the determination of business operating efficiency — transactions between economic entities are to be recorded in a schedule of accounts on the double-entry system, it then being possible to keep the number of sectors smaller because the number of individual items entered in an account is in principle a matter of choice. If we take production sector P, non-entrepreneurial households W, entrepreneurial households U and the change in net assets V as the balancing account, we obtain the following system of accounting entries:

P		W		U		V	
L	C_w	C_w	L	C_u	G	I_e	S_w
G	C_u	S_w		S_u		I_n	S_u
D	I_e						D
	I_n						
Y_b'	Y_b	L'	L	G'	G	I	I'

Another frequently employed method of presenting circular flow is the explanatory diagram, each of whose nodes (rings) represents an (aggregate) economic entity and whose arrows represent the transactions taking place between the economic entities as an inter-relation between two poles in each case. The circular-flow model selected yields the following diagram for the respective flows of payment:
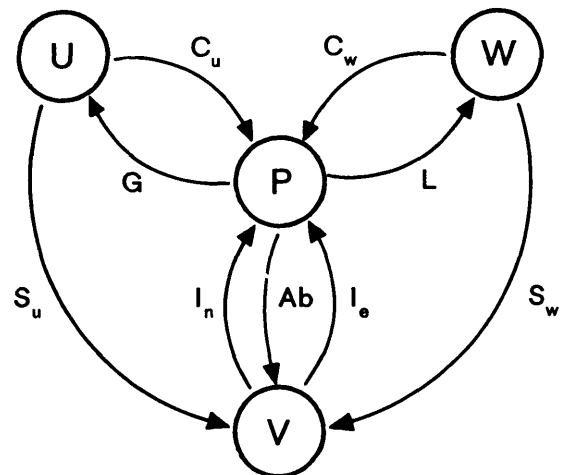
The directions of all the arrows in the diagram are reversed if, instead of the flows of payments (for consumer goods, labour services, etc.), the corresponding flows of priced goods and services (supplies of consumer goods, work done, etc.) are considered. As a

result of the introduction of the balancing pole (change in net assets), we obtain here also a closed circular flow where the value of all the flows to a pole (the total of the different flow widths) equals the value of the flows away from it.

In addition to these four main forms of presentation other kinds of circular-flow models have also been elaborated, such as analogue models in the form of piping systems, electrical wiring networks, control circuits, etc. With the further development of cybernetic and other systematic theoretical processes, the conception of circular flow as a control circuit — i.e. as a dynamically self-regulating system with specific control mechanisms (e.g. markets, planning authorities, etc.) — will become important. This conception was introduced by W. G. Waffenschmidt (*Anschauliche Einführung . . .*) in the form of block-circuit diagrams and has since been developed further on the lines of control-system engineering (cf. Tustin, *The Mechanism of Economic Systems*, . . .; Allen, The Engineer's Approach to Economic Models, . . .; Id., *Mathematical Economics . . .*; Föhl, *Geldschöpfung u. Wirtschaftskreislauf*, . . .; and others). By analogy with the theory of chemical chain reactions B. I. Pliukhin and R. N. Nazarova (Upravliaemaia tsepnaia reaktsiia rasshirennogo vosproizvodstva v odnosektornoi i dvusektornoi modeliakh. In Nemchinov, ed. *Primenenie matematiki . . .*, t. 2, p. 342–428) have worked out one-sector and two-sector circular-flow models of the controlled chain reaction of economic growth.

## B. Development and Applications of Circulation Theory

I. QUESNAY'S TABLEAU ÉCONOMIQUE

The first exact statement of the notion of circulation is to be found in François Quesnay's *Tableau économique* (1758), which distinguishes between three social classes: the tenant farmers (*classe productive*), the landowners (*classe des propriétaires*) and the – in the physiocratic view unproductive — class comprising all those who do not work in agriculture (*classe stérile*). By generalizing the numerical examples given by the table, the following circular-flow model is arrived at:

(a) The total gross product of society is produced by the productive class and distributed, via payments of rent to the landowners and purchases by the sterile class, between all three sectors of the economy.

(b) In successive periods circulation remains unchanged (stationary), since no new production capacities are created nor does technological progress take effect.

A clear picture of Quesnay's idea of circulation is conveyed if the flows of goods and services and of money are each represented in respective diagrams slightly modified from Bénard, Marx et Quesnay . . .):
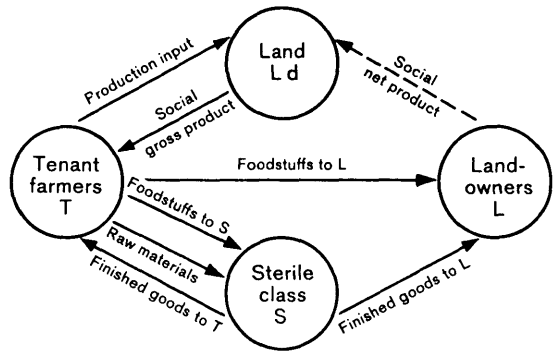
In order to close the circular flow of goods in this diagram the credit pole "land" and a fictitious flow of goods and services (the "social net product") from L to Ld are introduced, thus providing a clear illustration of the physiocratic view that land is the source of all wealth and that landownership is tantamount to the fact that the entire social net product rests in the hands of the landowning class. This is seen even more clearly in the circulation of money, which can be expressed in values that have already been balanced and therefore does not need "land" as an additional pole to balance it.
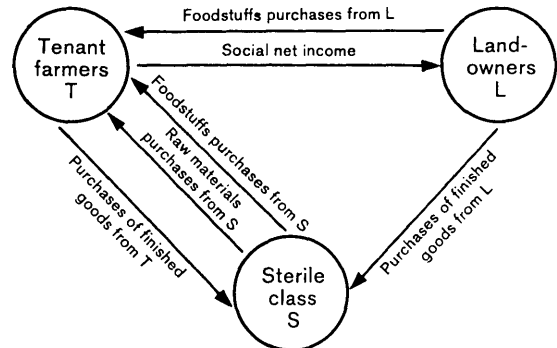
Taking into account what has been said above about the correspondence between the various forms of representation and also the circular-flow axiom, we can easily obtain from these diagrams the general system of definitional and identical equations underlying the *Tableau économique* and the matrix of macro-economic relationships. In the third edition of the *Tableau* Quesnay deduced in his "zig-zag diagram" a preliminary form of the multiplier theorem which is fundamental to the work of Keynes and Leontief (see below: B, IV & V).

II. MARX'S SCHEMATA OF REPRODUCTION

Quesnay's pioneering work in the field of circulation theory remained unnoticed in classical political economy for more than a century — except by Adam Smith and Simonde de Sismóndi who made unsuccessful attempts to develop it further (Smith, *An Inquiry . . .*; Simonde de Sismondi, *Nouveaux principes . . .*) — until Marx took up the idea of circulation again and elaborated it further in both form and content (in Volume 2 of

Capital). Marx based his circulation analysis upon a division of the economy into two departments (the producer goods department and the consumer goods department) and two classes (workers and capitalists). (See DEPARTMENTS OF SOCIAL PRODUCTION.)

According to Marx the output w in terms of value in both departments equals the sum of depreciation on capital goods (constant capital c), the wages paid for labour (variable capital v) and the profits realized (surplus value s). This is illustrated in the following transaction matrix:

Department		Total (commodity value)
Department I (Producer goods)	c_1 v_1 s_1	w_1
Department II (Consumer goods)	c_2 v_2 s_2	w_2
Total (Value elements)	c v s	w

Since by definition $w_1 + w_2 = w = c + v + s$, the circular flow is closed. For a stationary circulation (simple reproduction) the following conditions obviously apply (see also above: A, II):

The producer goods department (Department I) must produce within each period sufficient capital goods to enable the fixed capital consumed in both departments to be replaced:

$$w_1 = c_1 + v_1 + s_1 = c_1 + c_2 \qquad (i)$$

Since in the stationary economy no net investments are made, capitalists and workers must spend their incomes entirely on purchasing consumer goods from Department II:

$$v + s = v_1 + v_2 + s_1 + s_2 = c_2 + v_2 + s_2 = w_2 \qquad (ii)$$

Both equations reduce to a single condition for simple reproduction:

$$c_2 = v_1 + s_1 \qquad (iii)$$

— i.e. the value added (wages and profits) in Department I must equal the replacement requirements of Department II; or in other words, Department I must produce sufficient in excess of its own replacement requirements to be able to satisfy the replacement demands in Department II with appropriate supplies of producer goods. A striking feature of this conclusion is that the fulfilment of either one of conditions (i) and (ii) immediately guarantees the validity of the other. Interestingly enough, quite similar conclusions can be deduced from the Keynesian circular-flow analysis (see below: B, IV).

With a given state of technical knowledge the expansion of existing production capacities — i.e. net investments and corresponding reductions in expenditure on consumption by capitalists and/or workers — is necessary for the growth of an economy (see above: A, II). (In Marx, however, the level of wages is established in the community at subsistence level, so that only entrepreneurs' savings are available for the formation of real capital.) Thus the totality of wages and profits must not be spent entirely on consumer goods, and the value of the producer goods produced within a particular period must exceed the depreciation of the existing productive equipment. Both requirements now reduce to a single condition for expanded reproduction:

$$c_2 < v_1 + m_1 \qquad (iii\ a)$$

which requires a surplus of value added in the producer goods department exceeding the consumption of the means of production in the consumer goods department. We can convert (iii a) into an equation by taking net investment explicitly into account in both departments (Δc_1 and Δc_2):

$$\Delta c = \Delta c_1 + \Delta c_2 = v_1 + m_1 - c_2 \qquad (iii\ b)$$

This relation — which according to V. S. Nemchinov amounts to the growth potential (see INVESTMENT) — shows that the level of overall net investment (Δc) varies positively with the level of value added in the producer goods department and negatively with the consumption of producer goods in the consumer goods department. The modern theories of economic growth and technological progress (qq.v.) take this equation as their starting-point (see below: B, VI).

III. DEVELOPMENTS UP TO KEYNES

Shortly after the publication of Marx's schemata of circulation in Volume 2 of *Capital* in 1885 Eugen von Böhm-Bawerk, the Austrian theorist on capital, put forward his "ring schema" conception of circulation (*The Positive Theory of Capital*, . . .) in which he arranged national capital in "annual rings" (*Jahresringe*) according to "categories of maturity (*Reifeklassen*) He regarded capital goods as a kind of intermediate product which, when the greatest "maturity of enjoyment" (*Genussreife*) is achieved, become consumer goods. Thus production, as it is conceived by Böhm-Bawerk, is a kind of one-way street, each processing stage bringing the products nearer to their ultimate destination (consumption). However, supplies of products "ready for consumption" to production stages apparently further back (e.g. incandescent lamps ready for consumption supplied to the mining industry) cannot be explained by way of this theory. This erroneous view of the structure of production in the economy was not rectified until Leontief made his pioneering studies (see below: B, V).

Although in his analysis of expanded reproduction Böhm-Bawerk took over from Marx the importance of positive net investment, by stressing the saving function of entrepreneurs, which is crucial for the growth of the economy, he reinterpreted the inexorable laws of accumulation to which, according to Marx, all capitalists are subject. He thus abstracted from the conditions for the realization of profit, without which saving by entrepreneurs is impossible, and explained the latter's economic function as promoters of economic growth in terms of their saving activity.

A more important contribution was made in 1910 by Wilhelm Lexis (*Allgemeine Volkswirtschaftslehre*, ...) with his attempt to elaborate further Marx's theory of reproduction in conjunction with Smith's theory of value and Böhm-Bawerk's ring concept and in particular with his efforts to ascertain the dynamic structure of the process of reproduction. But the fundamental defects of Smith's theory of value (especially his failure to take into account those producer goods which are consumed) and of Böhm-Bawerk's ring schemata precluded the construction of a useful circular-flow model; and his attempt at cyclical analysis also remains of purely formal interest.

Other theorists before World War I who used the concept of circular flow include J.J.O. Lahn (i.e. N. A.L.J. Johannsen, *Der Kreislauf des Geldes ...*) and Joseph Schumpeter (*The Theory of Economic Development ...*). On the other hand, both the historical school in Germany and the neo-classicists (particularly the various marginal utility schools) practically ignored this aspect completely. An exception in this respect was the Lausanne school founded by Léon Walras (*Elements of Pure Economics ...*), whose conception of micro-economic equilibrium (see below: V and VI) is based upon the idea of a stationary circular flow.

Of the Marxist economists Lenin (On the So-Called Market Question, ...) was the first in 1893 to take up the Marxian schema of expanded reproduction, and in his numerical example he took into account changes in the organic composition of capital ($\frac{c}{v}$) and the effect of technological progress. Divergences from the exponential trend underlying Marx's numerical example are bound up with this in the trend of the circulation parameters over time; but these differences can be computed in the form of an elementary chain index. The conclusion which can be drawn from Lenin's dynamic model, which includes Marx's schema as a special case, is that it is necessary to observe certain relationships between the trend of the different circulation parameters and that there is a change in the structure of production in favour of the capital goods sectors under the conditions of technological progress. These findings were later realized in practice at the time of the first five-year plans — i.e. during the extensive phase of Soviet economic planning — when heavy industry was accorded priority (see INDUSTRIALIZATION, B).

In Marxist discussion of "realization" crises and of the theory of economic collapse considerable differences of opinion arose out of the question of the correct interpretation of Marx's schema of reproduction, especially between M.I. Tugan-Baranovsky (*Theoretische Grundlagen des Marxismus, ...*) and Rosa Luxemburg (*The Accumulation of Capital, ...*), the latter deducing that a *closed* circular flow of expanded reproduction was impossible under the implicit assumptions of simple reproduction. She thus attempted to explain — erroneously — the need for the imperialistic opening-up of foreign markets as a means of ensuring adequate demand and also the ultimate collapse of the capitalist system (see IMPERIALISM).

The considerable increase in the state's share of the national product during and after World War I gave rise to a new stage in the development of circulation theory; the quantitative effects of the growing state activity in the economy as a whole — observed already in 1883 by Adolph Wagner (*Finanzwissenschaft, ...*) — now had to be investigated. The overall balance of the USSR for 1923/24 represents the first attempt to record statistically the quantitative relations between the different sectors and to set them out in a "chessboard balance", the general features of which are illustrated in the following specimen balance:

Balance of Productive Equipment and Buildings in the USSR for 1923/24

Sources \ Uses	Productive Consumption (Investment)				Consumption (investment) outside production sphere	Exports	Stocks		Total	
	Agriculture	Industry	Transport and Communications	Commerce			in production sectors	in distribution channels	Productive Equipment	Buildings
A. Productive Equipment										
Agriculture										
Industry										
Building										
Total										
B. Buildings										
Agriculture										
Industry										
Total										
Total A + B										
C. Imports										
Distribution Costs										
Initial Stocks										
Total A + B + C										

Although the collection of statistically and economically important data is incomplete and the classification of economic sectors is very rough, this Soviet balance sheet represents a significant step towards the production of the modern inter-industry transaction matrices (see INPUT-OUTPUT ANALYSIS), which are very important as instruments both of centralized economic planning in the socialist countries and of general macro-economic control in the advanced capitalist countries (see below: VI).

In the 1920s and 1930s German researchers into circular flow devoted especial attention to the monetary aspect and that of business-cycle policy (cf. Lederer, Der Zirkulationsprozess als zentrales Problem der ökonomischen Theorie, . . .; Löwe, Wie ist die Konjunkturtheorie überhaupt möglich? . . .; Neisser, Der Kreislauf des Geldes, . . .; Grünig, *Der Wirtschafts-Kreislauf*, . . .; and Föhl, *Geldschöpfung und Wirtschafts-kreislauf*, . . .). The Great Depression and later national-socialist economic policy in particular acted as concrete incentives to research and also determined the theoretical problems. That circular-flow research and the national-socialist armaments and wartime industry co-operated is apparent from the "Control Panel of the German War Economy 1942/43", which was intended to show the most important inter-industry relationships for the war effort (i.e. the production prerequisites).

IV. KEYNESIAN CIRCULAR-FLOW ANALYSIS

The impact of world-wide mass unemployment and the decline in production during the Great Depression of 1929–33 caused political economy in the non-Marxist countries to take a new line. Liberal and vulgar-economic concepts in neo-classical theory — particularly the notion of a kind of "prestabilized harmony" of the capitalist economic system (e.g. Say's Law, quantity theory, the need for "purging crises") — were abandoned and now concepts of circulation theory were again used to explain and eliminate macro-economic imbalances. This came about in part through deliberate recourse to Marx's theory of reproduction — e.g. by Michal Kalecki (*Essays in the Theory of Economic Fluctuations*, . . .) — and in part through the rediscovery of circulation theory, in particular by John Maynard Keynes (*The General Theory of Employment, Interest and Money*, . . .).

In Keynes's work a more or less automatic balancing of the supply of savings and the demand for investment funds through the market rate of interest (q.v.) is replaced by a system of more realistic behavioural hypotheses (functions). Both micro-economically and macro-economically the consumption (q.v.) and savings of private households depend primarily upon the level of the national income, while the volume of fixed investment planned by entrepreneurs is also determined by the newly formulated principle of the "marginal efficiency of capital". The demand for money of those active in the economy is no longer determined solely by the transaction motive — the need to be able to defray current payments — but also by the speculation motive, the desire to have money available for lucrative purchases of securities. Thus in the Keynesian system macro-economic equilibrium is characterized by a combination of real national income, price levels and rates of interest which harmonize saving and investment on the one hand and the supply of and demand for money on the other.

The above-mentioned conditions however by no means ensure full employment in the capitalist market economy. According to Keynes an inadequate volume of total demand can lead to involuntary unemployment, even if the workers or the trade unions accept a "marginal productivity wage" (see PRODUCTIVITY; ECONOMIC THEORY). But real wages and prices (qq.v.) that are rigid downward are also for Keynes important causes of a state of underemployment, which could possibly be an equilibrium state. This, he maintains, is generally associated with insufficient readiness on the part of entrepreneurs to make further investment equal to the supply of savings, thus causing an open deflationary gap. Many other disturbing factors, such as a low interest-elasticity of investment and savings or a floor to interest on the money market (i.e. the liquidity trap) make heavy demands on the stability of the system, which in reality cannot always be met.

From this detailed macro-economic analysis it is possible to deduce in principle those changes in macro-economic data which must be undertaken if the state is to eliminate economic disequilibrium. This may initially take the form of indirect macro-economic intervention: influencing the rate of interest by changing the volume of money or the bank rate, influencing household consumption and saving behaviour by varying taxation or encouraging various ways of utilizing income or changing income distribution (see below: VI), damping down or stimulating business investment demand by varying the rates at which assets are written off, etc. The most important consequence of the Keynesian conception of the circular flow is however the compensation for the lack of private investment activity by means of direct intervention in the form of compensatory government expenditure, especially for public investment projects, with the acceptance of deficit spending. An important rôle is played here by the multiplier theorem, which is based on the simple observation that purchases in one part of the economy generate further purchases in other sectors — the more so, the less is saved or hoarded of the monetary payment received in each case at each economic stage. This can be deduced in the elementary circulation system (see above: A, II) for the so-called investment multiplier, for example, which in the simple model equals the reciprocal of the marginal propensity to save (dS/dY) and gives the total increase in national income (ΔY) when investment expenditure is increased by the amount ΔI.

In order to make clear the dependence of consumption, and hence of saving, upon the level of the national

income, as postulated by Keynes, consumption and saving are represented as functions of national income. We thus obtain these macro-economic equations:

$$Y \quad C(Y) \cdot S(Y) \quad \text{(consumption side)} \qquad \text{(i)}$$
$$Y \quad C(Y) \cdot I \qquad \text{(production side)} \qquad \text{(ii)}$$

By differentiating (i) for Y and (ii) for I, we get on the one hand the definitional equation

$$\frac{dS}{dY} \quad 1 \quad \frac{dC}{dY} \qquad \text{(ia)}$$

between the marginal propensity to consume and the marginal propensity to save, and on the other hand the equation

$$1 \quad \frac{dY}{dI}\left(1 - \frac{dC}{dY}\right) \qquad \text{(iia)}$$

which still applies approximately, if finite but sufficiently small changes in income and investment (ΔY and ΔI) are considered. Then follows the multiplier effect, already formulated, of increases in investment upon the level of the national income:

$$\Delta I \quad \Delta Y \left(1 - \frac{dC}{dY}\right) \quad \Delta Y \cdot \frac{dS}{dY}$$

or

$$\Delta I \cdot \frac{1}{\frac{dS}{dY}} \quad \Delta Y \qquad \text{(iii)}$$

Multipliers for changes in government expenditure, exports and imports, the volume of money, etc., can be deduced from systems of circular-flow equations in the same way; but the extent of the actual multiplier effect usually depends upon other factors which are not taken into account in the circular-flow model, so that the isolated consideration of the various multiplier effects "renders absolute a state of affairs which in objective reality appears only as a tendency" (Müller, *Die bürgerliche Kreislauftheorie,* . . . p. 144).

Keynesian circular-flow theory has had an extremely stimulating effect upon non-Marxist economics and modern economic policy (the controlled market economy, state monopoly capitalism), and is being accepted increasingly in the socialist countries as well (despite many reservations) for the analysis of short-run problems (see below: B, VI & VII).

V. MODERN STRUCTURAL ANALYSIS IN PETER AND LEONTIEF

The most important contribution towards the formulation of a complete formal theory of circulation was made by the German economist Hans Peter (*Strukturlehre des Wirtschaftskreislaufes,* . . .; *Mathematische Strukturlehre des Wirtschaftskreislaufes,* . . .) who, using methods of topological group theory — graph theory in particular — evolved a system for the exact recording and presentation of circulation relationships (e.g. pole-width, the circular-flow axiom) and a quanti-

tative description of types of structure. Particularly important here is the formation of structure coefficients, which relate the individual flow-widths of a pole to its overall pole-width. Owing to the high degree of generality of formal circulation theory, the importance of these quotients can vary considerably in practice. In macro-economic models (see above: A, II) they represent, for example, the ratio of savings or of wages and salaries to the national product; but if individual branches of industry are chosen as poles, then we obtain the corresponding input-output coefficients. Thus to this extent Peter's formal circulation theory includes Leontief's input-output analysis (see below) as a special case. Like Leontief, Peter also made his circular-flow system dynamic by combining the accounting equation system with certain growth hypotheses (e.g. exponential functions), in order to ascertain the process of expanded reproduction too in terms of circulation theory.

The studies of Wassily W. Leontief (e.g. Harvard University, Harvard Economic Research Project, *Studies in the Structure of the American Economy,* . . .) focus on the investigation of inter-industry relationships, while the economic entities outside industry (e.g. households, the government, etc.) form the residual sector as final consumer demand in the open Leontief model. Thus, to begin with, market transactions are left out of account or clearing of the market is assumed, and flows of investments are likewise recorded in a separate investment account (see INPUT-OUTPUT ANALYSIS). The total of the supplies x_j priced at the price p_j and delivered by each sector j (j 1, ..., m) to itself (self-consumption), to the other m 1 branches of industry and to the residual sector (final consumer demand) must, according to the circular-flow axiom, equal the value of shipments received plus the factor outputs received from the residual sector. If the residual sector is identified with the "households" sector and its factor outputs with "labour", then the following diagram is obtained for two industries:
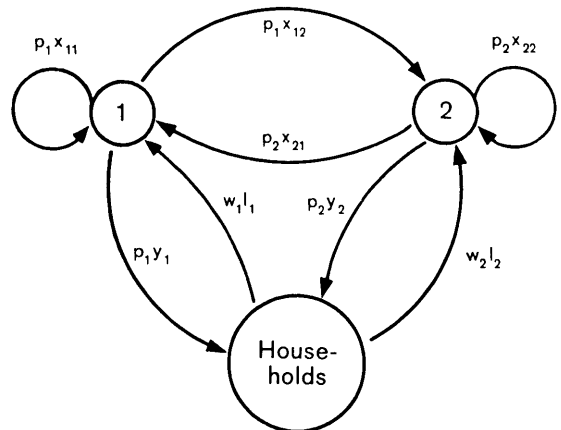
w_1, w_2	- wage-rates	p_1, p_2 prices
x_{ij}	— shipments from i to j	y_1, y_2 final products
	(i, j 1, 2)	l_1, l_2 labour supplied

By adding the accounting equations for the two industrial branches, we obtain the equation

$$p_1y_1 + p_2y_2 = w_1l_1 + w_2l_2 \qquad \text{(i)}$$

national product = total wages and salaries (= national income), which not only represents a simple identity but can also be conceived as a condition for equilibrium if prices are regarded as variables and the assumption of proportionality (linearity) underlying the Leontief system is made with respect to inter-industrial relationships and for factor input, and the input-output coefficients are accordingly defined $a_{ij} = \frac{x_{ij}}{x_j}$ and the labour input coefficients $r_j = \frac{l_j}{x_j}$. Then from the accounting equation of the poles we obtain the set of non-homogeneous linear equations

$$(1 - a_{11})x_1 - a_{12}x_2 = y_1$$
$$-a_{21}x_1 + (1 - a_{22})x_2 = y_2 \qquad \text{(ii)}$$

or more generally, in matrix notation:

$$(E - A)x = y \qquad E = \text{unit matrix}$$
$$A = (a_{ij}) \ i = 1, \ldots, m$$
$$j = 1, \ldots, m$$

and the condition that the labour input must not exceed the total available labour force l_0:

$$l_1 + l_2 = r_1x_1 + r_2x_2 \leqq l_0 \qquad \text{(iii)}$$

Now we must define the price system which for a given wage rate w brings the circular flow into balance in accordance with condition (i). In this simple case these equilibrium prices — also called shadow prices (Dantzig), multipliers (Peter), solution multipliers (Lur'e), objectively conditioned valuations (Kantorovich) — are obtained by multiplying system (ii) line by line by the corresponding prices. Since according to condition (i) the total wage sum must equal the priced national product, we obtain the schema

$$(1 - a_{11})x_1p_1 - a_{12} \cdot x_2p_1 = y_1p_1 \big\}$$
$$+ \qquad + \qquad \vdots \qquad = \text{national}$$
$$\qquad \qquad \qquad \qquad \text{product}$$
$$-a_{21} \cdot x_1p_2 + (1 - a_{22})x_2p_2 = y_2p_2 \big\}$$

$$\text{(iia)}$$

$$\text{total wages}$$

$$r_1 \cdot x_1w + r_2 \cdot x_2w = w(r_1x_1 + r_2x_2) = \overbrace{w(l_1 + l_2)}$$

and directly from this, vertically, the equilibrium price system

$$(1 - a_{11})p_1 - a_{21} \cdot p_2 = wr_1 \quad \text{more generally: } A' = (a_{ji})$$
$$(E - A')p = w \cdot r$$
$$-a_{12} \cdot p_1 + (1 - a_{22})p_2 = wr_2 \qquad \text{(ii b)}$$

This optimal price system satisfies the Marxian labour theory of value both in the sense that prices (q.v.) are proportional to the average labour expended and also in that "labour" appears as the sole value-creating productive force — in the optimum case profits according to schema (iia) are zero — and finally labour is conceived as a homogeneous factor; thus the various activities of labour are reduced, as in Marx, to "simple labour". This conclusion is based however on the unrealistic assumption that only labour and current input are included in social production (q.v.). If capital

goods and dynamic production structures are taken into account different results are obtained.

However, the open Leontief system need not be regarded as a special form of a micro-economic total equilibrium only (see below: VI); it acquires much more practical importance through the underlying assumption of linearity, which makes it possible to use the model with the methods of linear algebra for the widest possible variety of computations. At the same time the input-output coefficients vary widely in significance depending in each case upon the object of the investigation. In ex post studies they characterize, for example, inter-industrial relationships shown in statistical form, or the actual expenditure of materials and labour; ex ante, the model is suitable both for making forecasts and for general economic programming (in the latter case the coefficients have the significance of prescribed expenditure norms). Comparison of the coefficients over time enables technological progress to be ascertained, while the comparison of ex ante and ex post coefficients can be used as a measure of plan fulfilment for the different sectors of the economy and as a basis for the future programming, revision and checking of plans (see below: VII).

Particularly important is the computation of the gross industrial production and labour input required for the desired — or planned — final consumer demand (components of the national product [q.v.]), which can be calculated from (ii) by solving the set of equations or, more generally, by forming the inverse matrix (i.e. the Leontief inverse):

$$(E - A)^{-1}y = x \qquad \text{(ii c)}$$

This inverse matrix can — by formal analogy with the macro-economic consumption ratios of Keynesian analysis — be interpreted as a multiplier: the increase of final consumer demand by Δy leads initially to an increase of the same amount in gross production. But since additional inter-industry supply commitments now arise in proportion to the coefficients a_{ij}, we obtain the total change in the output as the sum of the different rounding-off adjustments

$$\Delta x = \Delta x^{(1)} + \Delta x^{(2)} + \Delta x^{(3)} + \ldots + \Delta x^{(n)}$$
$$= \Delta y + A \Delta y + A^2 \Delta y + \ldots + A^{n-1} \Delta y$$
$$= (E + A + A^2 + \ldots + A^{n-1}) \Delta y$$

which in the case of production (final demand producing) systems converge towards 0, and we therefore have for $n \to \infty$ the total $(E-A)^{-1}\Delta y = \Delta x$ analogous to (iic).

Leontief and many other writers after him have amplified and modified the model for practical and theoretical purposes. Instead of clearly defined production processes factor substitution in the form of alternative input-output coefficients is for example introduced — in a similar way to neo-classical theory — so that the choice of the processes to be used is determined by the basic object being aimed at and/or by additional constraints (thus giving rise to an optimization problem). The time dimension of circular flow

embraces, amongst other things, changes in technical coefficients over time (technological progress and capital formation) and the introduction of time lags between the beginning and the end of individual production processes; investments are also taken into account. In order to explain the demand for capital goods Leontief used the acceleration principle, according to which sectoral investments should be proportional to the change in gross output. For the purposes of forecasting the computation model is often expanded in that assumptions of proportionality are also made for exogenous variables such as wages and salaries, profits, tax yields, etc., so that not only the attainable final consumer demand, but also the total of wages, profits and similar values are related to the level of gross output — i.e. the overall turnover of the economy. In Peter's more generalized circular-flow model on the other hand the variables are determined endogenously and not — as in the Leontief model — subsequently incorporated by means of additional hypotheses of linearity. By contrast, the great importance of the Leontief system lies in the possibility that it affords of applying efficient mathematical procedures (e.g. linear algebra, optimization theory) in order to arrive at results which are directly usable in practice (see below: VI).

VI. CIRCULAR-FLOW ANALYSIS AND MODERN ECONOMIC THEORY

Formal circular-flow theory in the sense of Peter's system describes only the necessary conditions for building economic models and is thus a component of every theory but not in itself a complete theory. Significant conclusions can be drawn from circular flow models only when certain specifications which define the system are incorporated. These include the choice of poles, the circular flows postulated in each particular case and the assumed mechanism of interactions (behaviour equations, production coefficients, changes over time, etc.). The important heuristic value of formal theory for developing meaningful economic theories lies in the obligation it places upon the economist to define concepts exactly and to make consistent model assumptions as to the behaviour of poles, but it cannot ensure the practical relevance of the models. For this, however, the possibility of empirical verification or refutation by means of the data of economic statistics exists (see below: VII). This constitutes an important field of econometrics (q.v.) and has already been highly formalized through the application of modern mathematical methods, e.g. regression analysis and the statistics of probability (see STATISTICS). Historically, this assessment of circular-flow theory is confirmed for instance by the revolutionary effect of the theories of Marx and Keynes (see below: C). The fruitfulness of the flow-theory approach is apparent today in a wide variety of practical and theoretical economic fields. Here we give no more than a brief outline of the most important stages in its development.

The contradiction in Keynesian theory between stationary total demand and long-term expanding production capacities has made dynamic analysis necessary. The demand of entrepreneurs for capital goods has therefore been explained — more realistically than in the Keynesian system — in terms of the change in demand for consumer goods or in the national income (the acceleration principle). The trend of the national income over time is then always a function of the ratio between the multiplier and the accelerator. From the models of Paul Samuelson (Interactions . . .) and John Hicks (*A Contribution . . .*), both (increasing, decreasing or constant) cyclical fluctuations and also the continual growth (or continual decline) of the national income can be deduced. The circular-flow models of Roy Harrod (An Essay in Dynamic Theory, . . .; Id., *Towards a Dynamic Economics*, . . .) and Evsey D. Domar (Capital Expansion . . .; Id., *Essays* . . .) are clearly concerned with a question of growth theory — viz. the determination of an equilibrium rate of national income growth which accords with the sales expectations of entrepreneurs, the growth of the gainfully-employed population and the linear production structure of the economy ("growth on the knife-edge").

The circular-flow model

$$Y = C(Y) + S(Y) = C(Y) + sY \qquad s = \text{marginal saving ratio} \quad \text{(i)}$$

$$Y = C(Y) + I(\Delta Y) = C(Y) + \alpha \Delta Y \qquad \alpha = \text{accelerator} \quad \text{(ii)}$$

where s is the (average) marginal saving ratio.

gives this growth condition direct by equation: the equilibrium growth rate g_y is accordingly

$$g_y = \frac{\Delta Y}{Y} = \frac{s}{\alpha} \qquad \text{(iii)}$$

— i.e. equal to the ratio between the (marginal) saving ratio and the accelerator. The accelerator need not be regarded here as a decision parameter of business investment activity. *Ex post*, it can be identified with the marginal capital output ratio $\frac{dK}{dY}$ — a technical variable —if investments for replacement are left out of account. Finally, if a linear production structure is assumed then the marginal capital output ratio equals the average capital output ratio K/Y, and the accelerator is determined purely by technical factors.

The demand-orientated, post-Keynesian approach, as further elaborated by Joan Robinson (*The Accumulation of Capital*, . . .), Luigi Pasinetti (Rate of Profit . . .) and others, is opposed by the supply-orientated, neo-classical growth hypothesis. This postulates agreement between investment plans and saving plans and its basic model (Solow, A Contribution to the Theory of Economic Growth, . . .) defines the growth path of the national product — assuming continual substitutability of capital and labour (qq.v.), perfect competition and neutral technological progress — towards which, with a given savings ratio and a constant rate of technological progress and population growth, the system converges. The interdependence postulated in the post-Keynesian approach of the

national income and the national product on the one
hand and the savings ratio and the capital output ratio
on the other is of particular interest for socialist growth-
planning, because under the conditions of socialist
economic planning agreement between savings and
investment, and thus also between the savings ratio
and the investment ratio, can be achieved more easily
than in a state-influenced capitalist market economy
(dubbed "state monopoly capitalism"). For this very
reason, however, the orientation of the neo-classical
models towards supply is more in keeping with a cen-
trally planned socialist economy than with the situation
in the advanced industrial countries of the West, where
the main problem is usually to increase effective demand
through advertising, leisure activities, etc.   i.e., in
Marxist terminology, to realize the total social product
and the surplus (cf. Baran, Sweezy, *Monopoly Capital*,
. . .). Both these approaches to growth have been taken
up and developed further by Marxist economic theorists
as well (e.g. by Dobb, *An Essay on Economic Growth* . . .;
and Kornai, *Mathematical Planning* . . .). Similar studies
by Marxist economists (e.g. Volkonskii, V. A. Skhema
optimal'nogo perspektivnogo planirovaniia i otsenki
resursov. In Nemchinov, ed. *Primenenie matematiki* . . .,
t. 3, p. 88 106; Kornai, *Mathematical Planning* . . .) have
been prompted by the determination of optimum growth
paths of consumption (Phelps, The Golden Rule of Ac-
cumulation, . . .; von Weizsäcker, *Wachstum* . . .).

A particularly fruitful application of circular-flow
analysis lies in dynamic distribution theory. On the
basis of a Keynesian two-class model including saving
by workers' households and constant class-specific
rates of saving Nicholas Kaldor (Alternative Theories
of Distribution, . . .) has demonstrated the dependence
of income distribution upon the level of investment.
According to his theory, which bears a striking resem-
blance to corresponding Marxist ideas, a low share of
wages in national income — i.e. a high rate of surplus
value — and a high rate of consumption by workers are
bound up with high rates of profit and growth; this
admittedly assumes that the goods produced can all be
sold — possibly on foreign markets (see IMPERIALISM).
One weakness of the model is however the lack of
clarity of the causal relationships postulated.

With appropriate interpretations in terms of circular-
flow theory (e.g. Stobbe, *Untersuchungen* . . .; Wolfstet-
ter, Verteilungstheorie . . .), Kalecki's theory of the
degree of monopoly also provides valuable insights
into the process of income distribution under conditions
of monopolistic competition (Kalecki, The Deter-
minants of Distribution . . .). If the supply situation is
also incorporated into Kaldor's model (Preiser, *Wachs-
tum* . . .) — especially with regard to the privileged
position of the capitalist owners of the means of produc-
tion as compared with the workers dependent upon
their wages — then the superiority of the classical and
Marxist approach over neo-classical theory in the ex-
planation of the capitalist process of reproduction in
terms of distribution theory is clear.

The development of the micro-economic theory of
economic equilibrium (q.v.) is also closely bound up
with the economic theory of socialism (Lange, Taylor,
On the Economic Theory of Socialism, . . .) and with the
mathematical theory of optimization, which in turn is
also a constituent of formal circular-flow theory (see
above: B, V). The formal further development of micro-
economic equilibrium theory (Dorfman et al. *Linear
Programming* . . .; Debreu, Theory of Value, . . .) in
particular shows that the subjectivist explanation of
equilibrium price ratios by means of the relationship
between the corresponding marginal utilities is no
longer necessary, even though to date certain concepts
of utility theory are still involved in the explanation
of demand (see ECONOMICS). With the stock of resources
and the production coefficients taken into account, the
equilibrium price system assumes on the supply side the
significance of a schema of objectively conditioned
valuations (shadow prices), the socio-political charac-
ter of which is explained by the constraints and objec-
tives of social reproduction (e.g. the property system,
external effects, political objectives). Many of the
characteristics of the formal micro-economic equilibri-
um models are more reminiscent of actual representa-
tive socialist economies than of capitalist economies;
the market model of perfect competition on which they
are based can easily be structurally converted into a
planning model of perfect computation (Altvater,
Rationalisierung . . .; Kornai, *Mathematical Planning*
. . .; Ward, *The Socialist Economy*, . . .). This situation
clearly refutes the opinions voiced by liberal economists
such as Ludwig von Mises, Friedrich August von Hayek
and Lee Robbins on the possibility in principle or
practice of efficient allocation in economies planned on
socialist lines.

Finally, the theoretical and practical importance of
the Marxian analysis of expanded reproduction is con-
firmed in modern sectoral growth theory, which fre-
quently adopts the division of the economy into a con-
sumer goods department and a capital goods depart-
ment. But in content, too, interesting connections with
circulation theory are often found — for example, be-
tween J. von Neumann's growth model, the Walras
model and the schema of expanded reproduction.
Michio Morishima (Economic Expansion . . .) pointed
this out. Altogether, there is an unmistakable tendency
in both Western and socialist economic theory to
develop interdependent and dynamic systems instead
of static and partial models.

VII. THE APPLICATION OF CIRCULATION THEORY

As a constituent of economic theory, circular-flow
analysis is not dependent upon empirical verification.
Its importance for both Western and Marxist economics
is due precisely to the fact that it does not belong
to the sphere of praxeological rules of behaviour beyond
empirical demonstrability, which predominate espe-
cially in the micro-economic theory of the household.

Although circular-flow analysis can also be used for purely theoretical questions — for studying the functional principles of the capitalist economy as in the case of Marx and Keynes, for instance, or for abstract didactic description — e.g. for depicting the free economy as an object of economic cognition as Ellinghaus did — extensive formal development is due chiefly to its relevance as an instrument for the study (diagnosis), forecasting and active creation (planning) of empirically observed or observable interactions and transactions between the various economic entities.

The totality of concepts, data and procedures involved in the statistical calculation of these processes are subsumed in the Western countries under the term "national accounting" (q.v.). Both the requirements as to the precision and detail of the national accounts and the conclusions to be drawn from them for state activity vary according to the quantitative extent and qualitative function of state economic activity.

The methods of statistical data collection, classification and systems of accounting applied today in the Western industrial countries are largely standard (e.g. the OEEC standard system of 1952 and 1960), so that the value of the accounts for international comparisons is increasing all the time. However this is also leading to the development of a more or less standard set of instruments of economic policy, although their actual use depends in part upon the socio-political situation in each case. In principle this should also make for the better international co-ordination of measures of economic policy, but because of the different social systems (e.g. the state as comprising the production sector), statistical concepts (e.g. the national product seen not as a flow of goods, but as a stock of physical end products) and demarcations (particularly the separation of the productive and unproductive spheres), complete comparison with the corresponding data of communist countries is not possible.

The essential difference between Western economic statistics and those of communist countries arises in particular out of the varied nature of the functions of the authorities responsible for economic policy. In the case of the macro-economic overall control principally applied in capitalist economies the identifying and influencing of macro-economic aggregates such as private and public demand, investment, etc., are particularly important. Control of this nature serves primarily to stabilize the economic trend, and not so much to plan the economy's structure and growth. In the Western countries detailed input-output analysis has therefore not yet acquired the importance which it has in the socialist economies, where input-output coefficients are used not only descriptively but also prescriptively, as indices of economic efficiency, norms of direct and full expenditure or as price standards. Moreover, the elaboration of binding perspective and annual plans requires a higher degree of precision than the drawing-up of forecasts and guide-lines which, after all, carry no obligations with them. Finally, certain problems such

as the computation of macro-economically optimal production methods and product prices (macro-economic and sectoral optimization) or the co-ordination of various economic plans (plan consistency) have hitherto been excluded from the functions of government economic policy in the Western countries and have been left to the market — i.e. in effect to co-operation between monopolies and interest groups. But it was precisely because of these and similar problems on the other hand that economists in the communist countries came to develop special methods of mathematical economics to facilitate the drawing-up of overall regional and sectoral plans (planometrics).

Progress in the use of mathematical methods in overall economic planning is evident in, for example, the changeover from pure computation models of the Leontief type to models of optimal perspective planning (Kantorovich, L. V., and Makarov, V. L. Optimal'nye modeli perspektivnogo planirovaniia. In Nemchinov, ed. *Primenenie matematiki* ..., t. 3, p. 7–87), growth planning (Gavrilets, *ibid.*) and interregional planning (Gladyshevskii, Gavrilets, *ibid.*), as well as in the increasing use of methods of non-linear optimization and in the building of multilevel planning models (Kornai, Lipták. Kétszinti tervezés, ...; id., Lipták. Two-Level Planning, ...). In view of the conflicting tendencies amongst communist economists and politicians it is still not possible to foretell with any great accuracy how far the decentralization of decision-making functions in the "New Economic System of Planning and Managing the Economy" will cause market relations and economic incentives to take the place of centralized planning computations (see PLANNING). Nevertheless, socialist economic researchers are showing increasing interest in the development of macro-economic circular-flow models — e.g. for determining optimal investment ratios or efficient consumption paths (cf. Minc, B., and Przelaskowski, W. Uravneniia sotsialisticheskogo nakopleniia. In Nemchinov, ed. *Primenenie matematiki* ..., t. 3, p. 303–11). In a certain sense symmetrical with this is the increasing development in the Western countries of sectoral models for forecasting and planning purposes (e.g. Ragnar Frisch's "Oslo" model; cf. Frisch, Osnovnye cherty promezhutochnoi modeli "Oslo". *Ibid.*, t. 2, p. 429–531) and their growing use for statistical computation (e.g. the French regional planning models).

The combination of sectoral and macro-economic circular-flow analysis has proved particularly useful, as shown in the expanded input-output table (inter-industry transaction matrix) overleaf.

Quadrant I contains the input-output coefficients (or also only inter-industry sales) in money terms; Quadrant II breaks down the various sectors of final consumer demand (households, the state, etc.). In Quadrant III the primary inputs (labour, use of capital, etc.) are entered in money terms. Finally, the redistribution of the national product can be represented in Quadrant IV. That this circular-flow table is useful and

Uses	Industry					Final Demand				Export-Import
Sources	1	2	3	...	m	C	I_c	I_n	State	
Industry 1										
2										
3										
.		I			II					
.										
m										
Productive Consumption										
Depreciation										
Wages · Salaries										
Profits (Surplus)		III			IV					
Indirect Taxes										
Gross Social Product										

to a very large extent independent of any political system is indicated by the fact that it is used frequently in both the West for national accounting and in communist countries for the overall balancing of accounts. In view of this the efforts of some socialist economists to demonstrate a fundamental difference between the research into circular flow being done in the East and in the West do at times seem rather ridiculous; they are probably due largely to ignorance or to the misinterpretation of Western research in this field.

C. Critical Appraisal and Outlook for the Future

The importance of circular-flow analysis in both social systems is due chiefly to the possibility which it affords of using the computation of micro-economic and macro-economic interaction mechanisms (such as elasticities of demand, multipliers and capital output ratios) to estimate the effects of state intervention in the economic structure. There is hardly any doubt about the need for and practical advantages of such computations in the communist economies. The question of whether government intervention in the capitalist market economy is compatible with the latter's functional principles cannot, however, be resolved by the methods of circular-flow analysis. But the experiences of the Great Depression and recent economic trends in the USA and West Germany show clearly that government intervention is essential if this system is to function properly. This gives rise to prognoses about the future of the capitalist system, but these cannot be said to belong to the realm of theoretical economic analysis of the capitalist reproduction process. And the designation of this mixed private-enterprise and state-controlled system as a "social market economy" (Müller-Armack), "organized capitalism" (Hilferding) or "state monopoly capitalism" — which themselves each express a particular view of the rôle of the state in capitalist society (see CAPITALISM; STATE) — only implies a political

valuation, it does not expound an economic theory. At the present stage of economic knowledge "neo-classical synthesis" (Samuelson) can therefore also only be regarded as an attempt, with no objective foundation, to reconcile the praxeological rules of behaviour of micro-economic theory with the phenotypical description and regulation of the capitalist process of reproduction (see ECONOMIC THEORY).

The practical utility of circular-flow analysis in the two social systems should not however lead to the false assessment of circulation theory as an a priori objective theory, independent of socio-political conditions. In so far as it actually exists as formal circulation theory (as in the case of Peter), it does not yet constitute an economic theory. But the identification of the abstract model with spezific objects of reality and, still more, the specification of functional relationships — the formation of economic models and theories — themselves indicate that a dialectical relationship has been established between social reality and economic theory. This relationship becomes explicitly political through the practical application of circulation theory, which with regard to both its possible applications and goals is determined directly by political and social conditions.

The scientific structure of circulation theory leads to surprising ambivalences in its application. Thus the circular-flow analysis of the liberal economist Keynes found its most logical application in fascist social systems, and formal circular-flow research received powerful stimuli from the wartime economy and armaments industry, especially in Germany. And for its part Keynesian circular-flow analysis, which demonstrated the possibilities of eliminating macro-economic disparities and thus (for a time, at least) maintaining capitalism, again took up Marx's criticism of the contradictions inherent in the capitalist process of reproduction.

Many problems remain to be solved by circulation theory. Special importance attaches here to the consistent imputation of objectively conditioned valuations (shadow prices) in dynamic systems of the social reproduction process, which must replace subjectivist market or planned prices and which as indicators of the social extent of the scarcity of goods make possible the really efficient allocation of material and intellectual resources. The growing importance of circular-flow analysis, which in all its basic categories can be traced back to Marx, seems at all events today to confirm Joan Robinson's observation at the end of her *Essay on Marxian Economics*: ". . . and if there is any hope of progress in economics at all, it must be in using academic methods to solve the problems posed by Marx" (Robinson, *An Essay* . . ., p. 115).

BIBLIOGRAPHY

Allen, R.G.D. The Engineer's Approach to Economic Models. In *Economica, n.s. 22*, 1955, no. 86: 158–68. — Id. *Mathematical Economics*. 2nd ed. Ldn, N.Y., 1959. 1st ed. 1956. — Altvater, E. Rationalisierung u. Demokratisierung. In *Argument 8*, 1966, Nr 4: 265–89. — Baran, P.A., and Sweezy, P.M. *Monopoly Capital*. N.Y., 1966. — Bénard, J.

Marx et Quesnay. In *François Quesnay et la physiocratie*.
Vol. 1. Paris, 1958: 105 30. — Böhm von Bawerk (von Böhm-
Bawerk), E. *The Positive Theory of Capital*. Ldn, N.Y., 1891.
Ger.: *Positive Theorie des Kapitals*. Innsbruck, 1889. (*Kapital
u. Kapitalzins*. Abt. 2.) — Bombach, G. Kreislauftheorie u.
volkswirtschaftliche Gesamtrechnung. In *Jb. Sozialwiss. 11*,
1960: 217–42 & 331–50. — Debreu, G. *Theory of Value*.
An axiomatic analysis of economic equilibrium. N.Y., 1959.
Dobb, M.H. *An Essay on Economic Growth and Planning*. Ldn,
N.Y., 1960. — Domar, E.D. Capital Expansion, Rate of
Growth and Employment. In *Econometrica 14*, 1946, no.2:
137–47. — Id. *Essays in the Theory of Economic Growth*. N.Y.,
1957. — Dorfman, R., et al. *Linear Programming and Economic
Analysis*. N.Y., Toronto, Ldn, 1958. — Föhl, C. *Geldschöpfung
u. Wirtschaftskreislauf*. München, 1937. — Grünig, F. *Der
Wirtschafts-Kreislauf*. [And] *Das Wirtschafts-Modell*. Mün-
chen, 1933. — Harrod, R.F. An Essay in Dynamic Theory.
In *Econ. J. 49*, 1939: 14–33. — Id. *Towards a Dynamic Econom-
ics*. Ldn, N.Y., 1948. — Harvard University. Harvard Econom-
ic Research Project. *Studies in the Structure of the American
Economy*. Theoretical and empirical explorations in input-
output analysis. By W.W. Leontief et al. N.Y., 1953. — Hicks,
J.R. *A Contribution to the Theory of the Trade Cycle*. Oxford,
1950. — Horowitz, D., ed. *Marx and Modern Economics*.
Ldn, 1968. — Johannsen, N.A.L.J. (J.J.O. Lahn, pseud.) *Der
Kreislauf des Geldes u. Mechanismus des Sozial-Lebens*. Bln,
1903. — Kaldor, N. Alternative Theories of Distribution. In
R. Econ. Stud. 23, 1956: 83–100. — Id. A Model of Economic
Growth. In *Econ. J. 67*, 1957, no.268: 591–624. — Kalecki,
M. The Determinants of Distribution of the National Income.
In *Econometrica 6*, 1938, no.2: 97–112. — Id. *Essays in the
Theory of Economic Fluctuations*. Ldn, 1939. Pol.: *Próba teorij
konjunktury*. Warszawa, 1933. — Keynes, J.M. *The General
Theory of Employment, Interest and Money*. Ldn, 1936. — Kor-
nai, J., and Lipták, T. Kétszintü tervezés. In Magyar Tudo-
mányos Akadémia Matematikai Kutató Intézet. *A Magyar
Tudományos Akadémia Matematikai Kutató Intézetének közle-
ményei*. Vol. 7. Budapest, 1962: 577–621. [Planning on Two
Levels.] — Id. *Mathematical Planning of Structural Decisions*.
Amsterdam, Budapest, 1967. Hung.: *A gazdasági szerkezet
matematikai tervezése*. Budapest, 1965. — Id., and Lipták, T.
Two-Level Planning. In *Econometrica 33*, 1965: 141–69. —
Krelle, W. *Volkswirtschaftliche Gesamtrechnung einschliesslich
input-output-Analyse mit Zahlen für die BRD*. 2. Aufl. Bln, 1967.
1st ed. 1959. — Lange, O., and Taylor, F.M. *On the Economic
Theory of Socialism*. Minneapolis, Minn., 1938. — Lederer, E.
Der Zirkulationsprozess als zentrales Problem der ökonomi-
schen Theorie. In *Archiv Soz.-Wiss. Soz.-Polit. N.F. 56*, 1926:
1–25. — Lenin, V.I. On the So-Called Market Question. In
Lenin CW, vol.1.: 75–125. — Leontief, W.W. *The Structure
of the American Economy, 1919–1939*. An empirical applica-
tion of equilibrium analysis. 2nd ed. Cambridge, Mass., 1951.
1st ed. 1941. — Id. Die Wirtschaft als Kreislauf. In *Archiv
Soz.-Wiss. Soz.-Polit. N.F. 60*, 1928: 577–623. — Lexis, W.
Allgemeine Volkswirtschaftslehre. 3. Aufl. Lpz., 1926. 1st ed.
1910. — Löwe, A. Wie ist die Konjunkturtheorie überhaupt
möglich? In *Weltwirtsch. Archiv 24*, 1926: 165–97. — Luxem-
burg, R. *The Accumulation of Capital*. N.Y., 1964. 1st ed.
New Haven, Conn., 1951. Ger.: *Die Akkumulation des Kapi-
tals*. Bln, 1913. — Morishima, M. Economic Expansion and
the Interest Rate in Generalized von Neuman Models. In
Econometrica 28, 1960, 352–63. — Müller, K.O.W. *Die
bürgerliche Kreislauftheorie*. Bln [O], 1968. — Neisser, H. Der
Kreislauf des Geldes. In *Weltwirtsch. Archiv 33*, 1931: 365–408.
— Nemchinov, V.S. *Ekonomiko-matematicheskie metody i
modeli*. 2. izd. M., 1965. 1st ed. 1962. [Economico-Mathemati-
cal Methods and Models.] — Id., ed. *Primenenie matematiki
v ekonomicheskikh issledovaniiakh*. T.2 & 3. M., 1961–65.
[The Application of Mathematics in Economic Research.] —
Pasinetti, L.L. Rate of Profit and Income Distribution in
Relation to the Rate of Economic Growth. In *R. Econ. Stud.
29*, 1961/62: 267–79. — Peter, H. *Mathematische Struktur-
lehre des Wirtschaftskreislaufes*. Göttingen, 1954. — Id. *Struk-
turlehre des Wirtschaftskreislaufes*. Bln, 1943. — Phelps, E.S.
The Golden Rule of Accumulation; a Fable for Growthmen.
In *Amer. Econ. R. 51*, 1961: 638–43. — Preiser, E. *Wachstum
u. Einkommensverteilung*. 2nd ed. Heidelberg, 1964. 1st ed.
1961. — Quesnay, F. Analyse du Tableau économique. In

J. agricult. commerce finances 1766, juin. — Id. *Tableau
économique avec son explication*. 3. éd. Versailles, 1759. 1st ed.
1758. Eng. in: Mirabeau, V. de Riquetti. *François Quesnay:
the Economical Table (Tableau économique)*. N.Y., 1968.
Robinson, J. *The Accumulation of Capital*. Homewood, Ill.,
Ldn, 1956. — Id. *An Essay on Marxian Economics*. Ldn, 1942.
2nd ed. 1966. — Samuelson, P.A. Interactions between the
Multiplier Analysis and the Principle of Acceleration. In
R. Econ. Statist. 21, 1939, no.2: 75–78. — Schneider, E. *Ein-
führung in die Wirtschaftstheorie. T.1. Theorie des Wirtschafts-
kreislaufs*. 13. Aufl. Tübingen, 1967. 1st ed. 1947. — Schum-
peter, J.A. *The Theory of Economic Development, an Inquiry
into Profits, Capital, Credit, Interest, and the Business Cycle*.
Cambridge, Mass., 1934. Ger.: *Theorie der wirtschaftlichen
Entwicklung*. Eine Untersuchung über Unternehmergewinn,
Kapital, Kredit, Zins u. den Konjunkturzyklus. Lpz., 1912.
Simonde de Sismondi, J.C.L. *Nouveaux principes d'économie
politique*. 3. éd. Genève, 1951. 1st ed. Paris, 1819. — Smith, A.
An Inquiry into the Nature and Causes of the Wealth of Nations.
2 vol. Repr. N.Y., 1966. 1st ed. 1776. — Solow, R. A Contri-
bution to the Theory of Economic Growth. In *Quart. J. Econ.
70*, 1956, no.1: 65–94. — Stobbe, A. *Untersuchungen zur
makroökonomischen Theorie der Einkommensverteilung*. Tü-
bingen, 1962. — Sweezy, P.M. *The Theory of Capitalist
Development; Principles of Marxian Political Economy*. 4th
print. N.Y., 1956. 1st ed. 1942. — Tugan-Baranovskii (Tugan-
Baranowsky), M.I. *Theoretische Grundlagen des Marxismus*.
Lpz., 1905. — Tustin, A. *The Mechanism of Economic Systems*.
An approach to the problem of economic stabilization from
the point of view of control-system engineering. 2nd ed. Ldn,
1957. 1st ed. 1953. — von Bortkiewicz, L. Wertrechnung u.
Preisrechnung im Marxschen System. In *Archiv Soz.-Wiss.
Soz.-Polit. 23*, 1906: 1–50; 25, 1907: 10–51 & 445–88. — Id.
Zur Berichtigung der grundlegenden theoretischen Konstruk-
tion von Marx im dritten Band des "Kapital". In *Jhr. Nat.-
Ökon. Statist. 89*, 1907: 319–35. — von Weizsäcker, C.C.
Wachstum, Zins u. optimale Investitionsquote. Basel, Tübingen,
1962. — Waffenschmidt, W.G. *Anschauliche Einführung in die
allgemeine u. theoretische Nationalökonomie*. Meisenheim/
Glan, 1950. — Id. *Wirtschaftsmechanik*. Stuttgart, 1957.
Wagner, A.H.G. *Finanzwissenschaft*. Bd 1.–3. Aufl. Lpz.,
1883. — Walras, L. *Elements of Pure Economics; or Theory
of Social Wealth*. Repr. N.Y., 1969. 1st ed. Ldn, 1954. Fr.:
*Éléments d'économie politique pure ou théorie de la richesse
sociale*. 2 t. Lausanne, 1874–77. — Ward, B. *The Socialist
Economy; a Study of Organizational Alternatives*. N.Y., 1967.
— Wolfstetter, E. Verteilungstheorie, Lohnpolitik u. gewerk-
schaftliche Strategie. In *Heidelberger Blätter 5*, 1968, Nr 12/13:
33–60.

Hans Gottfried Nutzinger