Theories of Growth and Theories of Value

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Introduction

A number of recent treatments of growth, otherwise widely divergent in approach, have found themselves confronted by certain common problems.[1] For example, a series of questions has arisen with respect to the concept of capital: how should it be measured? Does it consist of one "capital good" or of many goods? Should materials and depreciation be included as part of the capital upon which returns are calculated? Should the wage bill likewise be included? Secondly, some closely related questions concerning distribution have emerged, for the concept of capital adopted in a model determines to a considerable extent both what the model will say about the relation of the return to capital to the wages of labor and how this relation will be affected by growth. Consideration of relative shares leads naturally to a third question concerned with the relation between the amounts of the various factors advanced and the output produced. If this relationship, the "production function," is to be of any use in the study of technical changes during growth, it must be disaggregated to exhibit the structure of production as a set of relationships between technologically specific inputs and outputs. But in this case "capital" will be composed of different specific goods in different industries, with the result that the notion of a "marginal physical product of capital" must be discarded as meaningless. This requires the development of some alternative theory of distribution.

These problems are commonly believed to be inseparable from the consideration of growth, that is, to result from the fact that the models are designed to deal with an expanding economy. Yet this is not actually the case, as Walras, for example, knew. Even in a stationary economy, if there is net production, all the above difficulties about capital and the formation of a general rate of return arise.[2] If inputs and outputs are broken down into their specific components, then capital in different industries will consist of different sets of goods, with the result that a marginal productivity theory cannot be employed. But if specific inputs are not shown, then the supply and demand equations for intermediate

goods will not be stated explicitly.[3] Moreover, when inputs are shown specifically a complication is introduced into the determination of prices. For it is customary to assume that prices are set so as to return at least a normal level of profit on the capital advanced. Yet when capital consists of a multiplicity of separate items, its quantity must be expressed in value terms, which can only be done when the prices of the individual items are known.

This suggests that some, at least, of these questions arise not so much from the fact that it is growth which is being examined as from the type of value theory which is assumed to underlie the growth model. Most models of growth are implicitly or explicitly set in the context of a Walrasian general equilibrium theory, which, as Wicksell long ago pointed out,[4] cannot easily accommodate a concept of capital—a fatal shortcoming in a theory which is expected to provide the foundations for growth theory. Fortunately, it is no longer necessary to rely on Walrasian theory; enough is known about the mathematical properties of linear production systems to place growth models in a Ricardian setting. The purpose of this paper will be to contrast Walrasian and Ricardian general equilibrium theories, and in doing so to suggest that providing a Ricardian value theory as the context for growth models eliminates the difficulties outlined above.

1.

By a "Walrasian theory of value" we mean a model[5] in which there are a large number of consumers, variously endowed with property, and a large number of producers of each kind of good or service. Each consumer's preferences are described by a utility function, with positive first and negative second derivatives. Each producer's technical possibilities are described by a production function, also normally assumed to have positive first and (after a point) negative second derivatives. Consumers purchase final goods, maximizing their utility subject to the constraints of their incomes; they sell the services of factors, balancing disutility against expected return. Firms purchase factors, balancing expected productivity against cost, and sell final goods, setting quantities and prices so as to maximize their profits. Goods and services thus move in a circular flow: producers sell final goods to consumers, and with the proceeds from such sales they purchase factor services from consumers, which they combine into final products. With the proceeds from the sale of factor services consumers buy final products in accordance with their utilities. Competition ensures that demands and supplies will be equated in every market and that excessive profits will be eliminated. Briefly, marginal utility and marginal cost determine equilibrium in the final goods market; marginal disutility and marginal productivity do so in the factor market.

By contrast, in a "Ricardian theory of value"[6] firms and consumers are not mentioned; only industries are shown—or rather, only the tech-

niques of production appear, each industry being defined by the technique it employs. These are taken as given and are assumed to be costly to change.[7] Given a set of techniques, including the amounts of labor needed for production at the unit level, the system will be termed "productive" if and only if more of at least one good can be produced per period than is consumed in the aggregate in production, while at least as much is produced of every other good as is consumed. With given techniques productivity can be increased, for example, by cutting down on the labor-time required per unit output. Prices are set so as to cover the technical costs of production, which are shown explicitly, and to return a uniform level of profit in all industries.[8] Final demand will determine the allocation of labor among the industries, but operating an industry at a higher or lower level of intensity will not affect prices, given the usual assumptions. Since the technical composition of each industry's input is shown explicitly, each industry's capital will be made up of different combinations of goods; hence, to set the level of normal or uniform profits, the prices of the inputs will have to be known. But since the outputs of some industries are the inputs of others, all prices and the rate of profit will have to be determined together. Yet the rate of profit cannot be determined until the share of profits is given. Once relative shares are fixed, however, prices, the wage rate, and the profit rate can all be determined. Relative shares can be fixed, say, by collective bargaining. Given a wage rate, prices will be determined by the competitive condition that the rate of profit must be the same in every industry. To see the effect of changes in relative shares on prices, suppose the wage rate rises. At the given initial prices, labor-intensive industries will have to devote a greater than average share of their sales proceeds to paying their wage-bill, leaving a less than average return on capital, while capital-intensive industries will find themselves in just the opposite position, with a greater than average return. To equalize the rate of profit, therefore, when the wage rises the prices of labor-intensive goods must rise, while those of capital-intensive goods must fall.

The contrast between Walrasian and Ricardian theories of value could hardly be sharper. The most obvious difference, and the one most frequently discussed, concerns substitution. In a Ricardian system the coefficients of production are fixed; whereas in a Walrasian system continuous neoclassical production functions are assumed.[9] But this difference is both overworked and ultimately less important than others. For switches in technique are possible in Ricardian systems, and Walras in fact assumed fixed technical coefficients. More fundamental differences emerge when we look at the way the flow of transactions is presented. In Walrasian theory economic transactions are pictured as a circular flow of goods and services; in each market, whether for goods or for factors, the stream of goods moving in one direction is matched by a corresponding traffic traveling the opposite way. By contrast, modern Ricardian theory puts a good deal of emphasis on the fact that the payments to capital are

dispositions of a surplus and do not involve any kind of exchange. There simply is no corresponding stream moving in the opposite direction. In Walrasian theory both prices and quantities are determined by supply and demand acting in conjunction; in Ricardian theory prices are determined wholly by the conditions of supply; demand is relevant only to the determination of quantities. In Walrasian theory intermediate products are eliminated as far as possible; in Ricardian theory such products are given pride of place. In a Walrasian system both supplies and demands are closely tied to individual decision-making units; in a Ricardian system no such units are assumed. A Ricardian system shows the interlocking of possibilities and necessities, rather than of motives, plans, and information.

2.

The significance of these contrasts for growth theory must now be shown explicitly. Since much of this significance arises from the Ricardian distinction between matters of technology and matters of appropriation—between features of the system which depend on techniques of production and features which depend on division of the product—it is important to begin by examining the Ricardian concept of what is to be divided, i.e., the net product, or "surplus."

In a Ricardian model the net output is a physical surplus of output over and above the amounts needed for replacement, to make good depreciation, and (in some models) for the maintenance and support of the working population in the customary style.[10] We can represent net output more formally by means of a set of interdependent single-product industries, using only "circulating" means of production:[11]

$$\begin{array}{cccc} C_{11} & C_{12} & \cdots & C_{1k} \longrightarrow C_1 \\ C_{21} & C_{22} & \cdots & C_{2k} \longrightarrow C_2 \\ \hline C_{k1} & C_{k2} & \cdots & C_{kk} \longrightarrow C_k \end{array}$$

Each process will require the products of others, and at least one good must be used directly or indirectly by all processes. A composite consumption good supports labor, assumed fixed in amount. Normally some processes will produce goods that do not return to the system as inputs; these processes can be thought of as luxury industries. The surplus will be the vector, $(C_1 - \sum_i C_{i1},\ C_2 - \sum_i C_{i2}, \ldots, C_k - \sum_i C_{ik})$. The physical composition of the surplus can be varied (e.g., in response to demand) by reallocating labor (the "fixed factor") among the industries. Such reallocation leaves prices, and value relationships generally, unaffected.

When the rate of profit and prices are added, the system generally becomes:[12]

$$\begin{array}{l} (1 + R)(C_{11}p_1 + C_{12}p_2 + \cdots + C_{1k}p_k) = C_1p_1 \\ (1 + R)(C_{21}p_1 + C_{22}p_2 + \cdots + C_{2k}p_k) = C_2p_2 \\ \hline (1 + R)(C_{k1}p_1 + C_{k2}p_2 + \cdots + C_{kk}p_k) = C_kp_k \end{array}$$

Here the whole surplus goes to profit. When part of the surplus goes to labor, the wage can be shown as a uniform return paid on the basic subsistence wage, and the rate of profit will fall in proportion to rises in the wage.

One reallocation can be defined in which the ratios of the net amounts of each good produced to the total amount of that good consumed in production will all be the same. This common ratio will be the maximum rate of profit, and also, of course, the maximum possible rate of growth. So this ratio can be interpreted as the ratio of the value of the surplus to the value of the total current or circulating input.[13]

A surplus can be put to many uses. It can be used for the public benefit in the form of common goods, for privately consumed luxuries, to fight wars, or to support a lavish government. Or it can be reinvested productively, leading to growth. But in a private enterprise system, before one can say anything about the *allocation* of the surplus among these competing ends (or even about the influence of consumer preferences upon its composition), one must consider the logically prior question of its *distribution*. For in an economic system based on private property, everything produced belongs to someone, but the activity of production is carried out cooperatively by a number of different parties who, therefore, have competing claims. More specifically, the (value of the) net product must be divided among workers, managers, owners of capital, and owners of land, though it is convenient for many purposes to lump the first two and last two together and treat the product as being divided between wages and profits. This division is accomplished through the competitive market at the same time that the exchanges necessary for reproduction take place. The market mechanism, therefore, is obliged to do two things at once. It must allocate goods to make reproduction possible, and it must distribute the full value of the product as wages and profits, which means, among other things, deciding how much shall go to each.

In general, this decision cannot be analyzed in a static framework, for it both depends upon and affects growth. For example, when population growth equals or exceeds the rate of growth of capital, competition among laborers will force the wages down toward the cost-of-living level, raising profits toward their maximum. When population growth is less than the rate of growth of capital, competition between employers will bid wages up, lowering profits. Such changes in distribution can be expected to affect savings, since workers and profit-takers will normally have different saving propensities. And changes in the rate of profit can be expected to affect decisions to invest.

This suggests a view of competitive price determination somewhat different from that which has become customary, for it means putting the conflict between labor and capital in the foreground, making relative prices depend on the outcome of this conflict.

3.

In the system described above, the outputs of some industries served as the inputs of others. This makes it possible to trace chains of direct and indirect mutual dependence, which presents a further contrast with neoclassical thinking. For economic thought in the Walrasian tradition emphasizes the interdependence of markets, while neglecting the more fundamental technological interdependence of production. At first glance this may seem strange, since surely the analysis of one leads to the study of the other. But in a strictly neoclassical world this connection cannot be made so easily, for the factors influencing supply and those determining demand are assumed to be separate. In the neoclassical view of the economy, markets are connected not because the various products are consumed in the production of one another, but because, for example, an increase in the amount of any good purchased draws demand away from other markets; and similarly, an increase in the amount of any good produced draws factors away from the production of other goods. Production is regarded as a sort of one-way street, in which ultimate "factors" are converted into "final products" and all intermediate steps are ignored, as attention is concentrated, on the one hand, upon the conditions influencing the sale of final products and, on the other, upon the payments to the "factors." In a system of this kind production might be technologically interdependent,[14] but it is not necessary that it be so, for the scarcity of factors is a sufficient condition for the interdependence of markets.

It makes a good deal of difference in a growth model whether the interdependence emphasized is that of markets or of production. For if it is the former, the arguments of the production function will be factors which are specific not to technology but to the payment of income. Further, both supplies and demands will be tied to the decision-making units, the firm and the household. But the technological knowledge and the social conventions underlying production and consumption respectively are part of the common environment of all firms and households, and while for some purposes it may be important to emphasize the individual character of decisions to produce and consume, in the long term it may well be that this is less important than the influence of the common background. The introduction of irrelevant particulars concerning decision-making is made possible only by sacrificing the consideration of relevant technological facts.

4.

In classical (as in Marxian) economics, the focus of attention is the actual process of production. Such a concentration on technological interdependence leads to a different view of the role of the traditional "factors of production." These are now thought of as being kinds of income-bearing property, rather than actual productive agents. Of course, all income-bearing property is property in one form or another of means of production, but the point is that while "capital" and "labor" respectively receive

profits (including interest and dividends) and wages, they do not, *as such*, enter into production. *Particular* goods—such as various raw materials, tools, fuel and power, and machines—and particular jobs requiring specific skills and training are involved in production, but the general categories "capital" and "labor" are not, being mere aggregates of the particular items. This is clear enough from the fact that to produce any specific good it is not enough to have a certain amount of capital; it must be embodied in the technologically appropriate plant and equipment, manned by an appropriately skilled labor force. But just the reverse is true in the receipt of income. Whatever the particular goods in which capital is embodied, in equilibrium the same amount of capital receives the same profit income (making due allowance for risk), and whatever the particular job, labor of the same degree of skill and training receives the same wage.

In other words, "factors of production" are to be distinguished from "inputs." "Inputs" are the goods considered technologically as items entering into a productive process; but "factors of production" are collections of inputs held as income-bearing property. The fact that "factors" are collections or aggregates of inputs held in a certain relationship means that neither "capital" nor "labor" can be measured independently of prices.[15]

In neoclassical thinking, the market for factors is normally regarded as analogous to the market for final products. But this revised view of the role of "factors" implies a considerable difference between these "markets." In the markets for final and intermediate goods, value-equivalents are exchanged, i.e., objects differing in use-value but equal in exchange-value are traded either directly by barter or indirectly through some medium. But in the market for factors, income is paid out to those who have property rights in the productive process, in accordance with the nature and extent of their property. Of course, as the pattern of demand changes during development, and as technological innovations change the pattern of production, both capital and labor will shift in response to differentials in earnings between industries. But such movement does not imply that any *exchange* takes place between the recipient of net income and the source of income. The only service the owner of capital renders to industry is the service of permitting it to be owned by him.[16] Labor receives wages in exchange for work, but the level of wages, which cannot fall below a basic cost of living, is determined by bargaining power and not, as in the case of ordinary commodities, by a relationship between cost of production and value of product. This can be seen from the fact that there is no inherent connection between changes in productivity and changes in the cost of living. In short, while the way the wage rate and the rate of return are made uniform is similar to the way prices are made uniform, the "factor market" differs essentially from the markets for goods in that the payment of net income is not an exchange, despite the fact that the amount paid to a given factor will normally be determined through bargaining in a market.

There are also important differences between the various factor markets which are particularly relevant to distribution theory. For example, in the market for capital, savers compete with investors: the higher the rate of interest, the greater the earnings of savers and the lower the profits of investors. In such a competition one set of capitalists gains at the expense of another. Changes in this market will lead to a redistribution of profits among capitalists, but there is no direct effect upon relative shares. By contrast, the competition in the labor market directly involves relative shares, since what labor gains capital loses, and *vice versa*. Hence, given certain assumptions, it is possible to determine relative shares in this market alone.

5.

The fact that in a Ricardian linear production model the payment of net income in the "factor marker" is not an exchange suggests that the concept of exchange, perhaps the most fundamental idea of economics, is defined differently in Walrasian and Ricardian models. Even in a context described by a Ricardian model, the laborers must choose between work and "leisure," and the capitalist who puts his capital to work must thereby choose (at least implicitly) not to consume it (to "wait"). But these rather strained "choices" do not suffice to make the act of receiving income an *exchange* in the sense appropriate to a Ricardian system. In order for a transaction to be an exchange (rather than, e.g., a transfer payment) clearly defined, technologically useful goods or services must change hands; and for the exchange to be in equilibrium they must do so at a rate reflecting the relative production costs of the goods, given the competitive requirement that profit on capital be uniform. In other words, the Ricardian concept of exchange is irrevocably tied to the technological characteristics of the good involved; there is no exchange unless both items traded have a production equation. By way of contrast, in any neoclassical model an act can be considered an act of exchange if it has an opportunity cost, which can be estimated in terms of foregone utility.

The Ricardian emphasis on technology reveals a further difference between the two concepts of exchange. In neoclassical theory, value is determined "subjectively," as the result of a series of choices made under the influence of certain motives involving the attempt to maximize some quantity, usually utility or profit. But in Ricardian models no reference need ever be made to choices or to motives, and prices are determined without anything being maximized. The condition determining barter exchange values is that the system be able exactly to reproduce itself in the next production period, *given* the distribution between capital and labor of the surplus of output over necessary replacements. Clearly, "final demand" plays no role in this, though it will be important in determining the physical composition of the surplus.

Since in a Ricardian model prices are not determined by maximization, the Ricardian concept of equilibrium also differs substantially from the neoclassical concept. A neoclassical system is in equilibrium when and only when every individual in the system is choosing those quantities from the alternatives available to them that they prefer to produce and consume, where "preference" is interpreted as meaning, in some sense, maximizing. There are a number of different ways of expressing the idea underlying this definition of equilibrium, but however significant the modifications may seem for some purposes, all versions are based on the central ideas of choice among alternatives and maximization. By contrast, in a Ricardian (or any other) linear production model, this kind of "choice" is not relevant, and equilibrium is defined in terms of technology and distribution, so that exchange equilibrium is a relation between a pattern of production and the pattern of inputs required to maintain the system at its current level of activity, which meets the additional constraint of distributing the surplus in the given proportions.

The important thing to see at this point is that the two concepts of exchange have different logical forms. "Equilibrium in exchange" in one case means trading a set of outputs in such a way as to allocate them so that they can function as inputs; here exchange is an operation designed to eliminate the difference between the matrix of outputs and the matrix of inputs. In the other case, "equilibrium in exchange" means that the set of quantities associated with the prices (or the two sets taken together) will maximize some index. These two notions have nothing in common.

6.

Walrasian and Ricardian theories of value not only differ with respect to substitution, but, because of their divergent treatments of technological interdependence and distribution, are obliged to interpret certain basic economic terms in distinct and incompatible ways. For example, by putting the direct conflict of interest between labor and capital in the foreground, a Ricardian theory can more easily examine the effects of growth on the labor market and thus on distribution. Even more important, because a Ricardian value theory permits the specific technology used to be displayed in detail, it is able to present a closer analysis of all questions concerning technical progress. No matter how disaggregated a concept of capital is desired, a Ricardian value theory can accommodate it; for the object of the theory is to determine the rate of profit and prices together, given relative shares (determined, e.g., by the effects of growth on the supply and demand for labor), whereas the difficulty in the neoclassical approach arises in trying to determine relative shares along with prices and the rate of profit, given the quantities of capital. Hence, this latter theory can only work with a very simple concept of capital which is inappropriate for the study of growth.

In summary, we have tried to suggest, first, that some of the apparently

intractable problems facing modern growth theory actually have no very close connection with growth, but arise instead from tensions within the value theory normally presumed to underlie growth models; and second, that if this value theory is replaced by a Ricardian one, these problems will either disappear or become more amenable.

1 The following list is meant to be representative rather than exhaustive. H. Atsumi, "Mr. Kaldor's Theory of Income Distribution," *Review of Economic Studies*, Vol. 27 (February 1960). M. Dobb, *An Essay on Economic Growth and Planning* (London, 1960). J. R. Hicks, *Capital and Growth* (Oxford, 1965). N. Kaldor, "A Model of Economic Growth," in *Essays on Economic Stability and Growth* (London, 1960). ———, "Capital Accumulation and Economic Growth," in F. A. Lutz and D. C. Hague, eds., *Theory of Capital* (London, 1961). N. Kaldor and J. A. Mirrlees, "A New Model of Economic Growth," *Review of Economic Studies*, Vol. 29 (June 1962). W. A. Lewis, *Theory of Economic Growth* (Homewood, Ill., 1955). ———, "Economic Development with Unlimited Supplies of Labour," *Manchester School* (May 1954). I. M. D. Little, "Classical Growth," *Oxford Economic Papers*, Vol. 2 (June 1957). G. Mathur, *Planning for Steady Growth* (Oxford, 1965). L. L. Pasinetti, "Rate of Profit and Income Distribution in Relation to the Rate of Economic Growth," *Review of Economic Studies*, Vol. 29 (October 1962). ———, *A Multi-Sectoral Model of Economic Growth* (Cambridge, 1963). J. Robinson, *Collected Economic Papers*, Vol. II (Oxford, 1960). ———, *Essays in the Theory of Economic Growth* (London, 1963). P. A. Samuelson, "Parable and Realism in Capital Theory: The Surrogate Production Function," *Review of Economic Studies*, Vol. 29 (June 1962). A. K. Sen, *Choice of Techniques*, 2d ed. (Oxford, 1962). R. M. Solow, *Capital Theory and the Rate of Return* (Amsterdam, 1963).

2 L. Walras, *Elements of Pure Economics*, W. Jaffé, trans. (London, 1954), p. 269.

3 *Ibid.*, pp. 240–41.

4 K. Wicksell, *Value Capital and Rent*, S. H. Frowein, trans. (London, 1954), p. 169.

5 Two well known discussions of this type of value theory are R. G. D. Allen, *Mathematical Economics*, 2d ed. (London, 1960), Ch. 10; and R. E. Quandt, *Microeconomic Theory* (New York, 1958), Ch. 5. A mathematically more advanced discussion is given by G. Debreu, *Theory of Value* (New York, 1959).

6 The best example of a modern Ricardian model is P. Sraffa, *Production of Commodities by Means of Commodities* (Cambridge, 1960).

7 Alternatively, it could be assumed that the time required to change to a new technique is greater than one period of production.

8 The modern Ricardian approach outlined here, while in important ways akin to a Leontief system, nevertheless must be sharply distinguished from the latter. A Leontief system represents production in the same way and is similarly concerned with technological interdependence and the role of intermediate goods. But a Ricardian system is principally concerned with the relation between prices, wages, and profits under competitive conditions. Leontief systems never deal with a uniform rate of profit on capital nor with the effects of changes in distribution upon prices. Further, insofar as Leontief systems take account of fixed capital, they treat it as a necessary element in production and neglect its effects upon profits and prices. Cf. W. Leontief, *Structure of American Economy* (New York, 1952).

9 It is worth remarking that part of the process of development has been the reduction in the cost and difficulty of switching techniques; the difficulties in the way of this accomplishment (as well as the complexities involved in practice in switching techniques) should not simply be assumed away.

10 Cf. Ricardo, *Principles of Political Economy and Taxation*, Ch. 1 [P. Sraffa, ed., *Works and Correspondence of David Ricardo*, Vol. I] (Cambridge, 1951). Also P. A. Samuelson, "Wages and Interest: A Modern Dissection of Marxian Economic Models," *American Economic Review*, Vol. 47 (December 1957).

11 There are several ways of relaxing this assumption. If goods used in different industries are written off in the same number of periods, the columns showing the depreciation each period—which figures in circulating capital—can be multiplied by the write-off time. Alternatively, partly depreciated durable equipment can be treated as a joint product, produced along with the regular output.

12 When there is no surplus, call the matrix of inputs C and the matrix of outputs P. Then for the price equation we have $Cp = Pp$ or $(C - P)p = 0$, a unique and positive solution of which is guaranteed by the fact that $|C - P| = 0$, given certain other restrictions on the matrices. For a full discussion, cf. David Gale, *Theory of Linear Economic Models* (New York, 1960), Ch. 8.

13 For a proof that a maximum rate of profit always exists, is unique, and is associated with a unique set of positive prices, cf. Sraffa, *op. cit.*, Chs. IV and V. Also cf. F. Seton, "The Transformation Problem," *Review of Economic Studies* (June 1957).

14 Walras, however, maintained that references to intermediate goods could be eliminated by "reducing" them to equivalent expressions containing only primary factors. Cf. L. Walras, *op. cit.*, Lesson 20.

15 It is sometimes thought that a measure of the quantity of capital currently being invested can be got by considering the amount of consumption sacrificed. But this simply transfers the difficulties of measurement to consumption. An economy with a single consumption good is no more plausible than an

economy with a single capital good. Also, the attempt to estimate the rate of return on investment by the ratio of later consumption to sacrificed current consumption runs into two difficulties. First, the growth rate need not equal the profit rate (i.e., the productivity of capital is a different matter from its profitability), and second, the concern is for the return on capital in general, and not just on investment.

16 The owners of capital (the recipients of property income) are frequently said to sell the capital's "service" to a firm, the factor price of the capital being the interest or dividend they receive in return. But this is just a play on words, for the "owners of capital" are also, *ipso facto*, the owners of the firm. They are therefore "selling" this service to themselves. The "firm" only appears to be different from the owners of its capital because of their limited liability; but important as this is, in this context it means merely that they can lose no more on a given project than they choose to put into it. Yet the project is still theirs.