

7. Intertemporal Allocation with a Non-convex Technology

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7.1 Introduction

In his famous article on increasing returns and economic progress, Young (1928) concluded with the following summary:

“In recapitulation of these variations of a theme from Adam Smith there are three points to be stressed. First, the mechanism of increasing returns is not to be discerned adequately by observing the effects of variations in the size of an individual firm or a particular industry, for the progressive division and specialization of industries is an essential part of the process by which increasing returns are related. What is required is that the industrial operations be seen as an integrated whole. Second, the securing of increasing returns depends upon...the economies which are to be had by using labor in roundabout or indirect ways. Third, the division of labor depends upon the extent of the market, but the extent of the market also depends upon the division of labor. In this circumstance lies the possibility of economic progress, apart from the progress which comes as a result of the new knowledge which men are able to gain whether in the pursuit of their economic or the non-economic interests.”

Elsewhere, Young (1929) maintained the emphasis on the importance of roundabout methods, and the link between division of labor and the extent of the market but went further in describing a dynamic process with some other elements:

“The use of capital on a large scale in industry came later than its use in commerce, for the reason that not until there were markets which were able to absorb large outputs of standard types of goods was it profitable to make any extensive use of roundabout methods of production. Once established, however, industrial capitalism showed that it had within itself the seeds of its own growth. Cheaper goods, improved means of transport, and the increased advantages of specialization led to larger markets, so that the economies of industrial capitalism grew in a cumulative way. The increasing division of

labor...not only invited a larger use of instruments, but also prompted the invention of new types of instrument.”

Newman’s excellent entry on Young in *New Palgrave* (1998, vol. 4, pp. 937-9) has the second quote, and the thoughtful remarks:

“Apart from an interesting discussion by Marx, Young’s article was the first serious advance beyond Adam Smith on the relation between increasing returns and economic growth. However, the problems of formalizing that persuasive vision into a tractable model have proved formidable indeed, the chief technical problems being those of nonconvex technologies and the introduction of new intermediate commodities. So, old as it is, his paper remains important for us precisely because there is not much else.”

This survey looks at “something else”: it provides a selective and biased review of a relatively recent literature on intertemporal allocation theory which faced up to the “technical problems” of nonconvex technologies that Newman alluded to. As we shall see, substantial analytical progress has been made - within the confines of these models - in developing a “primal” approach to identifying the characteristics of “efficient” or “optimal” programs of allocation. The models sketched below capture an optimization problem faced by a “social planner” or a Central Planning Board of a Lange-Lerner economy. A nonconvex set of feasible plans (programs) precludes a routine application of the “classical” tools of optimization (e.g., separation theorems). One may analyze the complications at several levels. As noted by Dobb (1960), “investment in a planned economy is presumably determined as a policy-decision of the government, and not as the resultant of market forces which the government may seek to influence..but does not control directly”. Dobb provided a convenient classification of three types of decisions distinguished by alternative levels of aggregation: (i) determination of the total volume of investment (the choice or trade-off between immediate and future consumption), (ii) its distribution among sectors (and among the industries) and (iii) the technical forms (projects) in which the investment is embodied.¹ Sections 7.2 through 7.6 present results that attempt to resolve the first issue in an aggregative framework with a S-Shaped production function that made an early appearance in Frank Knight’s Ph.D. thesis at Cornell.² In Section 7.3, I briefly touch upon the question of efficient intertemporal choice, studied first by Malinvaud (and subsequently by Phelps, Radner, Koopmans, Starrett, Majumdar, McFadden, Peleg, Mitra, Benveniste, Gale, Cass, Yaari, Kurz, Alkan, and others). Next, in Sections 7.4 through 7.6, I move on to optimality criteria involving maximization of one period “returns” or “utilities generated by consumptions” and review both the Ramsey-Weizsacker (“overtaking”) approach to the “undiscounted” case and the “discounted” case. A reinterpretation of the model enables one to study problems of renewable resource management and the possible conflict between conservation and profit maximization (see Section

¹ The documents on planning in the Soviet Union, India or Pakistan give us concrete examples of such a broad classification that practical policy makers found useful.

² It should be mentioned the thesis was supervised by Young.