

Fritz Machlup's Methodology and *The Theory of the Growth of the Firm*

Carol M. Connell

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Fritz Machlup distinguished himself in several main areas, including industrial organization, with particular emphasis on the production and distribution of knowledge, and international monetary economics. However, his role as methodologist concerns us here. As the long-term mentor of Edith Penrose, whose M.A. and Ph.D. he supervised at Johns Hopkins from 1947 to 1951, and whose work on *The Theory of the Growth of the Firm* he co-directed, Machlup as methodologist was in the position to influence the structure of her thinking and modeling of the process theory of the growth of firms. Did he do so and how did he do so? These questions are the focus of this paper.

While management scholars and economists have since the 1990s begun to consider the Austrian influences on Penrose's work (Loasby 1991, 1999; Foss 1998; Mahoney and Michael 2005; Foss et al. 2006), little attention has been paid to the methodology underlying her process theory of the growth of firms and to the influence of Fritz Machlup. On the other hand, Machlup's methodology has been studied (Loasby 1976; Nelson and Winter 1982) and defended against the charge of neoclassical orthodoxy by Langlois and Koppl (1991) and Koppl (1992). In the sections that follow we explore the distinguishing features of that methodology and their appearance in *The Theory of the Growth of the Firm*.

The principal sources used in this study are the publications of Fritz Machlup and Edith Penrose, as well as the letters exchanged throughout 1955 when Penrose was drafting *The Theory of the Growth of the Firm*.

Fritz Machlup's Methodology

In his introduction to the *Methodology of Economics and Other Social Sciences*, a collection of papers published between 1936 and 1974, Machlup defines methodology

Carol M. Connell is assistant professor of economics at City University of New York—Brooklyn College.

C. M. Connell (✉)
City University of New York—Brooklyn College, Brooklyn, NY, USA

as “the study of the principles that guide students of any field of knowledge and especially any branch of higher learning (science) in deciding whether or not to accept or reject certain propositions as a part of the body of ordered knowledge in general or of their own discipline.” Machlup noted that methodology is not itself a method, “Instead, it provides arguments, perhaps rationalizations, which support various preferences entertained by the scientific community for certain rules of intellectual procedure, including those for forming concepts, building models, formulating hypotheses and testing theories” (Machlup 1978, pp. 54–55).

Machlup’s methodology as well as his economics was shaped by his teacher and mentor Ludwig von Mises. As in Mises (1996), the human actor in Fritz Machlup’s methodology is an anonymous, ideal type who makes decisions that serve his best interests, even though his knowledge is imperfect, his logic flawed and the outcome uncertain. With his subjective beliefs, expectations, plans, and theories, he is a change agent for knowledge creation. He allows us to interpret the effects of economic action on society, on institutions, on individuals (Machlup 1978, p. 268). Methodological subjectivism extends the idea of the individual as economic actor to include mental models of things like cost, price, depreciation, value, knowledge, productive opportunity, among other ideas which are created in the minds of individuals and which are shaped, refined, and continuously molded by experience (Machlup 1978, p. 187).

A key problem for Machlup, as for Mises (1981) and Hayek (1945), was adaptation to unanticipated change. In “Marginal Analysis and Empirical Research” Machlup (1946) argued that the purpose of assuming profit maximization is not to predict everything a firm does, but instead to predict how it will react to changes in its environment, especially with respect to demand or costs. Far from the neoclassical mainstream, Machlup’s unconventional version of marginalism produces a process story appropriate for analyzing exogenous changes and adjustments to those changes made by a representative ideal type who prefers more profit to less, knows of the exogenous change, and knows how to adapt more or less profitably to that change (Langlois and Koppl 1991, p. 96). Machlup’s subjectivist marginalism can be described in terms of a four-step adjustment model in which steps 1 (initial equilibrium) and 4 (final equilibrium) are methodological devices in a mental experiment designed to analyze causal connections between a disturbing change (step 2) and an adjusting change (step 3).

Just as adaptation to change and measuring change were important to Machlup, so was a third and related idea: verification, which Machlup defined as a procedure designed to find out whether a set of data about a class of phenomena is obtainable and, then, whether the data can be reconciled with a particular set of hypothetical generalizations about these phenomena. Machlup argues that the purpose is not to put the assumptions of economic theory to empirical test, but only the predicted results that are deduced from them (Machlup 1978, p. 143). It should be noted that other Austrians also refused to direct *modus tollens* or *ponens* at the basic assumptions of economic theory (albeit for reasons different from Machlup’s). Machlup’s “fixed part of the machine” is strikingly similar to Imre Lakatos’s “hard core” of scientific research programs (Langlois and Koppl 1991, p. 88). Here, the purpose of the model is to provide an “invisible hand,” genetic explanation of a process, involving social (rather than natural) phenomena, that unfolds in time. The story provides a plausible mechanism whereby the displaced activities of individuals

aiming at particular ends, and not at the phenomenon in question, nevertheless result in the occurrence of the phenomenon (Koppl 1992, p. 295).

To illustrate, Machlup constructs a model of an analytic apparatus, in which the input is an “assumed” change that causes other things to happen, and the output is the “deduced” or predicted change. Both assumed and deduced change can be empirically verified by observed data. The machine with all its parts furnishes the connection between the assumed cause, the input, and the deduced effect, the outcome. Machlup argues,

The machine consists of many parts, all of which represent assumptions or hypotheses of different degrees of generality. The so-called fundamental assumptions are a fixed part of the machine; they make the machine what it is; they cannot be changed without changing the character of the machine. All other parts are exchangeable...something that can be selected and put in, and again taken out to be replaced by a different piece of the set. (Machlup 1978, p. 148)

Among the exchangeable parts are assumptions about conditions, the hypothetical parameters that influence how the assumed change is supposed to cause the deduced change in the model. These assumptions include type of case (conditions that vary from case to case and affect results significantly, for example, types of goods, market position, market entry, etc.); type of setting (the underlying political structure or phase of the business cycle); and type of economy (capitalist versus socialist, for example, conditions that may vary from country to country). The fundamental postulates in this analytical apparatus must be understandable, but need not be verified independently, since simultaneous verification of the assumed and deduced change is sufficient to verify the theory as a whole (Machlup 1978, p. 153).

The exchangeable parts of Machlup’s model are a series of adjusting changes (comparative static/partial equilibrium positions) caused by a sequence of individual actions and reactions that must be explained or accounted for in terms of the knowledge, preferences, and expectations of the individuals doing the acting. Hence, the knowledge, preferences, and expectations of the actors must provide sufficient cause for their actions and seem reasonable and understandable in common sense terms (Koppl 1992, p. 303). The subjectivist Machlup was a critic of applications of evolutionary biology to economics to explain and predict the course of economic events without human knowledge, preferences, and expectations (Machlup 1978, p. 325). His student Penrose (1952) took up the same cause from the same perspective in her article, “Biological Analogies in the Theory of the Firm.”

While Machlup was not interested in the firm *per se*, but in price theory, we see Machlup’s influence clearly in the methodology and analytical apparatus behind *The Theory of the Growth of the Firm*.

The Analytical Model Behind

The Theory of the Growth of the Firm

Edith Penrose considered *The Theory of the Growth of the Firm* one long, logical construct, a single argument no step of which could be omitted without the risk of

Table 1 Analytical Model for the Process Theory of Growth

A	B	C	D	E
Assumed change/input	Deduced change/output	Possible empirical verification	Assumed type of action (fundamental postulates)	Setting, conditions
Productive opportunity (Increase) (Chap. 3)	Growth of knowledge, growth of firm	We will see growth if there is a change in external conditions, change in knowledge and, as a consequence, change in the internal supply of productive services...	Growth is limited to a firm's productive opportunity which is a composite of all the productive possibilities that its entrepreneurs see, choose or are able to take advantage of.	Opportunity for growth will be restricted to the extent to which a firm does not see opportunities for expansion, is unwilling to act on them, or is unable to respond to them.
Capacities of management/Time (Receding Managerial Limit, Chap. 4)	Growth limited within any time period by managerial services available for expansion.	We will see a change in costs—they will decrease; performance will be higher, and more opportunity will be captured because it is possible for firm to effect a progressive subdivision of function and operational decentralization equivalent to a positive change in the input of managerial services	The capacities of the managerial personnel in the firm set a limit to the growth of the firm for a period of time, until the capacities of managerial personnel can be released for additional expansion.	So-called managerial diseconomies must eventually come into play if it is assumed that there is no change in knowledge and hence no change in the quality and type of managerial service
Expanding large firm (Acquisition and Merger, Chap. 8)	Growth at lower bureaucratic cost by acquisition of, and merger with, devalued smaller incumbent firms	Change in bureaucratic costs (decrease) and managerial capability (increase) available for further growth and expansion	If the power of the expanding firm is believed to be great, each of the other firms in market will be devalued and will become a potential merger or acquisition candidate.	In a competitive economy in which the law permits one corporation to acquire another, then, whether expansion takes place through the building of a new plant or through the acquisition of another firm will depend on what appears to be the most profitable course of action.

Table 1 (Continued)

A	B	C	D	E
Assumed change/input	Deduced change/output	Possible empirical verification	Assumed type of action (fundamental postulates)	Setting, conditions
Managerial services/time (Fundamental Ratio, Chap. 9)	Firm growth rate depends on managerial services available for expansion/ managerial services required per dollar of expansion	Change in rate of growth: greater if supply of managerial services increases; less or not at all if the supply of managerial services decreases.	The maximum amount of expansion will be determined by the relevant managerial services <i>available</i> for expansion in relation to the amount of these services <i>required</i> per dollar of expansion.	When expansion takes place in fields closely related to the existing activities of the firm and to the types of knowledge already possessed by firm management, managerial effort per dollar of expansion will be less than a similar amount of expansion into unknown fields. The state of competition in factor and product markets will also powerfully influence managerial services per dollar of expansion.
Interstices/industry concentration	Growth of small firms and new firm/industry creation.	The existence of opportunities that large firms cannot or choose not to pursue reduces industry concentration. These are the “interstices” of the economy. The larger the interstices, the lower the concentration of industry and the more growth possible for smaller firms	As larger firms expand, their very growth opens up new opportunities for investment, because of the concomitant expansion of incomes and because of the increased demand for various kinds of producers’ goods. As technological knowledge grows and becomes increasingly diffused it will inevitably create innumerable and unpredictable opportunities for smaller firms.	(a) If entry restrictions are enforced by large firms against small firms, then the interstices in the economy which provide the opportunities for small firm expansion are significantly reduced; (b) If the restrictions are enforced by large firms against all other firms, then opportunity loss and economic impact will be reduced as large firms innovate to get around the restrictions.

Source: Author’s Analysis; Setting is market economy in which corporation is the dominant form of organization.

misunderstanding later conclusions (Penrose 1995, p. xxxii): a theoretic process model of firm growth. Chapters 3 through 11 in the Oxford 1995 edition make the theoretical argument, beginning with the individual entrepreneur and working outward to the industry and finally to the impact of the growth of firms on the economy as a whole.

Table 1 recreates the analytical model on which Penrose's process theory of the growth of firms is based, a mirror image of Machlup's previously discussed "Model of the Use of An Analytical Apparatus" (Machlup 1978, p. 149), where columns D and E are the "machine of pure theory," a mental construction for heuristic purposes, and columns A and B are assumptions of independent and dependent variables whose correspondence with empirical data may be tested. About the assumed conditions, Penrose acknowledges that her analysis is concerned "only with the incorporated industrial firm operated for private profit and unregulated by the state" (Penrose 1995, p. 6). While leaving verification for another day, Penrose suggests places to look if one wishes to verify the assumed or deduced change in firm growth. These suggestions are captured in column C.

While the basic growth argument was outlined by Penrose (1955) in a paper in the *American Economic Review* in the same year, the fundamental postulates and variables underlying this argument were the substance of the Penrose/Machlup correspondence of 1955. The correspondence focused on productive opportunity, the receding managerial limit, acquisition and merger, the fundamental ratio and the interstices argument.

The Productive Opportunity of the Firm and the Entrepreneur

At the heart of Penrose's theory is the fundamental assumption that growth is limited by a firm's productive opportunity, which comprises all of the productive possibilities that its entrepreneurs see and can take advantage of. Recalling Machlup's model (and the discussion of its comparative static/partial equilibrium adjusting positions), Penrose argues, "A theory of the growth of firms is essentially an examination of the changing productive opportunity of firms; in order to find a limit to growth, or a restriction on the rate of growth, the productive opportunity of a firm must be shown to be limited in any period" (Penrose 1995, p. 31).

It is clear that productive opportunity will be restricted to the extent that a firm does not see opportunities for expansion, is unwilling to act upon them, or is unable to respond to them, a consequence of the firm's entrepreneurial enterprise. Taking a clearly subjectivist approach (Mises 1996; Machlup 1978), Penrose defines enterprise or entrepreneurship as a psychological predisposition on the part of individuals to take a chance in the hope of gain, and, in particular, to commit effort and resources to speculative activity. The term "entrepreneur" throughout Penrose's study is used in a functional sense to refer to individuals or groups within the firm providing entrepreneurial services, whatever their position or occupational classification, leaving the door wide open for the firm's continued growth so long as the entrepreneurial services continue. Penrose defines entrepreneurial services as contributions to operations which relate to the introduction and acceptance of new ideas about products, location, significant changes in technology, acquisition of new

managerial personnel, fundamental changes in the firm's administrative organization, fundraising, and plans for expansion, including the method of expansion. Fundraising and creative use of capital by the firm's entrepreneurs may be linked to Austrian capital theory; and to the role of Lachmann's planner in the evolving capital structure of the firm (Lachmann 1978).

The decision to search for opportunities is an enterprising decision requiring entrepreneurial intuition and imagination and must precede the economic decision to go ahead with the examination of opportunities for expansion. In the Penrosean firm (as in Lachmann 1986), information must be gathered and interpreted, before a decision is made to pursue an opportunity—at least three generations of subjective entrepreneurial judgment and decision-making occur before a plan is executed.

Although the “objective” productive opportunity of a firm is limited by what the firm is able to accomplish, the “subjective” productive opportunity is a question of what it thinks it can accomplish. Expectations and not objective facts are the immediate determinants of a firm's behavior, for the success of a firm's plans depends only partly on the execution of them and partly on whether they are based on sound judgment about the possibilities for successful action (Knight 1964; Mises 1996). In the last analysis the “environment” rejects or confirms the soundness of the judgments about it, but the relevant environment is not an objective fact discoverable before the event; economists cannot predict it unless they can predict the ways in which a firm's actions will themselves “change” the relevant environment in the future. In any event, Penrose argues, what the economist sees may be very different from what an individual firm sees, and it is the latter, not the former, that is pertinent to an explanation of a firm's behavior.

The very idiosyncratic nature of entrepreneurship—based on preferences, judgment, willingness to see and act, access to information, knowledge based on previous decisions and actions—makes productive opportunity unique to each firm. The entrepreneur's “image” of the opportunity in his environment gives rise to the subjective opportunity set of the firm and is a further driver of firm heterogeneity and differential absorptive capacity (Boulding 1956). While Penrose acknowledged the firm's conjectural ability to shape its image of the environment, she notes that the environment determines the opportunities for any particular firm, for it must take its resources as given and must look to the opportunities it can find for using them for the source of its power to grow (Penrose 1995, p. 217). The unused productive services of resources “shape the scope and direction of the search for knowledge” (Penrose 1995, p. 70) hence change in the knowledge of the firm's entrepreneurs and managers is essential to the growth process.

Given the important role of productive services in the search for knowledge, it is not as strange as it might first appear that the Penrose/Machlup correspondence of 1955 focuses on the definition of productive services—the services of resources rather than on resources themselves. Penrose would have preferred to define productive services broadly, as she was still thinking through the meaning and implications of a theory in which, at its base, the heterogeneity of resources was a source of growth and a catalyst of continued growth. In a letter to Penrose of November 9, 1955, commenting on her draft of *The Theory of the Growth of the Firm*, Machlup discusses productive services, pushing Penrose to narrow her definition: “I believe that the theory will

make sense only if it is confined to managerial, entrepreneurial, and executive services...If you have the choice...of using a concept too narrowly or too widely, I would always prefer to make the generalization too narrow” (Machlup 1948–1955). What does Machlup mean by “the theory will make sense only”? The inputs to the analytical model for Penrose’s growth theory need to be consistent with the fundamental postulates. If the fundamental postulates are about the consequences of human action, then the inputs must be human decisions.

Expansion without Merger: The Receding Managerial Limit

According to Penrose, firms will grow only if their top management has a coordinated expansion plan in place. This growth will be limited by three factors—managerial ability, product or factor markets, and uncertainty and risk (Penrose 1995, p. 43). Since we are dealing with the rate of expansion of the firm as an administrative and planning organization,

It follows that the existing officials of such an organization must have something to do with any operations that are to be treated as an expansion of that organization’s operations...This being so, the capacities of the managerial personnel of the firm necessarily set a limit to the growth of the firm in any given period of time. (Penrose 1995, p. 46)

The generation of new productive services is a knowledge-creating process, and production itself involves both the making of products or services and the creation of new production-related knowledge (Penrose 1995, p. 56). After the expansion is completed, any unused services will remain available to the firm.

In time, the act of deploying unused resources will again set in motion the process whereby new knowledge is created and, with it, a new round of pressures for the firm to seek additional activities. The firm’s pursuit of productive opportunities engenders an increasing knowledge of the possibilities for additional action and the ways in which action can be taken. This increase in knowledge again forces the productive opportunities of a firm to change. (Penrose 1995, p. 53)

The point that knowledge is constantly changing, driving the expansion of the firm, appears also in Lachmann (1986).

Because there is a limit to the amount of expansion possible in any given period, Penrose argues that, in this sense, the productive opportunity of a firm can be considered “fixed.”

Thus a “static” analysis can be an appropriate method of exploring the conditions of “equilibrium.” The productive opportunity of the firm will be fixed if we assume that no change takes place in external conditions, nor any change in knowledge and, as a consequence, no change in the internal supply of productive services...These are the traditional static assumptions and by themselves they guarantee that increasing costs of production for all products produced by the firm must at some point set in. (Penrose 1995, p. 55)

Taking Adam Smith to his logical conclusions, and Machlup's managerial marginalism, Penrose argues,

So-called managerial diseconomies must eventually come into play if it is assumed that there is no change in knowledge and hence no change in the quality and type of managerial service; for it is widely agreed that the only reason managerial diseconomies do not arise is because it is possible for firms to effect a progressive subdivision of function and decentralization of operation...equivalent to a change in the input of managerial services, and some of these services become available only after experience has been gained of a given organization. (Penrose 1995, p. 55)

From the Penrosean perspective, as firms continually develop and respond to productive opportunities, they alter and further differentiate and re-characterize the "market." This thought is close to Machlup, for whom consumer demand drives the shape of the market. In Penrose, consumer demand is filtered through the mind of the entrepreneur:

There is no doubt that the growth of demand for a firm's existing products, as expressed through price changes and other sorts of market information, is a powerful influence on the direction of productive activity and on the expansion of firms...When, therefore, the market demand for existing products is growing an entrepreneurs expect continued growth, "demand" will appear as the most important influence on expansion, and current investment plans may be closely tied to entrepreneurial estimates of the prospects for increasing sales in existing product-lines. (Penrose 1995, p. 82)

Penrose's firm exists in an uncertain world where managers make the best decisions they can, knowing that they will not have complete information. In such an uncertain world, one of the most important tasks of a firm is that of obtaining as much information as is practical about the possible course of future events. Merely obtaining information requires an input of resources, and making a proper and complete evaluation of the information requires the services of existing management. Penrose throws off risk and Knightian uncertainty, with the challenge that uncertainty will limit expansion only to the extent that managerial resources are limited (Penrose 1995, p. 58).

Expansion Through Acquisition and Merger

In a letter to Fritz Machlup of May 27, 1955, during the drafting of *The Theory of the Firm*, Penrose considers merger as a method of growth, analyzing under what circumstances a firm would choose to acquire rather than build. Her discussion with Machlup forms the basis of chapter 8 in *The Theory of the Growth of the Firm*. She argues that most of the reasons for merger—i.e., vertical integration—are not reasons for merger at all but reasons why vertical integration was considered desirable, etc. etc. Merger for integration occurs for the same reason it occurs for other purposes and these boil down to three; (1) Merger may be cheap if there is a suitable firm wanting to sell out; (2) Merger may be the only way or the cheapest way to

acquire assets not otherwise easily available or to overcome barriers to expansion; (3) Merger may be a route to monopoly control of markets.

In his response from Kyoto, June 8, 1955, Fritz Machlup confirms that Penrose was right to throw out vertical integration as a reason for merger, but he urges her to distinguish between demand-based merger (the proactive search for a firm with which to merge) and supply-based merger (a bargain happily presents itself).

Penrose makes the prescient argument that signaling the market boosts the clout of the large dominant would-be entrant, devalues the incumbents, and encourages merger candidates actively to self-identify, understanding the advantage to themselves. In her May 27, 1955 letter Penrose assumes a large Firm Alpha, intending to enter a new market, and a group of smaller firms which she classifies as Firms Beta. Whatever the final make or buy decision of Firm Alpha, the large firm's intention to enter reduces the prospective profitability of each existing Firm Beta and, in extreme cases, causes the value of Beta to plunge far below the present value of the firm and below the cost of entry to Alpha. If Beta believes that Alpha could capture the entire market in a relatively short period, a merger would then be profitable for both firms.

In his June 8, 1955 response, Machlup calls Penrose's market signaling problem important theoretically and potentially important for economic policy. He calls her argument about the drop in value of the Beta assets in the minds of its owners, making them willing to sell their firm at a reduced price, convincing and a very ingenious hypothesis subject to verification.

The Fundamental Ratio

In a November 2, 1955 letter to Machlup, while she was writing chapter 9, Penrose reports on a conference presentation she made after which her discussion of what she called the "fundamental ratio" was first referred to as "Edith's Effect." The fundamental ratio describes the relationship between maximum expansion and managerial services required per dollar of expansion. Here managerial services are an input and a limit to growth, and the ultimate (although unfulfilled) aim of the discussion is to solve a maximization problem: "The factors determining the availability of managerial services and the need for them in expansion will therefore determine the maximum rate of growth of the firm, where rate of growth is defined as the percentage rate at which the size of the firm increases per unit of time" (Penrose 1995, p. 200). Extrapolating from the fundamental ratio, the large firm will not grow or must reduce organic growth unless the supply of managerial services available for expansion increases at a rate equal to or greater than the rate at which the managerial services required per dollar of expansion increase. Again, extrapolating from the fundamental ratio, related diversification is less costly because the managerial effort required per dollar of expansion is less than a similar amount of expansion into unknown fields. Related diversification also requires significantly less managerial effort per dollar of investment than vertical integration, if the objective is to own one or more pieces of the productive opportunity value chain. Despite its potential usefulness, Penrose's discussion of the fundamental ratio never culminates in the quantification which would have allowed her to fully

operationalize the impact of managerial services on firm growth, an important step in verification. As Machlup wrote,

For purposes of verification it does not suffice to have an operationally defined concept as the clear counterpart of the starting step that sets the theoretical apparatus in motion. We also need operational counterparts for some of the conclusions furnished by that apparatus, that is, for the consequences deduced from the propositions in the logical argument. (Machlup 1978, p. 201)

The Position of Large and Small Firms in a Growing Economy: Interstices

In chapter 10, Penrose pushes toward a relationship between firms and the economy as a whole and to the contribution of large firms to productive opportunity and growth of small firms. Here, expanding large firms are the input to the growth of small firms and to overall economic growth. In a letter of November 2, 1955, Machlup calls the “interstices” argument probably the most interesting phase of her discussion. Nevertheless he sees contradictions in the argument: Wouldn’t merged small firms shift growth from smaller firms to larger firms, reducing opportunities available in—and hence the size of—the interstices? Is this an exception to the interstices argument or is it a contradiction? A page later Penrose identifies interstices where large firms would never possess an advantage; again, is this not a contradiction? The objections raised by Machlup encouraged Penrose to develop more fully her discussion of competition among expanding large firms in capital intensive industries; the multiplier effect whereby the existence of large firms results in the expansion of incomes, increased demand for producers’ goods as well as technology diffusion, creating opportunities for investment by small firms; and the impact of business cycles on the existence and size of interstices. What began as a discussion confined to a single chapter now flows across two chapters.

Conclusion

Edith Penrose’s *Theory of the Growth of the Firm* did not emerge fully grown from the mind of Edith. There were important antecedents that provided insight into the fundamental postulates needed for a process theory of the growth of firms. Loasby (1991, p. 28) attributes to Menger a long causal chain of logic that puts knowledge in the driver’s seat: the division of labor is a *consequence* of increased knowledge, leading to direct consumption, production for exchange, exchange for consumption, production for exchange, and more division of labor for efficient production. That knowledge creates more specialized wants and needs has long been associated with the Austrian School of economics (e.g., Mises 1996; Hayek 1948; Kirzner 1973, Lachmann 1986). Here, the agent of knowledge creation is the individual with his *subjective* beliefs, expectations, capabilities and resources, plans and theories. Subjectivism suggests that the actions that entrepreneurs need to take to exploit market frictions are not knowable, *a priori*, and must be determined over time. Hayek (1945, 1978) saw competition as an effective procedure for discovering

knowledge that is potentially valuable but unpredictable and certainly different from the knowledge filtered through the mind of any other entrepreneur. Mises (1996) saw the market as a process driven by entrepreneurial competition. The attempt to capture emergent knowledge for one's own advantage—and how it is captured—is also a prime example of a productive opportunity, a core concept in Penrose's process theory of the growth of the firm.

Creating a theory of the growth of firms, even with antecedents to draw from, requires some kind of analytical modeling that allows the theorist to specify the parts of the model that are “pure theory” and the parts which are assumptions of independent and dependent variables which can be tested against empirical data. We have shown that the arguments for the firm's productive opportunity as envisioned by the entrepreneur; the receding managerial limit; growth by acquisition and merger; the fundamental ratio; and small firms in the shadow of big firms—the so-called “interstices” argument—were critical to the process and were discussed, debated, and shaped by the Penrose/Machlup correspondence. The correspondence focused on these issues because Penrose relied on Fritz Machlup, her mentor and the author of the basic analytical model, for guidance in getting the assumed changes, deduced changes, and fundamental postulates right. While she did not intend at this point to verify her independent and dependent variables against actual data, she certainly hoped that other scholars would do so and provided suggestions for empirical verification.

The correspondence supports the argument that both Penrose and Machlup anticipated that this study was not limited to the prediction of conditions leading to the growth of a single firm, but was intended to be a more comprehensive theory about the contribution of the growth of firms large and small to the growth of the economy as a whole. Certainly, this ambition is confirmed by the discussion of the interstices and industry concentration. Both Penrose and Machlup were seeking to accomplish a theory of growth that would be of value to economic policy. Far more work remains to be done with Penrose's analytic model and the interdependency between deduced and assumed change, mediated by her fundamental assumptions.

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