Journal of Institutional and Theoretical Economics (JITE) 144 (1988), 635–657
Zeitschrift für die gesamte Staatswissenschaft

Economic Change and the Boundaries of the Firm

by

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Introduction

The study of economic change – including technological change – has long been a subject of fascination to economists. It is also a subject that has proven refractory to most attempts to capture it adequately. This essay is an attempt to walk a small piece of this difficult ground. Specifically, it aims to examine the problems that economic change poses for the explanation of the organization of firms. By this I mean the problem of explaining the boundaries of the firm – explaining the extent of internal organization or vertical integration.

What follows is an intellectual progress report rather than a polished theory. In an earlier foray into the field (LANGLOIS [1984]), I tried to sort out some of the methodological issues that would attend an explanation of vertical integration in a regime of rapid economic change. That paper was in part an attempt to locate the connections between a transaction-cost approach to the study of internal organization (WILLIAMSON [1985]) and an evolutionary or process discussion of economic change (NELSON and WINTER [1982]). I suggested then that any explanation of internal organization in a regime of rapid change ought to take into account two factors: disequilibrium and path-dependency. The present paper sets out to elaborate such an explanation, incorporating both my own more recent ideas on the subject and the relevant work of such writers as SILVER [1984] and TEECE [1984, 1986a, 1986b].

Economists confronting a phenomenon as complex as internal organization are faced with an inevitable tradeoff. On the one hand is the impulse to multiply variables and auxiliary conditions in order to capture a passable likeness of the world. On the other hand is the quite sensible desire to edit out such entities, even at the risk of leaving the best scenes on the cutting-room floor. The tendency in the management literature is generally to err in the former direction; this is what makes that literature so rich and, for economists, so

* The author would like to thank Bo Carlsson, Gunnar Eliasson, Ken-ichi Imai, Brian Loasby, Richard Nelson, Paul Robertson, and L. G. Thomas for helpful suggestions and discussions.

frustrating. Economic theories of vertical integration tend, by contrast, to the other extreme. They try to explain the phenomenon of vertical integration by at most one or two variables. This is why such theories are typically stark and, in the end, unsatisfying. In the spirit of the transaction-cost approach – and the "New Institutional Economics" more broadly – I will try to keep a middle ground in this essay. Much of the analysis will proceed by examining arguments carefully, and therefore by making distinctions. But I hope to keep these distinctions few enough that they might eventually serve as elements for a coherent dynamic theory of internal organization.

Theories of Vertical Integration

Economic theories of vertical integration fall into a number of distinct categories.[1]

One kind of theory involves what WILLIAMSON [1985, pp. 86–89] calls technological determinism: it is the production technology that alone (or primarily) shapes the organization of the productive unit. Such theories are unsatisfactory for a number of reasons, not the least of which is empirical. If the advent of centralized water and stream power gave us the factory system, why did not the advent of small electric motors destroy that system?[2] To put the matter more generally, we observe far more organizational integration than is explicable on grounds of technological indivisibilities alone.[3]

Another class of explanations are those of standard Marshallian price theory and the "structure-conduct-performance" paradigm, now somewhat quaint and old-fashioned, that grew out of it. For both descriptive and normative purposes, this approach swings on a single analytical hinge: the concept of "monopoly" or "market power", conceived of as arising naturally, but for reasons unexplained, within the competitive system. To appraise this class of theories properly would take us far afield. But it would not be unduly harsh to say that explanations of vertical integration from this direction have been singularly unilluminating when not downright wrong.[4]

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[1] There have been a number of recent surveys of the theory of vertical integration. See especially BLAIR and KASERMAN [1983], CASSON [1984], and WILLIAMSON [1985].

[2] An example borrowed from LEIJONHUFVUD [1986], p. 205.

[3] This problem also limits the generality of the analysis of ALCHIAN and DEMSETZ [1972], which is an economic reincarnation of technological determinism. In this case internal organization results because of the monitoring costs that attend the common-pool problem in team production. But what makes team production necessary? The (given) production technology.

[4] This should not be entirely surprising, since Marshallian theory (or, more correctly, post-Pigovian theory) takes the equilibrium firm as a constituent given. It would be unfair to expect any theory to explain its own assumptions. (On the difference between the Marshallian and Pigovian versions of the firm, see Moss [1984].)

Almost all modern economic theories of vertical integration are transaction-cost explanations.[5] We can imagine production as taking place in various stages. Considering production costs alone tells us nothing about whether each stage is likely to be a separate firm or whether some stages are likely to be jointly owned.[6] Indeed, if there were no costs but production costs, we would expect the least possible vertical integration: every stage would be its own firm, and each thus could take best advantage of the particular production economies open to it. Production would be fully decentralized, and all coordination would be a matter of price-mediated spot transaction. As COASE [1937, p. 390] pointed out, however, there is "a cost of using the price mechanism" in this way. There are other costs – transaction costs – in addition to production costs; and it is these transaction costs that determine the extent of internal organization. As WILLIAMSON [1985] would now articulate it, the level of vertical integration we observe in the economy largely reflects a minimun of the sum of production and transaction costs.[7]

But what are these transaction costs? And where do they come from? The problem is not that we have no answer to these questions; rather, it is that we have far too many. At some level, we could say that a transaction cost arises from any impediment to price-mediated spot exchange that makes internal organization a less-costly alternative; the transaction cost would thus equal the opportunity cost of market exchange. This is, of course, rather unhelpful. So economists have set about finding specific costs of market exchange. The resulting cornucopia includes asymmetric information (ARROW [1975]); technological indivisibilities in team production (ALCHIAN and DEMSETZ [1972]); and differential risk perception (BLAIR and KASERMAN [1978]). Most of these explanations suffer from a lack of generality, and many from a failure to ask whether there might not exist contractual alternatives that cope with these problems quite as well as vertical integration.

The dominant – and perhaps most appealing – set of explanations today centers on the concept of asset specificity (KLEIN, CRAWFORD and ALCHIAN [1978]; WILLIAMSON [1985]). Efficient production frequently requires the use of specialized assets – unique machinery, for example – that have few alternative uses. The owners of such assets are vulnerable to the appropriation of their rents by their contractual partners. One alternative would be to use less-specialized equipment, but that frequently means a sacrifice of production efficiency. Another alternative is internal organization[8] – common ownership

[5] Such explanations are *sometimes* also called "market failure" explanations. This is Pigovian terminology, and it is arguably both prejudicial and misleading. On this see COASE [1960], DEMSETZ [1969] and DAHLMAN [1979].

[6] Or about any of the many other organizational alternatives.

[7] On the methodological implications of this assertion, see LANGLOIS [1984]. We will also return to the issue below. I should note that Williamson allows for the possibility of what he calls "mistaken" vertical integration.

[8] Yet another alternative might be a hostage. See WILLIAMSON [1985], chapters 7 and 8.

of both the specialized asset and the relevant surrounding stages of production. This eliminates the threat of expropriation and renders unproblematical the choice of the efficient specialized technology.

In Williamson's work, asset-specificity has become the centerpiece of the explanation of vertical integration. But it is not by any means the whole story. Most theories of internal organization, Williamson's included, are static theories in an important sense. They take the circumstances of production as given and investigate comparatively the properties of market-contract arrangements, internal organization, and sometimes other modes of organization. What happens, however, when the technologies of production – and perhaps other environmental factors – are changing rapidly? In Williamson's view, the approach from asset specificity alone may then be less persuasive. "The introduction of innovation," he writes, "plainly complicates the earlier-described assignment of transactions to markets or hierarchies based entirely on an examination of their asset specificity qualities. Indeed, the study of economic organization in a regime of rapid innovation poses much more difficult issues than those addressed here" (WILLIAMSON [1985], p. 143).

Innovation

We can begin to approach the problem by asking this question: is rapid economic change likely to make market contracting more costly or less costly relative to internal organization? Almost without exception, writers who have asked this question (in one form or another) have concluded that, in such circumstances, internal organization is clearly superior to arms-length contracting on transaction-cost grounds.

One way to think about this is in terms of the flexibility of internal organization in comparison with that of a decentralized system of market contracts.[9] The firm, it is often remarked, is a nexus of imperfectly specified contracts; this is in contrast with the more fully specified contracts of arms-length transaction. In the face of rapid change, imperfect specification allows some maneuvering room to adapt adroitly. To put it another way, the decentralization of markets makes it difficult to coordinate a complex reorientation of production in the face of change; a more-centralized arrangement, by contrast, might face lower costs of radical change, all else equal.

To be successful, an innovation must mesh with the complex system of production of which it is a part. Sometimes this is easy because the innovation fits neatly into the existing system. Sometimes, however, an innovation is sufficiently radical that its success requires significant changes elsewhere in the

[9] We might trace this observation back as far as KNIGHT [1971], p. 268.

system. The first kind of innovation is what TEECE [1984] calls an *autonomous* innovation; the second is a *systemic* innovation. The costs of coordinating a systemic innovation among many decentralized market participants is likely to be high – higher, at any rate, than the costs of coordinating the change within a single organization that owns most or all of the relevant stages (ADELMAN [1955]; SILVER [1984]; TEECE [1984]).

In a marvelous but neglected article, G. B. RICHARDSON [1972] articulated a number of ideas useful in developing this hypothesis. He begins by drawing on Edith PENROSE's [1959] notion of the *capabilities* of a firm. Production is not (as the production-function model would have it) a matter of combining resources according to explicit blueprints of some sort. Rather, production is a matter of human skill and experience. The organization puts its capabilities to use in the coordination of the various *activities* that go into producing goods and services. These activities correspond more or less to what I have called stages of production: research and development (R & D); the various stages of manufacturing; marketing; etc. The firm's boundaries will depend on its capabilities; it will undertake activities to which its capabilities are appropriate and leave other activities to the market. In general, the firm will undertake *similar activities,* activities that require similar capabilities.

The systemic character of production means that activities are related or, in Richardson's terms, *complementary* to one another. Complementary activities are those that must be coordinated in the process of production; in the context of systemic innovation, they would be those that must be adapted for the innovation to succeed. Clearly, not all complementary activities will be similar. Producing random-access memory chips is probably an activity similar to producing logic chips; but complementary activities like producing the capital equipment used in fabricating chips or the computers into which the chips are plugged are not particularly similar.[10]

Richardson's thesis is that when complementarity requires close coordination – he speaks of *closely complementary* activities – but the firm involved does not possess the necessary capabilities, the result may be an intermediate form of organization like licensing, joint venture, or equity investment. These intermediate modes allow some degree of coordination without incurring the high costs of complete vertical integration into activities for which the firm's capabilities are ill adapted.

More recently, TEECE [1982, 1986a, 1986b] has developed (apparently independently) a strikingly similar framework that extends these ideas in a number of ways. He too is influenced by Penrose and by the idea that a firm possesses capabilities – various skills and experience, some explicit, some

[10] For example, the optical stepper, a device used in the photolithography of semiconductors, is produced by firms with specialized capabilities (like GCA near Boston) or by firms specializing in similar – but non-complementary – activities (like camera-manufacturer Nikon).

tacit[11] and inexplicit. Rather than speaking of complementary activities, Teece talks of complementary *assets.* This formulation connects with the literature emphasizing asset specificity. It differs from Richardson in its focus on the asset rather than the activity, but these notions are surely related at some level.

TEECE [1986 b] distinguishes complementary assets according to whether they are *specialized* or *cospecialized.* A specialized asset is one whose relationship to the innovation is unilateral. For example, the value of an asset may depend on the success of a particular innovation – but the success of the innovation does not depend on the availability of the asset. Sometimes the reverse is true: the success of an innovation may depend on the availability of a particular asset – but the value of the asset does *not* depend much on the success of the innovation. When the dependence is mutual, however, the assets are cospecialized. To use Teece's example, the innovation of containerized cargo required the coordination of both containerized ships and specialized equipment in port. Both sets of assets had to be called into existence and were thinly supplied (at least at first).[12] Notice that the notion of cospecialization bears a striking resemblance to Richardson's idea of close complementarity.

The other factor Teece brings in is *appropriability,* the capacity of one party (in this case the innovator) to appropriate the rents or quasirents of the innovation. The innovator's ability to appropriate these rents will determine the extent of internal organization. And that ability will depend both on the degree of complementarity and on the "regime of appropriability," the ability – both practical and legal – to create and enforce property rights in the innovation (TEECE [1986 a], p. 188).

The innovator need not own all complementary assets in order to profit from his or her innovation; one need only take positions in those assets, long positions in assets likely to appreciate and short positions in assets likely to decline in value. But when the assets involved are cospecialized, the familiar problems of "holdup" and "opportunistic recontracting" are possible. This creates the usual motive for single ownership of all the relevant assets. The innovator may also have a motive to integrate into assets not cospecialized if imitators could otherwise quickly enter and bid away the quasirents of innovation. Where the knowledge involved is of a sort easily protected by patent (as in pharmaceutical),[13] licensing may obviate complete internal organization; but where this is not the case (as in most process technologies, such as semiconductor fabrication), internal organization may be the most effective way of protecting the quasirents.

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[11] In the sense of POLANYI [1958].

[12] By contrast, the trucks needed to bring the containers inland from the port were specialized assets, since existing trailers could be easily modified to the task. The success of the innovation depended on the availability of trucks, but those assets were already in existence and thickly supplied.

[13] LEVIN *et al.* [1987].

Notice that much of the story here involves what we would ordinarily call "bottlenecks" in the innovation process. In Teece's story, bottlenecks cause transaction costs because they pose the threat of strategic expropriation of rents. "The owner of the bottleneck asset, realizing its strategic importance to the innovator, is in a position to threaten to withhold services, causing the price of its services to be raised" (TEECE [1986a], p. 188). What is interesting is that SILVER [1984] uses many of the same building blocks – especially the notion of bottlenecks – to create an explanation of vertical integration with a somewhat different slant.[14]

Citing SCHUMPETER [1934], Silver begins with the observation that innovation frequently involves the qualitatively new. The individual – the entrepreneur – who attempts to introduce the qualitatively new often meets with strong resistance. Such resistance may be cultural and psychological, as Schumpeter emphasized. But, more interestingly, it may also be informational. As we saw, the success of an innovation often requires the adaptation of complementary activities; if the innovation is indeed qualitatively new, many of the necessary activities will also be qualitatively new (and thus normally specialized to or cospecialized with the innovation). The problem for the innovator is to call forth these specialized activities. To do this through arms-length contracting, the innovator would have both to inform and to persuade those with the necessary capabilities. Since the innovator's vision is novel and idiosyncratic virtually by definition, this may not be an easy task. The innovator's potential contracting parties may have to invest in specialized assets, and it may take a high price to get them to bear the risk of an irreversible investment under such circumstances. This may make it less costly for the innovator to integrate into the cospecialized activities and to employ those parties with the relevant capabilities instead of contracting with them. Silver sees the benefits to this largely in informational terms: the innovator can communicate the procedures and routines the employee is to follow more easily than the detailed specifications of end-product a contractor would need. There is also a cost to such internal organization: the innovator will likely be integrating into areas to which his or her own capabilities are relatively less adapted, that is, into relatively dissimilar activities.

This story is clearly quite akin to that of Teece; but it is also different in a crucial way. Silver has picked up the Richardsonian thread more clearly. He emphasizes the costs of coordination in a regime of economic change, the costs of transmitting information that is novel and fundamentally qualitative in nature.[15] Asset specificity enters in a secondary way. But the threat to the

[14] The notion of bottlenecks as a motive for vertical integration was first suggested by ADELMAN [1955].

[15] This was also the theme of LANGLOIS [1984].

specialized assets arises not from the opportunism of fully convinced asset-holders; rather it arises from the uncertainty in the innovation process, as perceived by asset-holders who may not fully grok the innovator's vision. "In my scenario," says Silver,

> "... the entrepreneur does not "do it himself" in order to keep the profitability of good X a secret (MAGEE [1981]). Just the opposite is the case! The innovator would prefer to concentrate his managerial resources narrowly on X. His problem is that he cannot, at reasonable cost, convey his implausible "secret" to those with the technical capabilities needed to produce the required operations at the lowest cost. Finding himself unable to secure the cooperation of the latter producers, the entrepreneur must direct his finite managerial resources into areas for which he does not have a comparative advantage. This in fact reduces the profitability of his innovation." (SILVER [1984], p. 17.)

In order to distinguish these two variants of the theory, I will call Teece's the *appropriability* version and Silver's the *entrepreneurial* version. In both cases, of course, the innovator is motivated to integrate by a desire to "appropriate" the rents of innovation. But in Teece's case, he or she does so in order to prevent others from grabbing the rents, whereas in Silver's case, he or she integrates in order to create rents that otherwise wouldn't exist (or wouldn't be as great).

I don't propose to choose between these variants. Instead, I intend to try to bring them together – to determine the circumstances under which each is applicable and to fit them both into a slightly roomier story. In order to do this, however, I'm afraid that some additional preliminaries are in order.

The Division of Labor

In one sense, of course, the dynamics of organization is a concern that goes back over 200 years in economics. One might even say that, in one form, it was the starting point for Adam Smith in the *Wealth of Nations*. Smith's theme was the division of labor. And his observation that the division of labor is limited by the extent of the market suggests a possible link between vertical integration and economic change in the form of market growth.

One economist who sees such a link is George Stigler. In a well-known 1951 article, he attempts to unpack the implications of Smith's observation by considering the various activities – he calls them "functions" – in terms of their individual (Marshallian) cost curves. Why do firms with increasing-returns technologies not grow indefinitely large? he asks. His answer is that the increasing-returns activities are held back by other activities within the firm that exhibit decreasing returns. As the market for the final product expands, however, it becomes profitable for the increasing-returns activities to spin off and exploit their economies of scale by aggregating the demands for their services across the industry.

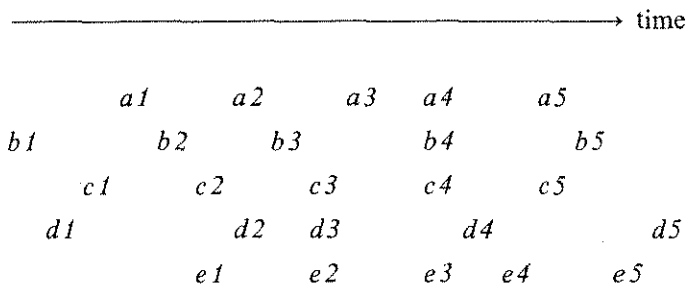
Stigler draws from this analysis his much-discussed hypothesis about vertical integration.[16] Since a larger market means more of this "spinning off", he concludes, "Smith's theorem suggests that vertical disintegration is the typical development in growing industries, vertical integration in declining industries" (STIGLER [1951], p. 189). I will argue presently that this conclusion is unwarranted and, if taken narrowly, is probably exactly backwards. Before making that case, however, let me recast Stigler's analysis somewhat. Following LEIJONHUFVUD [1986], we can open up the black box of the Marshallian cost curve and look in a more Smithian fashion at the structure of production and the sources of economies of scale.

Consider first the paradigm of wholly undivided labor: crafts production. Here a single individual undertakes many of the relevant activities of production. Figure 1 a shows this pictorially. Each of the artisans (*a* through *e*) performs sequentially all of the tasks (1 through 5). Consider now the reorganization of production in the manner of Smith's pin factory. In Figure 1 b, each artisan now performs only one task: *a* performs only task 1, *b* performs only task 2, etc. This allows for specialization and comparative advantage, permitting production to partake of all the economies with which Smith was impressed: the increase in individual dexterity; the saving of time otherwise lost "sauntering" between tasks; and the concentration of attention, which would lead workers to perceive opportunities for mechanization and (autonomous) innovation.

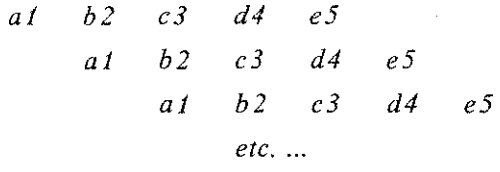
There are several differences of note between crafts and factory production. In crafts production, each artisan requires relatively broad capabilities (in Penrose's sense). The artisan must be adequately skilled in all the tasks necessary to complete the product. This implies a certain degree of flexibility. Innovation of a stage-specific, efficiency-enhancing sort is, as Smith argued, less characteristic of crafts production. But innovation of a more systemic sort is likely: for the artisan, systemic innovation – innovation across the stages of production under his or her command – is in fact autonomous. This accounts for the distinctiveness of, and the lack of standardization in, a crafts product. It also suggests, once again, that an artisanal product is more protean, and that more-or-less radical product modification is cheap in this mode of production. Notice also that each artisan is the rival of all others, a factor that further encourages differentiated and nonstandard products.[17]

[16] Actually, he proposes *two* hypotheses in this article. The second – perhaps equally well-known – hypothesis is that taxes and other government-induced distortion of market prices accounts for much vertical integration.

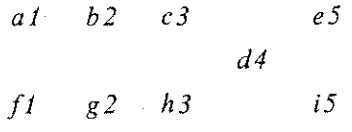
[17] A complicating issue, of course, is the existence of cospecialized activities elsewhere in the system that militate in favor of standardization: the need for replacement parts, for example, or for irreversible human-capital investments by users. But this is getting ahead of the story.



a. Crafts production.



b. Factory production.



c. Parallel-series scale economies.

Note: letters represent artisans, numbers represent tasks.
Source: LEIJONHUFVUD [1986].

Figure 1. The Vertical and Horizontal Divison of Labor.

In factory production, by contrast, the artisan's on-the-job capabilities are narrower in scope. This increases the efficiency of production, and even increases innovation – but innovation of a stage-specific, efficiency-enhancing sort. For the artisan in factory production, the opportunities for autonomous innovation are no longer more-or-less coextensive with those for systemic innovation. Increased production efficiency comes at the price of reduced flexibility, including product flexibility, implying standardization, interchangeable parts, etc. At the same time, however, the machinery used in production

becomes more idiosyncratic and specialized (LEIJONHUFVUD [1986], p. 215). Notice also that the factory operatives are now *complementary* to one another rather than rivals.

This reorganization in the manner of the pinshop is what most people have in mind when they speak of the division of labor. But it is by no means the entire story. Factory production requires that the stages of production be closely coordinated in time. Since the various stages are unlikely to be uniformly efficient, however, some stages may be bottlenecks.[18] More interestingly, some stage may be anti-bottlenecks, that is, they may have excess capacity. Suppose one stage of production – stage 4, for example – is running at half capacity. If the firm were to double its sale of final product, it could run two assembly lines, both feeding into the same stage 4 (see Figure 1 c). The doubled output comes at the expense of less than twice the inputs. These economies of scale arise from organizational change not from technology, although mechanical innovation can renew the potential for generating economies by increasing the capacity of the stages.

Stage 4 in Figure 1 c can be "spun off" as in Stigler's story. Notice, however, that this spinning-off process is a manifestation of the division of labor quite different from what is implied in the pinshop reorganization. In Smith's terms, stage 4 has become a "peculiar trade" of its own. Leijonhufvud calls this spinning-off process the *horizontal* division of labor to distinguish it from the *vertical* division of labor implied in the pinshop reorganization. One important difference between the two is that the horizontal division of labor does not necessarily carry the implication of narrowed capabilities (or lowered human-capital requirements) on the part of workers; it may in fact mean an *increase* in human capital per worker (LEIJONHUFVUD [1986], p. 212). Eventually, of course, the "spun off" stage will itself subdivide labor in vertical fashion as the market for its (intermediate) product grows.

The important point to notice about the division of labor story so far – whether it is Smith's or Stigler's or Leijonhufvud's – is that it is incomplete in a crucial way. The division of labor is at base a matter of *production* costs alone. And, as we saw earlier, one cannot say much about the extent of internal organization without an overlying consideration of transaction costs. The horizontal division of labor can take place within a firm, as the assembly-line picture of Figure 1 c perhaps implies. Or it can take place through the creation of a legally separate entity, as when the anti-bottleneck stage becomes a firm of its own. Production efficiencies by themselves say nothing about the choice. This is precisely the difficulty with Stigler's analysis: he has made a case that there should be more (horizontal) division of labor when the market is growing (or, more correctly, when the extent of the market is large) and less division

[18] And, as ROSENBERG [1976, p. 125] has argued, such bottleneck stages are the most likely targets for innovation.

when the market is contracting (when the extent of the market is less). He assumes that this translates directly into statements about vertical integration; but without additional argument, it really does not.

Disequilibrium

We could, of course, simply overlay this analysis of the division of labor with a transaction-cost story based around asset specificity and appropriable rents. Both Leijonhufvud and Williamson do in fact tell the story this way. As we saw, the (vertical) division of labor leads to a reduction in the human-capital requirements (the crafts skills) of labor while at the same time increasing the idiosyncrasy and specificity of capital used in production. If each stage of production were owned separately – that is, if labor hired capital – the various capital owners could threaten, in the usual way, to withhold the services of their machines in order to appropriate more of the rents of production. This would lead to costly bargaining, disruptions of production, or the use of less efficient technology. If instead the owners of capital do not own specific machines but instead own shares in all the machines (*voilà* the capitalist firm), these problems disappear. The capitalists hire labor to run the machines; but, because labor has become "deskilled" (as the radicals put it),[19] the labor market is, in effect, contestable. There are still labor unions to contend with; but bargaining with a single agent is less costly than dealing with many individual threats.

This explanation has much to recommend it. In the large, it is probably right. But notice that it really has the most to say about the motives for integration that arise from the *vertical* division of labor. It says less about whether newly created "peculiar trades" will be carried out internally or by separate firms. Since the horizontal division of labor need not involve "deskilling," the labor input to the stage may be just as specialized as the capital component. It is thus ambiguous whether there are advantages to pooling the capital of this stage with the rest of the larger firm's capital.

Moreover, it is the thesis of this essay that rapid economic change may introduce other sources of transaction costs – costs that may dominate those from asset specificity of this kind. Consider Stigler's hypothesis once again: vertical disintegration should be characteristic of growing industries and vertical (re)integration characteristic of declining ones. Using the words "growing" and "declining" seems to imply an emphasis on rates of change. In fact, I would argue, Stigler means nothing of the sort. His analysis, like Smith's is about the *extent* of the market – not about the *rate of change* of the extent of the market. This difference is probably inessential for the analysis of the division of labor – of production costs – alone. But for the analysis of vertical integration, the difference may be a crucial one.

[19] MARGLIN [1974].

If we link together the ideas of growth and innovation as manifestations of economic change, then we can apply our earlier analysis in a straightforward way. Growth – or rapid growth, at any rate – must involve a large degree of systemic innovation. The costs of coordinating such innovation through arm's-length transaction suggest that vertical integration is in fact more typical of growing industries; and there does seem to be some empirical support for this possibility (JEWKES [1930]; ADELMAN [1955]; HARRIGAN [1985]).

We can also mount the complementary argument: where the market is not growing rapidly – where systemic innovation is not occurring on a significant scale – we should expect that the horizontal division of labor will take place through the formation of separate firms rather than internally. Internal organization also has its (transaction) costs.[20] These arise from the limits to the capabilities of managers and management structures. Now, one can enlist the division of labor in management as well as in production,[21] and thus try to limit these costs through decentralization; this is part of the logic behind the M-form structure (WILLIAMSON [1985], ch. 11). In the extreme, however, the least-costly structure of internal management is complete decentralization – vertical disintegration into the price system. If there is little economic change, and therefore no transaction costs to market organization, the only reason to bear the costs of internal organization would be whatever "static" sources of transaction costs happen to arise in the particular case. We would thus expect vertical integration to be lower when economic change is less, all else (including extent of the market) equal.

One implication of this hypothesis is that the evolution of industry structure in response to an increase in the extent of the market will depend crucially on the time pattern of growth.

If growth is gradual and innovation incremental, something like Stigler's story is probable. Firms will start off relatively integrated. They will slowly increase their division of labor as markets grow, spinning off (or calling forth) a web of specialist firms who will work on contract. As the industry declines and demand for final product diminishes, the division of labor will be forced to recede, and the firms will reintegrate. In this scenario, organization is driven by the division of labor, and production-cost considerations dominate transaction-cost considerations. What integration remains will be dictated by static transaction costs particular to the case.

If, by contrast, growth comes in spurts or is the result of radical innovation, the picture may be rather different. The times of rapid change are periods of "disequilibrium" (to use the word loosely) in which the transaction-cost disadvantages of markets outweigh the disabilities of internal management.

[20] Vertical integration can also increase production costs, of course, to the extent that an anti-bottleneck stage is not as fully utilized within the firm as it would be if "spun off" to aggregate demands across firms in the industry.

[21] An observation going back at least to BABBAGE [1835].

Holding the extent of the market constant, the disequilibrium industry is more integrated. As the industry matures, two potentially countervailing effects will come into play. First of all, the market will be increasing in size, which means that the division of labor will be increasing. At the same time, maturity means that the pace of change is slowing and that learning is taking place. What effects are stability and learning likely to have on the extent of internal organization?

As SILVER [1984, pp. 47–50] notes, the effects of stability and learning are somewhat ambiguous. On the one hand, learning will occur within the already-integrated firm: the cost of internal management decreases as managers develop their capabilities and as they institute managerial innovations of various kinds. On the other hand, learning will also take place within the economic system as a whole. In Silver's terms, the success of the integrated venture means that potential contractors no longer need be persuaded to invest in the necessary cospecialized assets. So the costs of market contract are also declining. On average, though, it seems likely that stability and learning will shift the balance in favor of disintegration. Silver's argument[22] is that learning may reduce or leave unchanged the level of vertical integration that minimizes the sum of production and transaction costs; but it would not *increase* the cost-minimizing level. Thus, on average, vertical integration should diminish with stability and learning (SILVER [1984], p. 48). Moreover, it is clear that in the limit – as the system of production becomes completely stable, with no change or qualitative uncertainty[23] to disturb it – most sources of transaction costs disappear, leaving market contracts, with their superior incentive attributes, clearly in the superior position (LANGLOIS [1984]). In this (admittedly unrealistic) world, even such sources of transaction costs as asset-specificity would disappear as contingent-claim markets develop and as behavioral norms appear within the contracting process to help mitigate opportunism.[24] Let us operate, then, on the assumption that stability and learning favor disintegration. Industry maturity – a stable or slowly growing phase of the life-cycle – would then mean decreased internal organization. Finally, a phase of decline would mean reintegration, both because the division of labor is receding and because the transaction costs of change are once again stirred up.

There may also be an intermediate case. In describing the rapid-change scenario, I relied implicitly on the entrepreneurial version of the theory rather than the appropriability version. The source of transaction costs in this story was the information costs of alerting contractors to, and persuading them of the

[22] Which he supports with a graphical analysis that I will not reproduce.

[23] As I argued in LANGLOIS [1984], it is qualitative – what I called "structural" – uncertainty that matters here. Uncertainty of a more routine sort, such as uncertainty about parameters like price or demand, poses no fundamental problems for market contracting. Indeed, HARRIGAN [1985] found empirically that uncertainty about price and demand actually *decreases* the observed level of vertical integration.

[24] On this latter possibility see, e.g., ULLMANN-MARGALIT [1978], SCHOTTER [1981] and AXELROD [1984].

benefits of, the qualitatively new. We could, however, also imagine an industry that is growing and innovating but in which the costs of alerting and persuading potential contracting partners is relatively low. In such an industry, the motives for integration may hinge to a far greater extent on questions of appropriability.

What kind of an industry might this be? One answer is that it may be an industry in which innovation is relatively less radical in some sense. The changes involved may be more or less systemic, but the economic system is not entirely unprepared for them. Indeed, potential contracting parties (and others) may have the capabilities, flexibility, and alertness not only to work with the innovating firm but actually to compete with it. In such an industry, a firm that has its hands into many of the relevant cospecialized activities may be in a better position to appropriate the rents of its innovation – and thus to prosper in the face of competition – than a firm less integrated.[25]

We are now in a position to articulate the refined version of the hypothesis more clearly. There are now two dimensions that matter: the extent of the market and the pace of change. Figure 2 illustrates this.

	Extent of the Market: small	Extent of the Market: large
slow change	Division of labor: low Internal organization: high Example: The highlands of Scotland, 1776.	Division of labor: high Internal organization: low Example: 19th-century gun manufacture.
rapid change	Division of labor: low Internal organization: high Example: Apple Computer, early 1970s.	Division of labor: high Internal organization: high Example: "The Visible Hand." Japanese firms?

Figure 2. The Hypothesis Refined

In the upper-left-hand corner, we have little economic change and a market of small extent. This is the case of largely crafts production from which Smith began, a world exemplified for him by "so desert a country as the Highlands of Scotland," where "every farmer must be butcher, baker and brewer for his own family" (SMITH [1976], I.iii.2, p. 31).

In the upper-right-hand corner, we have relatively slow economic change but a larger market. Here the division of labor is extensive, and the horizontal

[25] There are, of course, methods of coordination intermediate between arm's-length contracting and complete vertical integration. For a particularly illuminating discussion in a relevant context, see IMAI and ITAMI [1984].

division of labor manifests itself as a network of independent contractors connected by market exchange. An example of this might be nineteenth-century firearms manufacture, which was characterized by "inside contracting" to specialized but independent artisans (ALLEN [1929], BUTTRICK [1952]); but there are other examples, dating back at least to the fourteenth-century arsenal of Venice (LANE [1973]).

In the lower-left-hand corner, we have rapid economic change and a small market. The extent of the market here will dominate, making extensive division of labor – and thus extensive contracting – unprofitable. Even in a high-tech world, the firm with a small market for its product is a crafts shop. An example would be any of the small, high-tech startups that have attracted so much attention in the last couple of decades.

Finally, in the lower-right-hand corner, we have rapid economic change and a relatively extensive market. Here we might expect to find the degree of vertical integration higher than in the upper-right-hand box. This may be for reasons emphasized by the entrepreneurial variant of the theory. Much of Alfred Chandler's discussion of the "Visible Hand," the evolution of large, vertically integrated firms in the nineteenth century, is probably consistent with this view (CHANDLER [1977]; and cf. SILVER [1984]). There may also be examples of integration under these conditions that stems from motives suggested by the appropriability variant. One interpretation would locate the success of Japanese microelectronics firms (compared with their American counterparts) in the greater ability to appropriate the benefits of innovation that their more-integrated structure confers upon them.

Path-Dependency

This elaboration of the theory of internal organization under conditions of economic change is clearly somewhat richer than hypotheses that do not distinguish between the effects of change and the effects of the extent of the market. Moreover, this elaboration begins to make room for both the entrepreneurial and the appropriability variants of the theory.

Unfortunately, the result so far is still rather unsatisfactory. Some further elaboration – and some cautions – are in order.

Throughout the essay so far I have operated on the methodological framework standard in transaction-cost analysis. I have assumed that an argument about which form of organization minimizes the sum of production and transaction costs is also immediately an argument about which form of organization we ought to observe under the conditions specified. In fact, of course, this assumption makes sense only with the collateral argument that something is enforcing cost-minimization on the system. To put it another way, we need to assume that some kind of "selection mechanism" is not only operating but operating tightly: organizations that do not minimize the sum of production and transaction costs are somehow more-or-less filtered out.

This is not a wholly unreasonable assumption. It is a fundamental insight of economics that a competitive system incorporates not only an invisible hand but also various kinds of invisible feet that go around prodding the ill-adapted. At the same time, of course, it *is* unreasonable to believe that such selection mechanisms always operate instantly and completely. To the extent that they do not, we may in fact observe to exist forms of organization that do not minimize cost.[26] We may also observe competing forms of organization to co-exist, either because selection pressures have not yet weeded out the inefficient or because the competing forms do not differ much in their survival value.

What this means is that, in a quite specific sense, history matters in the explanation of organizational form. The forms we observe today may be the result not (only) of conditions existing today but also of a constellation of past events. Indeed, if the alternative organizational forms are (or were) relatively similar in survival value, the explanation of the ones now in existence may come down in part to "historical accident", specific events that shunted history onto one track rather than another.[27]

The possibility of path-dependency has already thrown its shadows on our discussion. It appeared in the context of organizational learning. Suppose, I suggested, that rapid change motivates a high degree of internal organization (relative to what we would have expected with the same extent of the market under more tranquil conditions). How, I asked, will stability and learning affect the level of internal organization, all else equal? The tentative verdict was in favor of greater decentralization on balance. But notice that the question hinted at path-depencency. If both the highly organized and the decentralized structure improve in efficiency with learning, and if the advantages of decentralization are modest (either inherently so or because of relaxed selection pressure), might not the degree of internal organization we observe (for a given

[26] The issues here are in fact more complicated even than this. For example, one has to be extremely careful about what one means by cost minimization in a dynamic context. As SCHUMPETER [1942, chapter 8] pointed out, a firm that appears to be inefficient from a static point of view (that is, from a point of view that excludes past and future) may actually be quite efficient from a dynamic point of view. For a more detailed discussion see LANGLOIS [1984, 1986a].

[27] This sort of path-dependency has always been a concern of economic historians. One of these is DAVID [1985, 1986], who has tried to find cases in which, when faced with a choice of competing technologies, history chose essentially by accident – and may not have chosen the more efficient alternative. In some ways, however, his examples are not perhaps as persuasive to theorists as the historian might like. His cases – the choice of the QWERTY layout for the typewriter keyboard or the choice of AC over DC power for electric generation – all hinge on network externalities of a sort that are the meat of neoclassical theory (KATZ and SHAPIRO [1985]). If path-dependency occurs only under such restricted circumstances, then the very peculiarity of QWERTY-like phenomena is actually testimony to the power of selection mechanisms to make history irrelevant. By contrast, the economics of organization may be a field in which path-dependency matters for more general reasons rather than because of theoretically tractable externalities of this sort.

extent of the market) depend crucially on past history? Consider two identical hypothetical industries. In one, change occurs slowly but steadily within a decentralized structure; in the other, market size and technological change come in periodic gulps. We observe the same extent of the market (and probably something like the same division of labor) in both. But the former may have a good deal less internal organization than the latter. And we would not be able to explain the difference without appeal to history.

What makes this all significant is that the possibility of alternative regimes of this sort may not always be so hypothetical. Consider the case of national or regional economies that develop (or enter into a particular technology or market) at different rates. Because of their different starting points, the various competing economies may ride quite different organizational tracks – yet may be equivalently efficient over some period of time. Indeed, the issue arises in a somewhat milder form within any given economy: for might not new entrants choose a different degree of organization from that found in incumbent production?

We can quickly give these abstract questions some life. For it is a central consideration in present-day discussions of international competitiveness that both Europe and Japan found themselves in a technological and institutional position quite different from that of the United States after World War II (ROSENBERG [1982], chapter 12). Devastated by the war, these economies were forced to rebuild both their technological and their organizational capabilities. They naturally looked to the United States for technology; but, both for internal historical reasons and probably for efficiency reasons as well, they often chose organizational structures quite different from those in the United States. In microelectronics, for example, the Japanese industry consists of ten or so large, vertically integrated systems firms, in contrast with a much more diverse and decentralized American industry that includes many small, unaffiliated "merchant" firms (LANGLOIS *et al.* [1988]). In other industries – like automobiles – the picture is more nearly reversed; though large, Japanese car companies are less vertically integrated than their American counterparts, a structure widely held to be one part of the Japanese success story (ALTSHULER et al. [1984], pp. 147–48).

A key issue in all this, it seems to me, is the relationship between technological capabilities and organizational form. One way to look at the issue is in terms of the proximity of an economy to the mythical "technological frontier." This may give us a way of analyzing more carefully the learning properties of relatively decentralized as against relatively integrated regimes. And this in turn may give us a clue to the dynamic properties of the various organizational paths that firms and economies may embark upon.

As NELSON and WINTER [1977] point out, the technological frontier is a place fraught with a quite dramatic and largely qualitative kind of uncertainty. No one knows which technological strategies will work or which working technologies will pay off; the tests are all ultimately empirical. If the frontier is

advancing rapidly, it is a time of surprise and of rapid trial-and-error learning. And diversity – the trying out of many paths – is what keeps the frontier advancing. Under these circumstances, a decentralized structure may have advantages: there is likely to be some duplication of effort if many firms are working in isolation, but there is also likely to be a healthy pluralism of alternatives.[28]

Notice that we are now in the lower-left-hand box of Figure 2. The market is small, and the decentralized firms are all flexible craft shops able to modify the product quickly. As the market expands and the technical winners begin to emerge, the imperative to the subdivision of labor and associated process innovation will gain force. Whether this leads to much vertical integration will depend on the web of complementary activities already in place. For an economy alone at a frontier it created – like Britain in the nineteenth century or the United States after World War II – that web is likely to be woven relatively densely. This means that the entrepreneurial costs of introducing an innovation – even a more-or-less systemic one – are likely to be lower than in an economy not at the forefront.[29]

But it is important to keep in mind that it is often organizational innovation rather than technological innovation that drives economic change. And organizational innovation very often operates *behind* the technological frontier, seizing upon technological possibilities whose outlines are already fairly clear. Sometimes such innovation is revolutionary because it is entrepreneurial – it takes place in the absence of a well-developed network of complementary activities. But sometimes organizational innovation is revolutionary because it *supersedes* an existing – and perhaps passably efficient – web of activities. And sometimes an organizational innovation that owes its origins to the entrepreneurial motive can end up surviving because of its strategic or appropriability attributes.

Consider the case of Japanese microelectronics firms. Although Japan entered the semiconductor business quite early, its firms until recently operated behind the frontier of both product and process technology. They had no need for a structure well-adapted to advancing the frontier; they needed to get there in the first place. For this and other reasons, the Japanese industry developed within a relatively integrated stucture. Since their technology was imitative, system-wide trial-and-error learning was less important. And, since Japan did not possess the web of complementary activities that the United States did (and because Japanese government policy discouraged tapping directly into that web

[28] This also seems to have been Smith's view. See LANGLOIS [1986b].

[29] I tend to think of this situation as akin to what Marshall had in mind when he advanced the idea of "external economies" as an explanation for why industries seem to exhibit decreasing costs even though individual firms ought eventually to encounter increasing costs. The existence of thick markets for complementary assets is a benefit external to the individual firm, though not, of course, to the economy as a whole.

through imports and foreign investment), each Japanese firm needed to generate a good many related activities internally. As the market for Japanese semiconductors grew (spurred by import restrictions and government procurement), the firms subdivided labor, mechanized, and mastered the "experience curve" internally. Japan is now up to the frontier – and ahead of most American firms except probably IBM – in process technology; there is no longer a lack of complementary activities in the Japanese system. But, not only does the integrated structure of the Japanese industry persists, it is displaying a survival value distressing to the American competition. The point, however, is that what called that integrated structure into existence is not what now gives it survival value.

A similar example might be Amercian competition with Britain in the nineteenth century. In small-arms manufacture, for instance, the "American system" of interchangeable parts came to surpass a British system relying more heavily on crafts production. This is normally discussed in terms of the technological innovation of interchangeability; but the real innovation was that Samuel Colt and others applied the techniques of factory production to a greather degree than did British firms. The reasons for this were likely consistent with the entrepreneurial variant: there were far fewer trained craftsmen in the United States. Contrary to popular perception (fostered by Colt) that factory production was cheaper than British crafts production, the reverse was probably true initially (CLARKE 1985). But factory production put the Americans in a position to learn process skills and mechanize more rapidly, so that American firms eventually surpassed the British. The same is probably true of the Japanese in microelectronics: starting from scratch with an integrated structure was originally much more costly than buying the intermediate products from the United States; but it put those firms on a trajectory that allowed them to learn and eventually master high-volume production more effectively. Once again, this is all consistent with Chandler's account of the "Visible Hand": what was important was organizational not technological innovation, and the advantage conferred by internal organization was the ability to learn and perfect mass-production – and to appropriate the rents of doing so.

None of this is to suggest that internal organization of the "Visible Hand" kind must always be superior to decentralized production. The case of the automobile industry seems to be a counterexample. When the visible hand of Henry Ford and others scrunched the young automobile industry together, it put that industry on a path of extensive vertical integration.[30] But here the Japanese success in manufacturing was apparently accomplished with less integration – more subcontracting – than had been prevalent in American

[30] For an analysis of vertical integration in the auto industry before 1940, see ROBERTSON and LANGLOIS [1988].

industry, and the American response seems to be involving an increase in subcontracting (ALTSHULER et al. [1984], p. 148). This should not be surprising.

The manufacture of automobiles is a business in which the basic parameters of product and process are much better known – are changing far less rapidly – than in microelectronics. The costs of market coordination are thus much lower, and the benefits of vertical integration correspondingly less in relation to its costs.

Summary

This paper attempts to synthesize and extend the theory of vertical integration in a regime of rapid economic change. In particular, the paper develops a tentative theory in which the degree of vertical integration in an industry depends on such factors as the extent of the market; the rate of change of the extent of the market; the level of Marshallian "external economies"; and past history. Asset specificity – the variable stressed in the most influential of modern transaction-cost theories – appears as only one strand in a larger tapestry.

Zusammenfassung
Ökonomischer Wandel und die Grenzen der Unternehmung

In diesem Artikel wird versucht, die Theorie der vertikalen Integration innerhalb eines Regimes schnellen ökonomischen Wandels zusammenzufügen und zu analysieren. Insbesondere wird versucht, eine vorläufige Theorie zu entwickeln, in der das Ausmaß der vertikalen Integration in einer Industrie von Faktoren abhängt wie: Größe des Marktes, Änderungsrate der Größe dieses Marktes, Niveau der externen Effekte im Sinne von Marshall, vorausgegangene Entwicklung. „Asset specificity" – die Größe, die in den einflußreichsten modernen Transaktionskostentheorien im Vordergrund steht – erscheint nur als ein Strang in einem größeren Gebilde.

References

ADELMAN, M. [1955], "Concept and Statistical Measurement of Vertical Integration", pp. 281–330, in: *Business Concentration and Price Policy*, Report of a National Bureau of Economic Research Conference, Princeton.

ALCHIAN, A. A. and DEMSETZ, H. [1972], "Production, Information Costs, and Economic Organization", *American Economic Review*, 62, 777–795.

ALLEN, G. C. [1929], *The Industrial Development of Birmingham and the Black Country, 1860–1927*, London.

ALTSHULER, A., ANDERSON, M., JONES, D., ROOS, D., and WOMACK, J. [1984], *The Future of the Automobile: The Report of MIT's International Automobile Program*, Cambridge.

ARROW, K. J. [1975], "Vertical Integration and Communication", *Bell Journal of Economics*, 6, 173–183.

AXELROD, R. [1984], *The Evolution of Cooperation*, New York.

BABBAGE, C. [1835], *On the Economy of Machinery and Manufactures*, London.

BLAIR, R. D. and KASERMAN, D. L. [1978], "Uncertainty and the Incentive for Vertical Integration", *Southern Economic Journal*, 45, 266–272.

–– [1983], *Law and Economics of Vertical Integration and Control*, New York.

BUTTRICK, J. [1952], "The Inside Contract System", *Journal of Economic History*, 12, 205–221.

CASSON, M. [1984], "The Theory of Vertical Integration: A Survey and Synthesis", *Journal of Economic Studies*, 11, 3–43.

CHANDLER, A. D. [1977], *The Visible Hand: The Managerial Revolution in American Business*, Cambridge.

CLARKE, B. N. [1985], *Early American Technology: A Reexamination of Some Aspects of Connecticut's Industrial Development*, Unpublished M. A. thesis, University of Connecticut.

COASE, R. H. [1937], "The Nature of the Firm", *Economica (N. S.)*, 4, 386–405.

–– [1960], "The Problem of Social Cost", *Journal of Law and Economics*, 3, 1–44.

DAHLMAN, C. [1979], "The Problem of Externality", *Journal of Law and Economics*, 22, 141–162.

DAVID, P. [1985], "Clio and the Economics of QWERTY", *American Economic Review*, 75, 332–337.

–– [1986], *Technological System Rivalries: Lessons from History*, Paper presented at the Economic History Association annual meeting, September, Hartford, Connecticut.

DEMSETZ, H. [1969], "Information and Efficiency: Another Viewpoint", *Journal of Law and Economics*, 12, 1–22.

HARRIGAN, K. R. [1985], "Vertical Integration and Corporate Strategy", *Academy of Management Journal*, 28, 397–425.

IMAI, K. and ITAMI, H. [1984], "Interpenetration of Organization and Market: Japan's Firm and Market in Comparison with the U. S." *International Journal of Industrial Organization*, 2, 285–310.

JEWKES, J. [1930], "Factors in Industrial Integration", *Quarterly Journal of Economics*, 44, 621–638.

KATZ, M. L., and SHAPIRO, C. [1985], "Network Externalities, Competition, and Compatibility", *American Economic Review*, 75, 424–440.

KLEIN, B., CRAWFORD, R. G., and ALCHIAN, A. A. [1978], "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process", *Journal of Law and Economics*, 21, 297–326.

KNIGHT, F. [1971], *Risk, Uncertainty, and Profit*, Chicago.

LANE, F. C. [1973], *Venice, A Maritime Republic*, Baltimore.

LANGLOIS, R. N. [1984], "Internal Organization in a Dynamic Context: Some Theoretical Considerations", pp. 23–49, in: M. Jussawalla and H. Ebenfield (eds.), *Communication and Information Economics: New Perspectives*, Amsterdam.

–– [1986a], "Rationality, Institutions, and Explanation", pp. 225–255, in: R. N. Langlois (ed.), *Economics as a Process: Essays in the New Institutional Economics*, New York.

–– [1986b], *Science, Technology, and Public Policy: Lessons from the Classicals*, Paper presented at the American Economic Association annual meeting, December 28, 1986, New Orleans.

–– PUGEL, T. A., HAKLISCH, C. S., NELSON R. R., and EGELHOFF, W. G. [1988], *Microelectronics: An Industry in Transition*, London.

LEIJONHUFVUD, A. [1986], "Capitalism and the Factory System", pp. 203–223, in: R. N. Langlois (ed.), *Economics as a Process: Essays in the New Institutional Economics*, New York.

LEVIN, R. C., KLEVORICK, A., NELSON, R. R., and WINTER, S. G. [1987], "Appropriating the Returns from Industrial R & D", *Brookings Papers on Economic Activity*, **3.**
MAGEE, S. P. [1981], "The Appropriability Theory of the Multinational Corporation", *Annals of the American Academy of Political and Social Science*, 458, 123–135.
MARGLIN, S. A. [1974], "What Do Bosses Do? The Origin and Function Hierarchy in Capitalist Production", *Review of Radical Political Economics*, 6, 60–112.
MOSS, S. [1984], "The History of the Theory of the Firm from Marshall to Robinson and Chamberlin: the Source of Positivism in Economics", *Economica*, 51, 307–318.
NELSON, R. R. and WINTER, S. G. [1977], "In Search of Useful Theory of Innovation", *Research Policy*, 5, 36–76.
–– [1982], *An Evolutionary Theory of Economic Change*, Cambridge.
PENROSE, E. [1959], *The Theory of the Growth of the Firm*, Oxford.
POLANYI, M. [1958], *Personal Knowledge*, Chicago.
RICHARDSON, G. B. [1972], "The Organisation of Industry", *Economic Journal*, 82, 883–896.
ROBERTSON, P. L. and LANGLOIS, R. N. [1988], *Innovation and Vertical Integration in the American Automobile Industry, 1900–1940*, paper presented at the Economic History Association annual meeting, September 24, Detroit.
ROSENBERG, N. [1976], *Perspectives on Technology*, New York.
–– [1982], *Inside the Black Box: Technology and Economics*, New York.
SCHOTTER, A. [1981], *The Economic Theory of Social Institutions*, New York.
SCHUMPETER, J. A. [1934], *The Theory of Economic Development*, Cambridge.
–– [1942], *Capitalism, Socialism, and Democracy*, New York.
SILVER, M. [1984], *Enterprise and the Scope of the Firm*, London.
SMITH, A. [1976], *An Inquiry into the Nature and Causes of the Wealth of Nations*, Glasgow Edition. Oxford.
STIGLER, G. J. [1951], "The Division of Labor is Limited by the Extent of the Market", *Journal of Political Economy*, 59, 185–193.
TEECE, D. J. [1982], "Towards an Economic Theory of the Multiproduct Firm", *Journal of Economic Behavior and Organization*, 3, 39–63.
–– [1984], "Economic Analysis and Strategic Management", *California Management Review*, 26, 87–110.
–– [1986a], "Firm Boundaries, Technological Innovation, and Strategic Management", pp. 187–199, in: L. G. Thomas (ed.), *The Economics of Strategic Planning*, Lexington, Mass.
–– [1986b], "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing, and Public Policy", *Research Policy*, 15, 285–305.
ULLMANN-MARGALIT, E. [1978], *The Emergence of Norms*, New York.
WILLIAMSON, O. E. [1985], *The Economic Institutions of Capitalism*, New York.

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