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CHAPTER 9

Capitalism and the factory system

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9.1 Introduction

Economic theorizing utilizes, on the one hand, mathematical techniques and, on the other, thought experiments, parables, or stories. Progress may stagnate for various reasons. Sometimes we are held back for lack of the technique needed to turn our stories into the raw material for effective scientific work. At other times, we are short of good stories to inject meaning into (and perhaps even to draw a moral from) our models. One can strive for intellectual coherence in economics either by attempting to fit all aspects of the subject into one overarching mathematical structure or by trying to weave its best stories into one grand epic.

This chapter attempts to revive an old parable, Adam Smith's theory of manufacturing production, which has been shunted aside and neglected because it has not fitted into the formal structure of either neoclassical or neo-Ricardian theory. The discussion attempts to persuade not by formal demonstrations (at this stage) but by suggesting that the parable can illuminate many and diverse problems and thus become the red thread in a theoretical tapestry of almost epic proportions.

The subject may be approached from either a theoretical or a historical angle. Regarding the theoretical starting point, it is possible to be brief since the familiar litany of complaints about the neoclassical constant-returns production function hardly bears repeating. The one point about it that is germane here is that it does not describe production as a process, that is, as an ordered sequence of operations. It is more like a recipe for bouillabaisse where all the ingredients are dumped in a pot, (K, L), heated up, $f(\cdot)$, and the output, X, is ready. This abstraction from the sequencing of tasks, it will be suggested, is largely responsible for the well-known fact that neoclassical production theory gives us no

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clue to how production is actually organized. Specifically, it does not help us explain (1) why, since the industrial revolution, manufacturing is normally conducted in factories with a sizable work force concentrated to one workplace; (2) why factories relatively seldom house more than one firm; or (3) why manufacturing firms are capitalistic in the sense that capital hires labor rather than vice versa.

9.2 Revolutions: agricultural and industrial

The story of the industrial revolution has often been told around the theme of technical invention and innovation in spinning and weaving, in steel making and power generation, in freight transportation, and so on. Similarly, the agricultural revolution that preceded it sometimes seems just a long catalogue of new crops, new rotations, new ways to drain or fertilize land, new techniques of selective breeding, and the like.

If one looks at the two revolutions from the standpoint, not of technological history, but of a new institutional history, the agricultural revolution becomes primarily the story of enclosures and the industrial one the story of the coming of the factory system and, eventually, of the joint-stock corporation.

It is customary in standard treatments of eighteenth-century English economic history to hail both these organizational developments as obvious examples of progress. Carl Dahlman (1980, pp. 209–10) has pointed out that the juxtaposition of the two poses something of a paradox, for one process seems to be almost the reverse of the other. The reorganization of agriculture, known as the enclosure movement, was a move away from the collective "team" working of village land. Each family ended up working their own farm. Correspondingly, it required the unscrambling of joint-ownership rights in land held in common (and of obligations owed to the collective). In the somewhat later reorganization of manufacturing we have the reverse. The coming of the factory was a move toward collectively organized modes of production. It replaced the family-firm craftshop and the putting-out system. The craftshop run by a master craftsman with a couple of journeymen and apprentices and with family helpers had been the dominant type of manufacturing business since the early Middle Ages. Under the putting-out system, an entrepreneur "put out" materials for processing at piece rates by workers who usually worked at home. The factory pulled the work force in under one roof. Later on, the limited liability manufacturing corporation arose to pool individual titles to physical capital in the joint-stock arrangement.

Thus the Dahlman paradox: What is progress in manufacturing is backwardness in agriculture and vice versa! The open field system and enclosures are admirably analyzed in Dahlman's book. The present inquiry concerns the factory system.

9.3 The factory system

Contemporaries tended, of course, to marvel at the new inventions and to be deeply impressed by the (very visible) role of fixed capital in the new factories. The most prominent features of the factories were (a) the size of the work force in one and the same workplace, and (b) the new machinery. The impulse has been to explain (a) by (b), that is, to take for granted that the novel spinning frames, weaving looms, steam engines, and the other new machinery made the explanation for factory organization of the work almost too obvious to require explicit comment.

Some histories of the industrial revolution have taken the line that the new machinery explains the factories. The point has been made, for example, that the early steam engines, with their low thermal efficiency, were very large, stationary ones; consequently, if one wanted to utilize steam power, one had to pull a sizable labor force in under one roof and run the various machines of the factory by belt transmission from a single source. The answer suggested in this sort of illustration is that the new technologies introduced obvious economies of scale (e.g., in power generation) that led quite naturally to large-scale factory production.

Economies of scale were obviously one aspect of the story. But they do not make the whole story. Some 150 years later, small-scale electrical motors removed the basis for the particular type of scale economy just adduced – but did not, of course, thereby undermine the factory system. (At the same time, the economies of scale in generating electricity were even more formidable than they had been in steam power.) We might also check some centuries earlier. The fourteenth-century arsenal of Venice was one of the wonders of the world for the size of the labor force concentrated in it. Yet, the organization of shipbuilding in the arsenal was not that of a single firm; instead, numerous craftsmen, owning their own tools, each with a few journeymen and apprentices, operated within the arsenal and cooperated via exchange transactions in the building and outfitting of ships. In short, the famous arsenal was not a factory and not a firm.[1]

[1] See Lane (1973, esp. pp. 162–5). Production by small firms inside a larger facility remained an important organizational form in manufacturing into this century. A famous example is the Winchester Repeating Arms Company, which operated in this manner until the outbreak of World War I. See Buttrick (1952).

There are other examples of large work forces in one location before the industrial revolution. Large woolen manufacturing workshops existed in England since at least the beginning of the sixteenth century. Their size would not have been dictated by machine technology.[2] Although medieval mining was in general organized as independent partnerships of miners, by the sixteenth century, deeper mineshafts with dangerous ventilation and drainage problems raised the capital requirements in mining beyond the means of artisan miners. The mines became capitalist firms. Alum, bricks, brass, and glass were seventeenth-century examples of technology dictating production in sizable establishments.[3] In these instances, the workplaces were factories and were firms.

The putting-out system was also replaced by the factory system. It exemplified capitalist control of production often without capitalist ownership of the means of production.[4] The organization could be large but the workplaces were, of course, small.

It is not all that obvious, therefore, what role should be assigned to indivisible machinery in explaining the emergence of the factory as the dominant form of manufacturing enterprise. Some questions remain. Why, for example, did not the steam engine simply lead many independent masters to locate in the same workplace (and, perhaps, pay rent for the right to attach their new-fangled machines to the overhead steam-powered shaft)?[5]

9.4 The classical theory of the division of labor

There is one contemporary observer whom economists might be particularly inclined to pay attention to, namely, Adam Smith. The *Wealth of*

[2] See Mantoux (1962, pp. 33–6). Mantoux was not willing to count the royal manufactories sponsored by Colbert in France as forerunners of the industrial factory system, mainly because they required royal subsidies or patronage for their continued existence.

[3] Nef (1934). Nef also discusses large plants, such as cannon foundries, in various metallurgical branches.

[4] That is, the individual weaver might own his own loom, for instance. The jobber would own the working capital (the materials).

[5] It was tried: "In the Coventry silk weaving industry the experiment of 'cottage factories' was tried. In the centre of a square surrounded by rows of cottages, an engine-house was built and the engine connected by shafts with the looms in the cottages. In all cases the power was hired at so much per loom. The rent was payable weekly, whether the looms worked or not. Each cottage held from 2 to 6 looms; some belonged to the weaver, some were bought on credit, some were hired. The struggle between these cottage factories and the factory proper lasted over 12 years. It ended with the complete ruin of the 300 cottage factories" (Marx 1906, p. 503). Marx mentions other examples "in some of the Birmingham trades."

Nations is, of course, a bit early (1776) for the mechanized, steam-powered, relatively fixed-capital-intensive factory system to have become established as the wave of the future. Even so, it is worth remembering that Smith did *not* dwell much on machinery as one of the "Causes of Wealth." Instead, of course, he made the "*division of Labour*" his grand theme. In fact, Smith (1776 [1937, p. 9]) does treat the role of machinery as important but as secondary and subsidiary to increasing division of labor in his account of economic progress:[6]

> [E]very body must be sensible how labour is facilitated and abridged by the application of proper machinery. It is unnecessary to give any example. I shall only observe, therefore, that the invention of all those machines by which labour is so much facilitated and abridged, seems to have been originally owing to the division of labour.

The classical theory of the division of labor was greatly advanced by Karl Marx in *Das Kapital*.[7] In his day, of course, the factory system was the wave of the present. Marx made the use of machinery the criterion of modern industry, which he associated with factories. At the same time, however, he emphatically agreed with Smith that mechanization followed from the division of labor.[8] In Marx's (1906, p. 369) historical schema, capitalism was subdivided into a manufacturing period ("from the middle of the 16th to the last third of the 18th century") and the subsequent modern industrial epoch. Manufacturing, in Marxist terminology, resulted from applying the principles of the division of labor to as yet unmechanized industry.

In Smith's famous pin-making illustration of the benefits of the division of labor, two modes of organizing production were contrasted.

[6] See also Smith ([1776] 1937, p. 86): "The greater their number, the more they naturally divide themselves into different classes and subdivisions of employment. More heads are occupied in inventing the most proper machinery for executing the work of each, and it is, therefore, more likely to be invented." And, of course, the opening paragraph itself (p. 1): "The greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity, and judgment with which it is any where directed, or applied, seem to have been the effects of the division of labour."

[7] Marx (1906, Pt. IV, Chaps. XIV, XV, pp. 368–556). This is, of course, a far more extensive treatment than we find in Smith. It is far superior to that of J. S. Mill, who had little of any interest to add to Smith. See *Principles*, Book I, Chaps. VIII and IX:1 (Mill 1964, pp. 116–36.) It is worth noting, however, that Mill (pp. 132, 135) too shared the opinion of Smith and Marx that the advantages of division of labor had precedence over "the introduction of processes requiring expensive machinery" among the "causes of large manufactories."

[8] Kenneth Sokoloff's (1983) study of a large 1832 sample of manufacturing firms in the U.S. northeast finds that "the evidence serves to undercut the notion that the early period of industrialization was based on a proliferation of new, machinery-intensive technologies."

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    a1    a2    a3    a4    a5

b1      b2    b3      b4    b5 – artisan b in crafts
                                 production
  c1 c2     c3 c4      c5

  d1      d2 d3     d4  d5

        e1   e2   e3    e4   e5
x ------------------------------------------→ time
```

Figure 9.1. Crafts production.

Prejudging matters a little, let us call them crafts production and factory production, respectively.[9]

In *crafts production,* each craftsman sequentially performs all the operations necessary to make a pin. In *factory production,* each worker specializes in one of these operations so that "the important business of making a pin is, in this manner, divided into about eighteen distinct operations which, in some manufactories, are all performed by distinct hands"[10] (Smith 1937, p. 4–5).

Suppose, for illustration, that we have five craftsmen producing a product that requires five successive operations. These must be undertaken in temporal sequence, running from left to right in Figure 9.1. Here each artisan is working at his own pace and the individuals differ in (absolute and comparative) skill across the different operations.

Suppose, next, that we simply rearrange the work in some given workshop as indicated in Figure 9.2. People who previously worked in parallel now work in series. Worker b now performs only operation 2 but does so on all units of output produced by the team. Each individual now has to work at the pace of the team. This, obviously, makes supervision of work effort easier. Note, however, that we do not change the engineering descriptions of the operations performed, we do not change the tools used, and we do not change the people involved. We

[9] Marx's distinction between "manufacturing" and "factory production" is a perfectly good and useful one. It is omitted here so as not to burden the discussion with too much terminological baggage.

[10] Everyone recalls his calculation: "Those ten persons, therefore, could make among them upwards of forty-eight thousand pins in a day." Marx checked on pin making in his own day: "[A] single needlemachine makes 145,000 in a working day of 11 hours. One woman or one girl superintends four such machines and so produces near upon 600,000 needles in a day" (Marx 1906, p. 502). The most recent report is Pratten (1980): Today, one operative supervising 24 machines, each of which turns out 500 pins per minute, will make about 6 million pins in a day.


```
a1  b2  c3  d4  e5

    a1  b2  c3  d4  e5

        a1  b2  c3  d4  e5

            etc. . . .
x ----------------------------→ time
```

Figure 9.2. Factory production.

might expect output to be unchanged as well, therefore. Yet both Smith and Marx would tell us to expect a large increase in productivity from this reorganization of the work.

The sequencing of operations is not captured by the usual production-function representation of productive activities; nor is the degree to which individual agents specialize. A production function simply relates a vector of inputs to one or more outputs without specifying the method by which the tasks involved are coordinated. Thus Smith's division of labor – the core of his theory of production – slips through modern production theory as a ghostly technological-change coefficient or as an equally ill-understood economies-of-scale property of the function.[11]

The economies achieved by switching from crafts to factory production arise from increased division of labor. In the above example, labor was entirely undivided to begin with, so that the conversion takes us from individual production to *team* production. There are three aspects to this that deserve comment. First, the specialization of labor in team production will require *standardization of product.* Under crafts production, in contrast, the skills and care of individual artisans will be reflected in nonstandard output. Second, serial production requires coordination of activities in the sense of the *time phasing* of the inputs of individual workers. Third, the labor of individual workers become *complementary* inputs. If one work station on an assembly line is unmanned, total product goes to zero.

So far we have supposed that the number of workers and the tools are unchanged and that the only change arises from their improved coordi-

[11] Professor Georgescu-Roegen especially stresses the failure of neoclassical production theory to illuminate the fundamental difference between manufacturing processes and agricultural production processes where nature dictates the time phasing of operations. See Georgescu-Roegen (1972), which is reprinted (with several other essays germane to our subject) in Georgescu-Roegen (1976).

nation. But it is obvious that the conversion from crafts to factory production will present opportunities to economize on inputs.[12]

The switch is *capital-saving.* This is an aspect easily missed. The reorganization of production undertaken to increase the division of labor will very often also create opportunities for mechanizing some stage of the process. Hence what we tend to observe is that an increase in fixed capital takes place at the same time. The impression we are left with is that productivity increases are normally due to more capital-intensive technology being adopted.[13] But the pin-making illustration is a counterexample.

In crafts production, each artisan would be equipped with a full complement of pin-making tools. Suppose, for simplicity, that there is a different tool for each of the five stages in the series. Then, four out of five tools are *always idle* when artisans work in parallel under crafts production.[14] In factory production, only one complement of tools is needed, not five.[15]

It is possible that the more decisive capital-saving incentive may be the opportunity to economize on goods-in-process inventories. Suppose that, under crafts production, considerable time (and concentration) is lost in switching from one task to the next. A master craftsman with a thick enough market to allow him to produce in batches would then perform operation 1 x times, before moving on to operation 2, and so on. If his dexterity (as the classical writers used to say) at each task were equal to that of the specialized factory worker, the factory's competitive edge would lie mainly in its lower working-capital requirements. Economizing on goods-in-process is likely to have been particularly important in the evolutionary struggle between the factory and the putting-out system.

[12] Sokoloff has mustered impressive evidence on the efficiency advantages of small, nonmechanized factories over craftshops in the early industrialization of the American northeast. His estimates of total factor productivity show "factories" with more than five employees to be more than 20 percent more productive than artisanal shops. See Sokoloff (1984, secs. III, IV).

[13] Events will sometimes challenge that impression. Swedish economists will recall the Horndal effect (so named by Erik Lundberg). Horndal was a steel mill considered outdated by its controlling corporation, which intended to concentrate production in its more modern plants. Investment in Horndal was therefore stopped altogether. The expectation, of course, was that in a couple of years the mill would not cover variable costs. To the consternation of observers, however, the rate of productivity growth in Horndal kept pace with that of the rest of the industry for many years (Lundberg 1959, pp. 663–4).

[14] It was in fact normal for each craftsman (guild member) to own the tools he was using.

[15] See John Rae (as quoted by Mill 1964, p. 129): "If any man had all the tools which many different occupations require, at least three-fourths of them would constantly be idle and useless."

The switch to factory production will also save on *human capital.* No worker need possess all the skills required to make a pin from beginning to end. Under crafts production, each individual has to spend years of apprenticeship before becoming a master pin maker. In factory production, the skills needed to perform one of the operations can be quickly picked up. The increased productivity resulting from specialization on simple, narrowly defined tasks is the advantage arising from increased division of labor most emphasized by the classical economists. Correspondingly, the decreased investment in human capital is the disadvantage that most concerned them.

9.5 Horizontal and vertical division of labor

There are two dimensions along which the division of labor may be varied. Adam Smith drew examples from both (without, however, making the distinction clear). The manufacture of pins illustrates what we will call *vertical* division of labor. Recall his observation that "in so desert a country as the Highlands of Scotland, every farmer must be butcher, baker and brewer for his own family." When the growth of the market turns slaughtering, baking, and brewing into specialized occupations, we have examples of *horizontal* division of labor.

The distinction is seldom drawn in the literature. This may be in part because those authors, who see the advantages of division of labor as deriving primarily from the concentration of time, experience, and ingenuity on part of individuals on a narrower range of tasks, are looking simply for *all* the differentiations of functions that the expansion of markets will allow. Charles Babbage (1833, pp. 175–6) improved on Smith's statement of the division of labor by making clear how functional differentiation brings comparative advantage into play also inside the individual firm:[16]

> That the master manufacturer, by dividing the work to be executed into different processes, each requiring different degrees of skill or force, can purchase exactly that precise quantity of both which is necessary for each process; whereas, if the whole work were executed by one workman, that person must possess sufficient skill to perform the most difficult, and sufficient strength to execute the most laborious, of the operations into which the art is divided.

But there are reasons for making the proposed distinction. An increase in the vertical division of labor requires less skilled labor at the various stages of the manufacturing process. Increased horizontal division of

[16] Babbage found that priority for this statement of the advantages of division of labor belonged to Gioja (1815).

labor does not in general carry this implication and is perhaps more likely to mean an increase in human capital per worker. Furthermore, increased horizontal division is a question simply of *minimum economical scale*, whereas vertical division of labor results from an increasing-returns-to-scale technology.

This implication of pin-making technology may be another reason why the distinction is most often fudged, particularly in the neoclassical literature. Stigler ([1951] 1968, p. 129), in his famous article on the subject, notes the dilemma bequeathed by classical to neoclassical theory:[17]

> Either the division of labor is limited by the extent of the market, and, characteristically, industries are monopolized; or industries are characteristically competitive, and the theorem is false or of little significance. Neither alternative is inviting.

Marx saw the significance of the distinction very clearly. The consequences of expansion of the market for a branch of manufacturing, he pointed out, would depend upon the technology. He distinguished two "fundamental forms," namely, "heterogenous manufacture" and "serial manufacture." The latter, of course, was exemplified by Smithian pin making and offered opportunities for vertical division of labor. As an example of the former, Marx used watch manufacturing. All the parts of a watch could be separately manufactured for final assembly. This "makes it . . . a matter of chance whether the detail labourers are brought together in one workshop or not." Heterogeneous manufacture might be carried out under the putting-out system, therefore (Marx 1906, pp. 375ff).

9.6 Social consequences

The competitive impetus to exploit the economies afforded by vertical division of labor would seem to explain, therefore, many of the social consequences of the nineteenth-century factory system that have been the object of so much adverse sociological commentary:[18]

1. When labor is subdivided vertically, less skill is required, less versatility as producer is acquired by the individual worker. The use of child labor at some work stations often becomes feasible.[19]
2. No normal prospect of promotion or improvement in social status is to be expected; the unskilled workman does not become a master of his guild by sticking to his job for many years.
3. More discipline is required and of a sort that most people will find irksome and that most rural emigrants would have to be taught; you cannot work at your own pace, you have to be on time; random absenteeism must be subject to relatively severe sanctions.
4. "Alienation from the product": No worker can take personal pride in the output or its quality.

[17] Compare Arrow (1979, p. 156): "This dilemma has been thoroughly discussed: it has not been thoroughly resolved." But, surely, there is no genuine dilemma – just our obstinate collective refusal to draw the obvious conclusion and allow the empirical reality of increasing returns to displace the convenient construct of "perfect competition."

[18] See especially Thompson (1967).

Considerations of this sort do not give one grounds for blundering into the much controverted subject of the development of standards of living during the industrial revolution in Britain. The point to be made is simply that the competitive pursuit of the productivity gains afforded by the vertical division of labor will explain many of those conditions in industry that were criticized by contemporary observers.

9.7 The extent of the market

In our simple five-worker example, a doubling of output under crafts production will require a doubling of all inputs. Under factory production, some economies of scale will *normally* be present. In factory production, "the division of labor depends on the extent of the market" – and so, therefore, do the scale economies that can be realized. These will be of two kinds.

9.7.1 Parallel-series scale economies

Suppose, in the example, that one of the workers (worker *d* at work station 4, let's say) is *idle* half the time after conversion to factory production. Then double the output can be had with nine workers, and the flow of work would be organized as in Figure 9.3.

This is the source of increasing returns emphasized by Georgescu-Roegen (1972) as almost universally present in manufacturing – but not, as all the classical economists agreed, in agriculture. Even on the sophisticated assembly lines of a large-scale factory some factor ("fund"

[19] Golden and Sokoloff (1984) find that, in the first half of the nineteenth century, even quite small factories (with five or more employees) were giving a greater share of jobs to women and children than did artisanal shops.

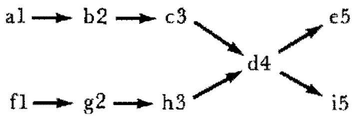

Figure 9.3. Parallel assembly lines.

in Georgescu-Roegen's terminology) is almost bound to have an input stream that is not perfectly continuous. Babbage's "master manufacturer" cannot always divide the work so as to "purchase exactly that precise quantity" of the services of the factor that is technically required to produce his output. A machine that is idle half the time cannot be replaced by half a machine employed all of the time. But it may be possible to double its utilization rate if, say, the machine can be shared between two parallel assembly lines *and* the firm can sell twice the output.

These parallel scale economies are probably never totally exhausted. In our five-stage example, it might be found, for instance, that worker b is busy only 80 percent of the time, in which case a quintupling of output can be had with only a quadrupling of stage 2 workers. And so on. But it is clear that, if we keep the number of serial stages constant, these economies of parallel replication become less and less significant as output is increased. It can in fact be shown that this is a case of assymptotically constant returns (although with a nonmonotonic approach to the assymptote).[20]

9.7.2 *Longer-series scale economies*

Smith, Marx, and Mill, however, were thinking more of another source of economies of scale, namely, increased vertical division of labor. As the extent of the market grew, opportunities would arise, they thought, for further efficient subdivision of the production process into a greater number of serial tasks. This vertical differentiation would not only be efficient in itself but, as it proceeded, it would open up new possibilities for exploiting scale economies of the Georgescu-Roegen kind.

[20] Sokoloff's data suggest that, for nonmechanized factories deriving their competitive advantage solely from the division of labor, economies of scale would tend to be very nearly exhausted already in the size range of six to fifteen employees and totally exhausted at twenty. (For the already mechanized textile industries, the scale economies were much stronger and remained significant up to a far larger scale.) (Sokoloff 1984, sec. III)

9.8 Mechanization and division of labor as a "discovery procedure"

As one proceeds with the analysis of this classical division-of-labor theory, it increasingly escapes the analytical categories of static neoclassical production theory. The classical theory becomes a theory of an *evolutionary process*, rather than a theory of the rational choice between known alternatives.

Recall that Smith and Marx both insisted that the new division of labor *preceded* the mechanization of industry. They also thought that one *led to* the other, and they thought it rather obvious what the causal link was: As one subdivides the process of production vertically into a greater and greater number of simpler and simpler tasks, some of these tasks become so simple that a *machine* could do them. The mental task of analyzing the production process so as to carry through the division of labor leads to the *discovery* of these opportunities for mechanization. Once the principles of the division of labor are mastered, the discovery of how industry can be mechanized follows.

Mechanization, in turn, will renew the sources of economies of scale. Suppose each stage of what was previously a five-stage process is subdivided into two. Suppose further that it is then discovered that stage 4b can be mechanized. But at the old scale of the enterprise, the 4b machine may be idle 90 percent of the time. In that case, the most economical scale of production has multiplied tenfold.

9.8.1 *Differentiation of function: capital and labor*

The process leads to increasing functional differentiation of both capital equipment and labor. But in one respect the consequences are quite different – and it turns out to be a socially important respect.

Although the tasks that become mechanized tend to be quite simple, completely standardized tasks, the machines very often will be extremely specialized to doing just this one task (or series of tasks) in the production of just one product. This means that they may have no alternative employment. This differentiation of equipment can be observed also in simple handtools:

> [S]o soon as the different operations of a labour-process are disconnected the one from the other, and each fractional operation acquires in the hands of the detail labourer a suitable and peculiar form, alterations become necessary in the implements that previously served more than one purpose. . . . In Birmingham alone 500 varieties of hammers are produced, and not only is each adapted to one particular process, but several varieties often serve exclusively for the different operations in one and the same process. (Marx 1906, pp. 374–5)

In the course of this vertical subdivision of the production process, *labor becomes increasingly unskilled.* The sociocultural consequences are disturbing. Adam Smith gradually became so convinced that the division of labor tended to produce an unskilled, illiterate, brutalized proletariat that in the end his *Wealth of Nations* contained two views of the division of labor (West 1964; Rosenberg 1965). In the early chapters, it was The Source of the Wealth of Nations. Toward the end of the book, it became the ruination of the laboring classes. This outlook Marx took over.

From the more narrowly economic standpoint, the vertical subdivision of production makes the machines functionally more specialized or dedicated. A particular machine, as a consequence, may have few alternative uses but is also not easy to replace. With labor, the result is rather different. The individual worker becomes a detail laborer, that is, specialized in the sense that, when at work, he performs only one task. But the task is an unskilled one. The worker, consequently, can be easily replaced and can also easily qualify for alternative tasks. Thus, increasing specialization has quite different implications for the competitive position of capital and of labor, respectively. We will return to this point shortly.

9.9 American and Japanese traditions in production management

The American tradition in production management has made the most of the static advantages of the division of labor: minimal human capital requirements, maximum dexterity in the performance of individual tasks, and minimal time lost in switching between tasks – these are the principles stressed on Henry Ford's assembly lines and in Taylorite time-and-motion studies.

Apparently, Japanese production management violates all of these principles. Each member of a production team is supposed to learn every work station on the assembly line. Human capital input is maximized rather than minimized. But the dynamics of the Smithian evolutionary process are improved. The Japanese teams are better at discovering potential improvements in both products and methods.

9.10 The capitalist firm

Consider next an idyllic thought-experiment of so-called *team production:*[21] A number of individuals come together for the purpose of producing a particular commodity. In the "Original State," we suppose, there are no marked distinctions of wealth, power, or status among these people. Some of them will contribute their skills and labor, others will commit themselves to bring machines to the joint enterprise.

[21] Inspired by Alchian and Demsetz (1972).

We may assume that they will decide to take advantage of the Smithian economies of vertical division of labor and so set up production in the form of a single, long assembly line. For simplicity, let there be stages of production, machines, and operatives – one per machine. The product could also be produced by individual artisans using a set of simple handtools or in k shorter assembly lines of n/k workers using less-specialized machines. But we presume, with Smith and Marx, that by setting up on one long assembly line, the collective effort will produce a larger output with the same resources.

The questions are: How many firms will there be? Will the typical firm be a capitalist one? If so, why?

One can imagine the possibility of successive firms, each one buying the output of the stage preceding and selling to the stage succeeding. In half of these firms (one might also imagine), the owner of the machine hires the operative and pays wages, whereas in the other half the worker rents the machine he or she is working with. But these imaginings, of course, fit singularly ill with the ways in which we find modern manufacturing to be organized.

Since the team utilizes the economies of scale due to the division of labor, the enterprise earns a joint rent (or a surplus, if you will). Total sales proceeds exceed the sum of the earnings that the inputs would find in alternative employments. The joint rent is a Ssssnake in this paradise. For how is it to be divided? In our illustration, all the inputs are assumed to be strictly complementary. If one machine is withdrawn from the assembly line, total output falls to zero. If one worker is missing, the consequence is the same. Marginal productivities will not supply the criteria for the distribution of product.

The division of the joint rent becomes a bargaining problem. Let the members of the collective form coalitions among themselves and bargain against the rest. How well might the various coalitions do? How stable would we expect them to be?

Consider first how the bargain might go between the machine owner (capitalist) and the operative (labor) at one of the work stations on the presupposition that the total sum going to this work station has somehow been arrived at. Each can threaten the other to withhold input so that their joint income will go to zero. But the bargaining situation is not symmetrical. There are plenty of unskilled laborers in the market, but few if any substitutes for the specialized machine. This might make us suspect a tendency for the capitalist to walk away with the joint rent, leaving the laborer with a wage equal to alternative earnings. But there is also another asymmetry: The unskilled laborer has many, the specialized machine few, alternative employment opportunities. If, therefore, the laborer could threaten to "fire" the machine, the worker's bargaining position would be very strong indeed. The question becomes who can fire and replace whom? Or: Who owns the work station, the machine owner or the operative?

To get a clue to this question, consider the bargaining situation among the capitalists. Each machine owner can threaten to reduce output and, therefore, everyone else's earnings to zero[22] – until a replacement for the machine can be found. But, again, the market for very specialized machines will be thin, so replacements – and alternative employments – for them are hard to find. Any agreement about the division of earnings among the machine owners would be extremely unstable.[23] So unstable, in fact, that some organization of production that avoids the complementarities between the highly specialized inputs of cooperating owners might be preferred – even at the cost of foregoing the advantages of the division of labor. To sink one's capital into these dedicated machines will not appear to be an attractive investment – unless some stable organizational form can be found.

The solution, of course, is to prevent individual capitalists from owning and controlling specific machines. Instead, a firm is formed and any capitalist who joins has to give up ownership of his machines and accept shares in the firm. Thus the assembly line is vertically integrated into one firm.[24] We might find a market gap between firms along the production chain at some stage where the market in the intermediate product issuing from the stage is thick enough so that firms on both sides of the gap are safe from hold-ups.

The formation of a firm as a solution to the machine owners' bargaining problem has one additional advantage (for them): It creates a cartel

[22] In the literature on vertical integration, this is familiar as the postcontractual "opportunistic behavior" of Williamson (1975) or the "hold-up" problem of Klein, Crawford, and Alchian (1978).

[23] Technically speaking, the core is empty since every distribution can be blocked. (It does not seem helpful to insist that the empty core is a transaction-cost problem.) I am especially grateful to Dan Friedman for clarifying the structure of the bargaining situation for me.

[24] That the integration should be vertical does not seem to be necessary in general. In Dahlman's theory of the open field system, avoidance of the hold-up problem explains why the scattering of strips was maintained over the centuries. With arable strips scattered, the individual farmer could not, in some dispute over communal production or distribution issues, threaten to withdraw and thereby to reduce the benefits of scale economies to the village as a whole (Dahlman 1980, pp. 120–30 and 135–8).

of capitalists that bargains as one unit against workers. This cartel will own the work stations. It can fire and replace workers; the workers cannot threaten to fire and replace the dedicated machines. The nonunionized worker is not going to come out of that contest with any part of the joint rent (unless, of course, he or she has some firm-specific capital). As long, at least, as unions can be kept illegal, the factory owners will continue to appropriate all the rent.

Unionization will look like labor's best bet in this situation. Workers cannot pool their labor power, as the capitalists pool their physical capital, in order to hire the machines at a rental that would leave the joint rent going to the workers of the labor-managed firm. Labor will not be owned and specialized machinery is not for hire. The producer cooperative is a possible compromise form but, on the whole, successful enterprises started as worker partnerships are going to end up owning capital and hiring labor – which is to say, end up as capitalist firms. Unions that do succeed in capturing part of the joint rent, on the other hand, might thereby discourage capital accumulation and the further productive subdivision of labor and hence weaken the competitive position of the enterprise over the longer run.

The labor union is a subject on which economics has a less than secure grasp. In neoclassical economic theory, unions are just another pernicious form of monopoly. The alternative "labor relations" tradition tends to reject economic theory and to draw lessons more friendly to unions from labor history. Perhaps the view of the manufacturing firm presented here might provide ground on which theoretical and historical analysis could finally meet?

9.11 Fluctuations and growth

Our representation of the pin-making technology is so simple as to be little more than a metaphor. It is obviously capable of considerable formal elaboration.[25] But at this point the question is whether there are good reasons to prefer it to that other simplistic metaphor, the neoclassical production function. The Smithian production function may well have advantages in areas other than the ones discussed in this essay. It may be worthwhile, in conclusion, to indicate some of these potential applications.

One of the mainstay stylized facts of applied macroeconomics is that employment in manufacturing fluctuates less than proportionally to output over the business cycle. Most macroeconomic models assume a

[25] An attempt in this direction is made in Ippolito (1977).

neoclassical constant-returns-to-scale technology and most macroeconomists explain the Okun's law phenomenon as reflecting the hoarding of labor, in particular of workers with firm-specific skills, during recessions. According to this hoarding hypothesis, firms keep workers on during recessions, although they are not needed in production, in order to make sure their skills are available when business picks up again.

The Smithian increasing-returns technology suggests a competing hypothesis. Firms that utilize the scale economies of parallel series (Figure 9.3) will reduce output by shutting down, say, one assembly line of two. But the work station that the two lines have in common cannot be left unmanned. Thus, half the work force cannot be laid off when output is cut in half.[26] By the same token, the laid-off worker cannot by cutting his or her own wage get the line started up again. Individuals are not able by marginal wage-cutting to expand the number of production jobs being offered at the factory in recession.[27]

When the Extent of the Market determines the Division of Labor, economic growth will bring productivity gains. The growing economy will show increasing division of labor not only within firms but among firms. The economy becomes more complex as it expands. When, in our simple illustration, the work of the five artisans was reorganized into a five-man factory, the production process became more complex in the straightforward sense that the number of people cooperating in making any given unit of output increased. It is this increasingly complex coordination (when it can be maintained!) of larger and larger numbers of specialists that shows up as increasing productivity.[28] It is

[26] Marshall's cost curves, which have managed to survive (at least in undergraduate teaching) in uneasy co-existence with neo-Walrasian theory, have a rather natural fit to the Smithian technology. In neoclassical production theory, we cannot be sure that there are any firms to talk about. With the Smithian theory, we at least have no doubts about their existence. Marshall tended to presume long-run decreasing cost for his firms; this property follows directly from the increasing returns of Smithian technology. Marshall's short-run U-shaped average cost schedule gets its downward-sloping segment by the same argument as used above in connection with Okun's Law and its upward-sloping segment, quite conventionally, from the diminishing marginal product of variable factors when fixed factors are kept fixed. Pricing in the markets supplied by these firms, however, should be analyzed in Hicksian, rather than Marshallian terms. We should expect them to be "fix-price" rather than "flex-price" markets.

[27] I very much agree, therefore, with Martin Weitzman that the prevalence of these increasing returns technologies must be taken into account if one is to understand the situation of manufacturing workers in a recession. Unemployment theory, Weitzman argues, must as a first logical requirement explain why unemployed factor units do not set up in production on their own. In the Smithian division of labor case the answer is straightforward: The manufacturing worker simply does not have the skills and knowledge required to make the product as an artisan (see Weitzman 1982).

[28] Another example of an important idea that has not found a home in neoclassical theory but would fit into a Smithian production theory is Erik Dahmen's "development block." In a growing economy, all the component sectors of a Dahmen block have to be completed before any one of them becomes economically viable (see Dahmen 1971).

perhaps overoptimistic to hope that explicit modeling of division-of-labor production would give us an econometric handle on the Solow-Denison growth residuals. But it could give us a better qualitative understanding of how economic development differs from mere economic growth, which would be worth having. An economist used to thinking of production in terms of the Smithian division-of-labor model is likely to be more impressed with the dangers of protectionism, for instance, than colleagues whose thinking runs in neoclassical or neo-Ricardian channels. To the welfare losses arising from impediments to trade in constant (or diminishing) returns models, the Smithian economist[29] would add not only the static loss of scale economies foregone but also the dynamic losses of innovative discoveries foregone when the Smithian evolutionary process is stemmed. Although the loss of competitive improvements never made may be unquantifiable, comparisons between open and closed economies suggest that they are nonetheless the most significant category of welfare losses due to protectionism.

9.12 Conclusion

The theory of the capitalist factory outlined here shares elements with other explanations that have been proposed. It is not to be expected, however, that the proponents of these other theories will be entirely happy with it. The present theory stresses the complementarity of inputs as a central problem as do Alchian and Demsetz (1972), but it does not at all accept their insistence that the bargain between capital and labor is essentially symmetrical. My story has a great many points in common with Williamson's "organization of work" (1980) but differs from his in seeing technological rather than transaction-cost considerations as central. Finally, like Marglin (1974), I recognize an element of power in the capital-labor bargain as essential. Marglin would insist, however, that the capitalists' control of production has no technological or efficiency rationale, whereas I see the capitalists' power as rooted in the efficient, Smithian technology.

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[29] This worthy, of course, expects countries with similar factor endowments to export similar products to each other and would not be surprised if trade of this description would reach large volume.

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