

Symposium on Harrison's "Lean and Mean": A Technological Perspective

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In a far-ranging book, *Lean and Mean*, my colleague at Carnegie Mellon, Ben Harrison, takes on the modern industrial advocates of the "small is beautiful" hypothesis. Increasingly, he sees industrial activity as being performed within international networks of organizations led by large firms. Some of these networks involve simple vertical relationships in which large firms subcontract less advanced technological functions to smaller firms. The "Lean" part of the title reflects the recent tendency of many large firms to pare down by subcontracting to smaller firms functions they previously performed themselves. Other networks Harrison considers, such as Silicon Valley and the Italian industrial districts, involve horizontal as well as vertical relations among innovative small firms. Harrison sees these networks as increasingly being coordinated by large firms through various types of alliances and ownership relations. In Harrison's world, the large firms are the key drivers of technological change. The "Mean" part of the title reflects Harrison's portrayal of small firms. He depicts them as increasingly the repository of society's economic drags – the low-skilled, poorly paid, and transiently employed.

Advocates of small firms, on the other hand, perceive small firms as an important source of vitality in developed countries. They argue that in many industries, small firms are more efficient at innovation than large firms. Consistent with this, they contend that in recent years the preponderance of new jobs in developed economies have

come from small firms. Moreover, they contend that recent innovations in flexible manufacturing have reduced the optimal firm size, making small firms even more viable competitors. To promote economic growth and technological change, they advocate policies to support small firms.

After an introductory chapter and a chapter devoted to setting the record straight on small firms and job creation, Harrison takes on the claims about small firms and technological change in Chapter 3. First, he gainsays recent evidence suggesting small firms are more innovative than large firms. Second, he marshalls evidence suggesting that flexible manufacturing technologies are not enhancing the competitiveness of small firms. Last, he uses the examples of software and biotechnology to argue that new technologies that may initially favor small firms eventually are invaded by large firms due to their inherent advantages. In biotechnology, he intimates that innovative networks that have formed involving small firms, universities, hospitals, and government institutes have been promoted by large pharmaceutical companies through ownership positions they acquired in the small biotech firms. Later chapters recount other examples of networks of small innovative firms either promoted or taken over by large firms and worldwide trends toward the formation of innovative networks headed by large firms. The implication is that firm networks are as much the domain of large as small firms.

In reviewing Harrison's arguments, I will first consider the evidence on innovation in non-network settings. I will then proceed to discuss networks and innovation. Most of my discussion will be on the former issue, largely because there is very little evidence on the latter. I will emphasize research issues and opportunities stirred up by Harrison's arguments. All quotes are from *Lean and Mean*.

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Harrison begins his discussion of the innovativeness of small firms by reconsidering the evidence used by Zoltan Acs and David Audretsch in their analysis of small and large firm innovation rates. The evidence, which indicates that small firms produce a greater number of innovations per employee than larger firms, is drawn from a list of innovations compiled from trade publications, engineering magazines, and product announcements. Harrison interprets the evidence as suggesting that small firms are more innovative than large firms, which would threaten his main premise about the superiority of large firms. Consequently, he goes to great lengths to discredit the evidence. He belittles Acs and Audretsch's innovation counts as being unreliable and claims that nothing can be learned from these data about small and large firm innovation rates. Yet Acs and Audretsch's findings are one piece of a broader literature that all points in the same direction. For example, in a comprehensive analysis of all patents issued to traded companies, Bound *et al.* (1984) find that small firms account for a disproportionately large number of patents relative to their size. Many detailed industry studies have also observed how small firms account for a disproportionately large share of significant innovations relative to their size (cf. Klepper, 1994). I will argue below that rather than reject the Acs and Audretsch pattern, it is more productive to try to explain it. It turns out that it can be explained without threatening Harrison's main premise about the superiority of large firms, making the whole debate between Harrison and Acs and Audretsch academic.

After seemingly winning one victory, Harrison attempts to repeat the feat by taking on proponents of the hypothesis that recent advances in flexible manufacturing favor small firms. Such technologies are thought to lower the minimum size plant/firm required to achieve all scale economies in production. Consequently, they have been conjectured as one of the factors contributing to the "measured decline in the mean firm and plant size in manufacturing industries (p. 59)." Harrison again rejects the findings of a study that specifically links the decline in plant and firm sizes to the use of flexible technologies, telling us how "my confidence in the results is shaken by the suspect quality of the data (pp. 59-60)." Again, it

is Harrison setting the record straight. Using instead what he considers to be superior data, Harrison reports that programmable machinery (a key element of new flexible manufacturing technologies) is more likely to be found in larger business units than smaller ones in Europe, Japan, and the United States. On this basis, Harrison rejects the claim that flexible manufacturing technologies favor small firms. But this is a non-sequitur. Rates of adoption of virtually all new technologies are lower among small firms, most likely because larger firms have a greater level of output over which they can reap the cost advantages stemming from the adoption of new technologies. Thus, even if new flexible manufacturing technologies lower the minimum efficient size firm, it would not be surprising to find them adopted first by larger firms. So we really learn nothing from these new data about whether flexible manufacturing technologies lower the minimum efficient size plant/firm. Moreover, the whole issue does not even seem very relevant to Harrison's main themes. So what if flexible manufacturing technologies lower the minimum efficient size firm? This just reduces one of the traditional advantages of large firms; it does not impart any particular advantage to small firms.

Harrison's next battle is the most bizarre. He takes on small firm advocates in what he sees as one of their backyards, namely the production of software. He describes software creation as an activity widely believed to be devoid of characteristics giving rise to scale economies and thus to be the bailiwick of small firms. Nonetheless, he points out how the Japanese are organizing software factories that may well supplant the current form of organization of the software industry. I am not sure what to make of this. Currently, the Japanese software industry is not much of a competitive threat, and it is not clear this will change in the near term. Moreover, the packaged software industry is already populated by large firms such as Microsoft, so it is not clear what the Japanese case adds to our understanding. Indeed, I am not convinced that packaged software was ever the bailiwick of small firms. Although the industry was initially populated by small firms, so were many other industries like autos that eventually came to be dominated by a few large firms. Surely no one would claim that automobile

production was the bailiwick of small firms. If the point here is that large size can confer significant competitive advantages, few would disagree. How the example of Japanese software factories adds to our understanding of this point is obscure.

The rest of Harrison's arguments against small firms involve networks of firms, which I will discuss further below. In sum, then, Harrison's pastiche of arguments against small firms in non-network settings is off the mark and thus unconvincing. Nonetheless, Harrison touches on a number of patterns that can be fashioned into an interesting argument about the role of firm size in innovation. He touches upon three intriguing regularities, particularly when viewed together. First, an objective reading of the evidence suggests that small firms account for a disproportionately large share of innovations, particularly product innovations, relative to their size. Second, the rate of adoption of new technologies, a key determinant of process innovation, is greater among larger firms. Third, over time many industries initially populated by a large number of small firms become dominated by a few large firms. The last regularity suggests some kind of competitive advantage of large firms in many industries. The second regularity suggests the advantage may emanate from process innovation. The first regularity, though, seems to run counter to the first two, suggesting that small firms have some kind of advantage in innovation. Suppose, however, that larger firms can earn a greater return from any given innovation because they can apply it to a larger level of output. Wes Cohen and I (1992) have demonstrated that this will enable larger firms to profit from marginal R&D projects that would not be profitable for smaller firms. As a result of this advantage, larger firms will pursue more R&D than smaller firms and will end up with a smaller *average* yield on their R&D, measured in terms of innovations or patents per dollar of R&D, which is precisely what has been observed. This hypothesis would also explain why more R&D intensive industries tend to be more concentrated, a pattern touched on by Harrison. It is precisely in these industries where the large firm advantage is particularly important, making it difficult for small firms to compete.

Does this suggest, as Harrison would no doubt argue, that there is no need for policies to promote

small firms? It is tempting to reach this conclusion. However, reflection on the fate of a number of U.S. industries that eventually became dominated by a few large firms makes one pause. Two industries that Harrison discusses, autos and televisions, were both decimated by international competition. A similar fate has befallen industries like steel and tires. Does this indicate the need for some kind of state intervention to prevent a similar outcome in other, more modern industries such as computers? I have recently developed a model that explains a number of regularities, including the above ones, concerning how industries evolve (Klepper, 1994). A cornerstone of the model is that all firms have limited vision regarding innovation. Consequently, as industries become dominated by a few large firms and small firms exit the industry, the rate of technological change in the industry withers. One solution is to subsidize outsiders with a different vision about the future of the industry's technology. It is not clear whether this should take the form of subsidies for new, possibly small firms, but some kind of state intervention is required to counter the domination of industries by a few large firms. Thus, even if large firms have a competitive advantage over small firms in innovation, as Harrison suggests (for the wrong reasons), it does not imply all is well with the evolution of market structure.

Harrison's attack against small firms extends into network settings, where he examines celebrated networks of innovative small firms such as Silicon Valley, the Italian industrial districts, and the clusters of biotechnology firms on the east and west coasts of the U.S. The very fact that these networks have been so innovative and composed primarily of small firms is extremely threatening to Harrison's main premise concerning small firms. Here his attack is a little different. He does not question the innovativeness of these networks. Rather, he questions the extent to which they reflect the virtues of small firms in innovation. He depicts Silicon Valley as having been shaped by big institutions like the U.S. Defense Department and more recently by large, international firms. In biotechnology, he intimates that large pharmaceutical companies, through equity positions in the biotechnology firms, have played an important role in forging ties between the firms and other key players such as universities, hospitals, and

government sponsors of research. In the Italian industrial districts, he recounts two examples of districts that have increasingly been dominated by one firm, in one case through acquisitions of firms in the network by an outsider and in the other case through expansion of one of the firms in the network.

These examples seem like a lot of smoke and mirrors. What do they buy us? Surely the U.S. Defense Department played a significant role in the development of Silicon Valley. For quite a while, though, the Valley seems to have followed its own juggernaut. In biotechnology, the large pharmaceutical companies may have played an important role, particularly in finance, but it is noteworthy how they refrained from buying up the companies. This seems like an admission of how large firms can stifle the innovativeness of small entities. In the two Italian industrial districts increasingly being dominated by a single firm, no evidence is presented that this has enhanced the performance of the districts. Indeed, one of them has been led by Benetton, which has fallen on hard times of late.

The interesting questions about small firm networks involve how they come to be formed, how they help overcome the putative advantages of large firms in innovation that cause so many R&D intensive industries eventually to be dominated by a few large firms, and how their structure evolves over time. Because Harrison is so determined to discredit small firms, these issues are not featured even though his case studies seem to have a lot to say about them. I am particularly intrigued by the idea that the structure of networks of firms may become increasingly concentrated over time. This is reminiscent of how many non-networked industries have evolved over time, such as autos, televisions, tires, aircraft, and aircraft

engines, to name just a few. Whether this is a general phenomenon that transcends the examples Harrison presents is an interesting question that is worth investigating. Related to this is the question of how the intrusion of large firms in networks of innovative small firms affects the performance of the firms in the network. While Harrison intimates that large firm involvement has been beneficial in the networks he reviews, this is a fertile topic for investigation.

So where do we end up in terms of a scorecard about firm size and innovation? Harrison's treatment of this issue is so slanted that little is learned about it. Indeed, if small firms had legal standing, Harrison would be guilty of libel. I am certainly not willing to jump on the large firm bandwagon championed by Harrison. On reflection, I am not sure why anyone would want to jump on this bandwagon. The relevant question for policy is not whether small firms are more innovative than large firms but whether there are circumstances in which we might want to promote and nurture small firms. Natural candidates are mature industries and emerging firm networks in new technologies. It might serve us well to devote more study to innovation in these domains before reaching any policy conclusions about small firms.

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