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Skill Development and Sustainable Prosperity:Cumulative and Collective Careers versus Skill-Biased Technical Change

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ABSTRACT

There is widespread and growing concern about the availability of good jobs in the U.S. economy. Inequality has been growing for thirty years and is now at levels not seen since the 1920s. Stable and remunerative employment has become harder for U.S. workers to find. With the widespread plant closings of the 1980s, the loss of these "middle-class" employment opportunities was confined largely to blue-collar workers with high-school educations. As a group, members of the U.S. labor force with college educations always do better than those with high-school educations, but over the course of the 1980s the wage premium to having a college education expanded significantly. During the 1990s and 2000s, however, older and experienced college-educated white-collar workers began to find their earnings under pressure as the career

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employment opportunities available to them became far less plentiful, stable, secure, and remunerative than they had once been. In the 1990s major industrial corporations shifted sharply away from the norm of a white-collar career with one company that had prevailed since the 1940s. Then in the 2000s U.S. white- collar workers faced the incessant offshoring of jobs to be filled by college-educated workers in lower-wage developing economies, with India and China in the forefront. The Great Recession of 2007 to 2009 and its aftermath have only heightened these concerns about the ongoing disappearance of middle-class jobs. In this paper, we present an approach for analyzing these changes in middle-class employment opportunities that differs fundamentally from the dominant paradigm among economists known as "skill-biased technical change" (SBTC). Like all economists who adhere to the neoclassical theory of the market economy, SBTC assumes that wages are determined through the forces of supply and demand in the labor market. In contrast, our study of the development of the U.S. economy over the past half century views the primary determinant of wages on a sustainable basis as the employment practices of major business enterprises. We contend that, except when labor is an interchangeable commodity, wages are determined in business organizations where the promise of wage increases over time are both an inducement to supply more and better work effort when engaged in productive activities, and a reward for having done so in ways that add value over time. For employees in high-tech fields – known collectively as STEM (science, technology, engineering, and mathematics) workers – wages are determined not by supply and demand in the labor market but rather by the employment relations that prevail within leading business enterprises. The reason: Productivity in high-tech fields depends on learning that is both *collective* and *cumulative*. Focusing on STEM employment, we explore the hypothesis that the productivity and earnings of high-tech workers depend on *collective and cumulative careers*.

JEL Codes: No. D3, D4, G3, J3, L2, M1, N8, O3, P1

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1. What Has Happened to Middle-Class Jobs?

There is widespread and growing concern about the availability of good jobs in the U.S. economy. Inequality has been growing for thirty years and is now at levels not seen since the 1920s. Stable and remunerative employment has become harder for U.S. workers to find. With the widespread plant closings of the 1980s, the loss of these "middle-class" employment opportunities was confined largely to blue-collar workers with high-school educations. As a group, members of the U.S. labor force with college educations always do better than those with high-school educations, but over the course of the 1980s the wage premium to having a college education expanded significantly.

During the 1990s and 2000s, however, older and experienced college-educated white-collar workers began to find their earnings under pressure as the career employment opportunities available to them became far less plentiful, stable, secure, and remunerative than they had once been. In the 1990s major industrial corporations shifted sharply away from the norm of a white-collar career with one company that had prevailed since the 1940s, as recognized in the 1950s in C. Wright Mills, *White Collar: The American Middle Classes* and William H. Whyte, *The Organization Man*.[1] Then in the 2000s U.S. white-collar workers faced the incessant offshoring of jobs to be filled by college-educated workers in lower-wage developing economies, with India and China in the forefront. The Great Recession of 2007 to 2009 and its aftermath have only heightened concerns about the ongoing disappearance of middle-class jobs.[2]

In this paper, we present an approach for analyzing these changes in middle-class employment opportunities that differs fundamentally from the dominant paradigm among economists known as "skill-biased technical change" (SBTC). Like all economists who adhere to the neoclassical theory of the market economy, SBTC assumes that wages are determined through the forces of supply and demand in the labor market. In contrast, our study of the development of the U.S. economy over the past half century views the primary determinant of wages on a sustainable basis as the employment practices of major business enterprises.[3]

We contend that, except when labor is an interchangeable commodity, wages are determined in business organizations where the promise of wage increases over time are both an inducement to supply more and better effort when engaged in productive activities and a reward for having done so in ways that add value over time. For employees in high-tech fields – known collectively as STEM (science, technology, engineering, and mathematics) workers – wages are determined not by supply and demand in the labor market but rather by the employment relations that prevail within leading business enterprises. The reason: Productivity in high-tech fields depends on learning that is both *collective* and *cumulative*.[4]

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[1] C. Wright Mills, *White Collar: The American Middle Classes*, Oxford University Press, 1951; William H. Whyte, Jr., *The Organization Man*, Simon and Schuster, 1956.

[2] William Lazonick, "Labor in the Twenty-First Century: The Top 0.1% and the Disappearing Middle Class", AIR Working Paper #14-08/01, at http://www.theairnet.org/v3/backbone/uploads/2014/09/Lazonick_LaborInTheTwenty-FirstCentury_AIR-WP14.0801.pdf

[3] For the larger critique of what one of the authors has called "the myth of the market economy", see William Lazonick, *Business Organization and the Myth of Market Economy*, Cambridge University Press, 1991; William Lazonick, "The Theory of the Market Economy and the Social Foundations of Innovative Enterprise," *Economic and Industrial Democracy*, 24, 1, 2003: 9-44; William Lazonick, "Innovative Enterprise and Shareholder Value," *Law and Financial Markets Review*, 8, 1, 2014: 52-64.

[4] There is a large literature on organizational learning that supports the argument that learning is collective and cumulative. Within economics, the foundational work on collective and cumulative learning is Edith T. Penrose, *The Theory of the Growth of the Firm*, Basil Blackwell, 1959. See William Lazonick, "The US Industrial Corporation and *The*

Productivity is collective because one learns through the interaction with others in a hierarchical and functional division of labor. It is cumulative because what the collectivity learns today provides the foundation for what it is capable of learning tomorrow. What we call "collective and cumulative careers" (CCCs) are essential for organizational learning in technologically complex industries, while organizational learning is in turn the essence of the innovation processes that can generate higher quality products at lower unit costs, and hence higher levels of productivity. It is on the basis of these higher levels of productivity that business enterprises, based on their organizational capabilities, can pay their valued employees higher wages on a sustainable basis.

In aggregate, the wages paid by the most productive enterprises in the economy set the standards for wages paid in the economy as a whole. Indeed, transmitted through market competition for "talent," the most productive enterprises compel less productive enterprises to either improve their productivity and hence the wages that they can afford or accept lower profit margins. Alternatively these less productive firms can seek to employ lower wage, yet qualified labor abroad, complete a merger or acquisition of a more productive firm, or simply go out of business. In other words, in an economy dominated by firms that have grown large through superior productivity, wages of skilled workers in both leading firms and in the firms that lag these leaders are determined by the business strategies of these major enterprises, not by the market forces of supply and demand.

In case one is in doubt that the U.S. economy is one on which large employers dominate, consider the data in Table 1. In 2007 (the latest year for which complete data are available), 1,927 firms with 5,000 or more employees had an average of 405 establishments per firm and employed 33% of all employees in the business sector of the U.S. economy while accounting for 37% of payrolls and 43% of sales revenues. Any perspective on the U.S. economy (or any economy) that does not possess an analytical framework for understanding how firms grow large and what their business strategies imply for overall economic performance cannot possibly comprehend productivity growth or the distribution of wages.

Table 1. Large firms in the U.S. economy, by employees, establishments, payrolls, and sales, 2007

	Firms, number	Establishments	Paid employees	Annual payroll, $millions	Sales revenues, $millions
All firms	6,049,655	7,705,018	120,604,265	5,026,778	29,746,742
% 500+ employees	0.303	15.04	50.36	56.14	61.74
% 5,000+ employees	0.032	10.13	32.74	37.22	43.43
% 10,000+ employees	0.016	8.64	27.24	30.76	35.82

Note: 2007 is the latest year for which the Census Bureau collected these data with the inclusion of receipts (i.e., sales revenues). The last year in which the Census Bureau collected any of these data was in 2008, when firms with 5,000 or more employees represented 0.033% of firms, 10.52% of establishments, 32.92% of employees, and 37.37% of payrolls.
Source: Census Bureau, http://www.census.gov/epcd/susb/2007/us/US--.HTM#table0

Technological change is of fundamental importance to the productive performance of the economy. But the development and utilization of technology to generate productivity embodied in high quality, low cost goods and services is performed by firms, not markets. Underlying our approach is a well-developed analytical framework based on "the theory of innovative enterprise" (TIE) that focuses on the interaction of organization and technology in the operation and performance of the firm. In the TIE approach, business strategy, influenced by a broader social

Theory of the Growth of the Firm," in Christos Pitelis, ed., *The Growth of the Firm: The Legacy of Edith Penrose*, Oxford University Press, 2002: 249-278.

context, is the key determinant of the relation between employment and pay.[5] The SBTC approach focuses on supply and demand in labor markets as the determinant of wages even as it invokes a process – technological change – that occurs within firms. In sharp contrast, the TIE approach to analyzing the issues of employment and wages focuses on the integral relation between productivity and pay within leading business enterprises.

The dominant SBTC view among economists, policy makers, and politicians is that wage inequality and the worsening job situation for middle-income, middle-skill Americans is the result of the development of increasingly sophisticated and skill-demanding technologies related to the digital revolution of the past three or four decades.[6] The impact of computerization on employment is captured by the notion that a fundamental characteristic of the technology revolution of the past decades has been, as already noted, "skill-biased technical change." The argument is that SBTC reduces the demand for jobs that require routine skills that computers can do, depressing the wages and numbers of those jobs, while it increases the demand for sophisticated skills that enable workers to perform tasks that complement computer technology. When growth in the demand for computer-era skill outpaces the growth in the supply of college-educated people with such skills, the wages of these college-educated members of the labor force will rise. If, in addition, SBTC results in a decline of wages for those with only high-school educations because of the disappearance of low-skill jobs, the wage premium to a college education relative to a high-school education will increase, with these different levels of education and pay reflecting different levels of skill.

The SBTC argument was originally put forward in the early 1990s as an explanation for the growing wage premium of a college education in the 1980s. There was a surface plausibility to this argument, although as we shall document in this paper, it was based on erroneous assumptions about the roles of technological change and labor markets in determining the college wage premium, as well as neglect of fundamental changes in the business models that prevailed in the U.S. economy. The original SBTC argument made in the 1980s failed to explain why wages at the bottom began to catch up to wages in the middle of the distribution in the late 1980s and through the 1990s.

This change in relative wages led to a modification in the analysis of the SBTC hypothesis by grouping the tasks associated with jobs and the degree to which these tasks are related to the operation and capabilities of computers. The argument about the effect of computer technology became a story of three broad segments of the job spectrum: a) the jobs at the top that require

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[5] For the most recent articulation of the analytical framework see William Lazonick, "The Theory of Innovative Enterprise: A Foundation of Economic Analysis," AIR Working Paper #13-05-01, May 2013 at http://www.theairnet.org/files/research/WorkingPapers/Lazonick_InnovativeEnterprise_AIR-WP13.0501.pdf. See also William Lazonick, "The Chandlerian Corporation and the Theory of Innovative Enterprise," *Industrial and Corporate Change*, 19, 2, 2010: 317-349; Lazonick, "Innovative Enterprise and Shareholder Value."

[6] Early versions of research using the SBTC framework are Lawrence F. Katz, and Kevin M. Murphy, "Changes in Relative Wages 1963-1987: Supply and Demand Factors," *Quarterly Journal of Economics*, 107, 1, 1992: 35–78; and Chinhui Juhn, Kevin M. Murphy, and Brooks Pierce, "Wage Inequality and the Rise in Returns to Skill," *Journal of Political Economy*, 101, 3, 1993: 410–442. An influential paper during this time by Alan Krueger cast the "TC" in SBTC as originating in the computer revolution. Alan Kruger, "How Computers Have Changed the Wage Structure: Evidence from Microdata, 1984-1989," *Quarterly Journal of Economics,* 108, 1, 1993: 33-60. This early SBTC research was subject to a good deal of criticism. A survey of the research and the criticisms are given in Philip Moss, "Earnings Inequality and the Quality of Jobs," in William Lazonick and Mary O'Sullivan, eds., *Corporate Governance and Sustainable Prosperity*, Palgrave, 2002: 183-225. The most prominent work arguing SBTC as an explanation of the historical path of the distribution of wages in the United States is Claudia Goldin and Lawrence F. Katz, *The Race Between Education and Technology,* Harvard University Press*,* 2008.

advanced thinking and skills for which computers are complementary, b) the jobs in the middle that require routine skills that computers can replace or that can be easily outsourced, and c) the jobs at the bottom, for example at the lower end of healthcare, childcare, and other personal services work, that require the performance of tasks that computers cannot yet do. Labeled the "job polarization hypothesis" (JPH), this version of SBTC argues that jobs at the top and bottom are growing at the expense of jobs in the middle.[7]

Taken together, SBTC and JBH[8] are the prevailing explanations from neoclassical labor economists for increasing wage inequality in the United States. Yet quite separately from the SBTC approach, a group of empirically oriented economists led by Facundo Alvaredo, Tony Atkinson, Thomas Piketty, and Emmanuel Saez gathered income tax data to provide a database for determining the concentration of income among the richest families in the United States. Their data extend back as far as 1913 and currently come forward to 2012.[9] These data show an extreme concentration of income among the 0.1% of the richest households since the 1970s, reaching a peak of 12.3% of total family income in 2007, up from a low of 2.6% in 1975, and standing at 11.3% in 2012. The only year since 1913 in which the top 0.1% share was higher than the 2012 figure was in 1928 when it reached 11.5%. Yet SBTC has been largely silent on this issue, for the reason that SBTC cannot plausibly deal with this phenomenon of the extreme concentration of income among the richest households.[10]

Many analysts of the U.S. income distribution have noted that this phenomenon of concentration of income at the top does not fit with the rest of the SBTC story. Yet, rather than attempt to integrate it into a coherent account of the decline of good jobs and falling or stagnant wages in a broad swath of jobs, most commentators have quarantined it as a unique problem, unrelated to the other developments in U.S. employment and wages.[11] While this paper, with its focus on the employment and incomes of STEM workers, does not enter into the analysis of the determinants of the incomes of the top 0.1% in the United States, the work of one of the authors, working with the TIE approach, has shown how in the United States over the past three decades the concentration of income at the top and the disappearance of middle-class jobs have been integrally related.[12]

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[7] The major works extending the SBTC framework to include job polarization are David Autor, Lawrence F. Katz, and Melissa S. Kearney, "The Polarization of the U.S. Labor Market," *American Economic Review* 96, 2: 189-94; Daron Acemoglu and David Autor. "Skill, Tasks and Technologies: Implications for Employment Earnings," in Orley Ashenfelter and David Card, eds., *The Handbook of Labor Economics,* vol. 4b, Elsevier 2011: 1043-1171; Daron Acemoglu and David Autor, "What Does Human Capital Do?: A Review of Goldin and Katz's *The Race between Education and Technology*," *Journal of Economic Literature*, 50, 2, 2012: 426-463 .

[8] Hereafter we will refer to the SBTC/JPH approach as simply SBTC, given that JPH is an extension of the SBTC school of thought.

[9] See "The World Top Incomes Database" at http://topincomes.g-mond.parisschoolofeconomics.eu/. These data are now widely known to the public because of the phenomenal success of Piketty's book, *Capital in the Twenty-First Century*, Harvard University Press, 2014. Lazonick has been using the Piketty-Saez database in lectures and papers since 2008. See William Lazonick, *Sustainable Prosperity in the New Economy? Business Organization and High-Tech Employment in the United States*, Upjohn Institute for Employment Research 2009, p. 16.

[10] Brynjolfsson and McAfee make the dubious SBTC argument that the high pay of top executives results from the availability of digital technologies that give them the ability to increase their direct oversight of factories throughout the world. Erik Brynjolfsson and Andrew McAfee, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, W. W. Norton, 2014, pp. 151-152.

[11] This shortcoming includes both those who adopt the SBTC argument – for example, David H. Autor, "Skills, Education, and the Rise of Earnings Inequality among the 'Other 99 Percent,'" *Science*, 344, 843, May 23, 2014; David Brooks, "The inequality problem," *New York Times*, January 16, 2014, at http://www.nytimes.com/2014/01/17/opinion/brooks-the-inequality-problem.html?_r=0 – and those who criticize it – for example, Lawrence Mishel, John Schmitt and Heidi Shierholz, "Wage Inequality: A Story of Policy Choices," Economic Policy Institute, August 7, 2014, at http://www.epi.org/publication/wage-inequality-story-policy-choices/ .

[12] Lazonick, "Labor in the Twenty-First Century".

Nevertheless, as an explanation of the wage distribution among normal (non-executive) employees, the SBTC framework remains the dominant approach.[13] The microelectronics revolution of the past three decades has been profound, and the economy's need for advanced skills to take full advantage of this revolution is very real. Yet the SBTC framework ignores the processes through which those skills are, or are not, developed and utilized within the business enterprises that have been central to that technological revolution. In this paper, within the TIE framework, we summarize evidence on the relation between employment and pay for STEM workers in the United States. Besides providing a new, and we argue, more empirically grounded, analysis of an important component of income distribution in the United States, TIE shows that SBTC is not at all convincing as an explanation for growing inequality in the wage distribution of income.

The specific focus of this paper is the careers of STEM workers, who are among the most highly educated and skilled members of the U.S. workforce. The SBTC framework would put the employment situation of STEM workers front and center, predicting that this type of labor would be well positioned to secure high and growing incomes in the U.S. economy. SBTC is consistent with the notion held by many that the United States has a shortage of STEM graduates and workers. The ability of STEM workers to obtain high wages and stable employment is therefore a very strong test of the SBTC framework.

Our summary of the employment situation of STEM workers shows that the current careers of STEM workers are characterized by less employment security, shorter job tenure, and declining returns to STEM education than SBTC would predict. At the same time, as we summarize in this paper, TIE provides a robust explanation for these outcomes and yields many testable hypotheses for further study. Central to the productive capability – or "skill" – of the STEM labor force are "collective and cumulative careers" (CCCs).

Higher education, the SBTC proxy for skill, is a necessary credential for entry into the vast majority of STEM jobs. However, the inclusion of technical workers within the STEM acronym means for many jobs a two-year community college certificate will suffice. But whatever the educational credential of a STEM worker, his or her skill level at any point in time will depend on the *accumulation of productive capability as a worker* over time. STEM workers learn how to do their jobs in business firms, not on labor markets or even, in most occupations that require higher education, in the classrooms of colleges and universities. More than that, in business enterprises, often on-the-job, many STEM workers also learn how to produce goods and services that are *higher quality than those that were previously available*. We call this learning process "innovation". It is by employment in innovation processes, not by selling one's labor on the market, that a STEM worker acquires the productive capability – the "skill" – that warrants paying him or her a higher wage than was previously the case.

[13] Piketty states that SBTC which, following Goldin and Katz, he characterizes as "the race between education and technology," is "in some respects limited and naïve. (In practice, a worker's productivity is not an immutable, objective quantity inscribed on his forehead, and the relative power of different social groups often plays a central role in determining what each worker is paid.)" But Piketty accepts the assumption that wages are determined in the labor market, and gives no hint that he views the SBTC approach as "limited and naïve" because of its failure to address the role of business organizations and their employment relations in determining productivity and wages. Piketty, *Capital in the Twenty-First Century*, p. 305.

Empirical study of these learning processes reveals that they cannot be done all alone and they cannot be done all at once.[14] That is, the learning processes that are the essence of innovation are collective and cumulative. The innovation process cannot be done all alone because learning how to produce higher quality products and how to access new markets on which to sell them requires the cooperation and collaboration of large numbers of people in a hierarchical and functional division of labor. The innovation process cannot be done all at once; if it could it would not be learning about how to produce higher quality products than had previously been available.

Different industries, characterized by different technologies, markets, and competitors vary dramatically in the type of collective and cumulative learning processes that they require to generate higher quality, lower cost products. But whatever the industry and whether innovation be radical or incremental, collective and cumulative learning requires collective and cumulative careers. Formal education contributes to the ability to learn, and educational credentials are undoubtedly important for gaining access to certain types of employment. Indeed such "market signals" may be used precisely because an employer cannot know the productivity of prospective employees until they have performed, and even learned to perform, on the job.[15] It is through these CCCs, not educational credentials, that members of the STEM labor force develop the skills that can enable them to contribute to productivity that warrants higher levels of pay.

In the post-World War II decades under what Lazonick has called the Old Economy Business Model (OEBM), the employment norm in major U.S. corporations was a career with one company, manifested by the possibility of promotion up and around the corporate hierarchy to positions of greater responsibility and higher pay, with a defined-benefit pension waiting when the employee reached retirement age. High-tech business enterprises jettisoned that norm with the rise of the New Economy Business Model (NEBM) which emanated from Silicon Valley in the 1970s and 1980s, and then became ubiquitous in the 1990s and 2000s. Indeed, Old Economy companies such as IBM, which had prided itself on its practice of "lifelong employment", and Hewlett-Packard, which branded its permanent employment practices "The HP Way", made strategic decisions to reject OEBM and adopt NEBM.[16]

In doing so they were responding to companies such as Microsoft, founded in 1975, and Cisco, founded in 1984, that, from their early years, offered all their professional, technical and administrative employees stock options as partial compensation to induce them to give up secure employment with Old Economy companies. As startups, these companies could not offer the promise of a career with one company, and as the most successful New Economy companies grew to employ tens of thousands of people in the 1990s, they continued to offer stock options to a broad base of employees. As we shall see, this labor-market competition from NEBM had a corrosive influence on the norm of a career with one company under OEBM.

CCCs did not disappear under NEBM, but, with a career with one company no longer the norm, high-tech workers now had to be prepared to pursue networked CCCs across business enterprises, government agencies, universities, and civil society organizations. STEM workers in the U.S. labor force have faced, however, three obstacles in sustaining their CCCs. First, under NEBM employers have a preference for younger workers not only because their pay tends to be lower and the hours

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[14] This formulation is attributable to Michael Best's succinct summary of Penrose's key insights in *The Theory of the Growth of the Firm*. Michael H. Best, *The New Competition: Institutions of Industrial Restructuring*, Harvard University Press, 1990, p. 125.

[15] Michael Spence, "Job Market Signaling," *Quarterly Journal of Economics*, 87, 3, 1973: 355-74.

[16] Lazonick, *Sustainable Prosperity,* Ch. 3.

that they will work longer, but also because NEBM is based on open-systems technology architectures that favor younger workers with the latest computer-related skills rather than the more experienced workers that OEBM valued for developing and utilizing its proprietary-systems technology architectures.[17] Second, under NEBM many of these younger high-tech workers are employed in low-wage areas of the world, including India and China. Third, and in our view most problematic, U.S. industrial corporations have become captive to the ideology that companies should be run to "maximize shareholder value," and in the process have shown themselves to be more interested in using corporate earnings to give manipulative boosts to their stock prices through massive repurchases of their own stock rather than making investments in CCCs.[18]

The next section of this paper provides a critical assessment of the dominant SBTC paradigm, citing research that pokes empirical holes in its argument as well as research that, more substantively, points to the importance of employment relations and career paths in the performance and pay of U.S. workers. The following section focuses specifically on STEM workers in the U.S. economy over the past two decades to raise questions on whether their employment and pay experience supports the predictions of SBTC for the high-skill segment of the U.S. labor force, or whether those outcomes can be better explained by the TIE focus on CCCs. Section 4 of the paper then proposes a research agenda that delves inside the "black box" of the large business corporation, in this case focusing on the major companies in high-tech industries in an effort to discover directly what has happened to employment relations in general and CCCs in particular over the past quarter century.

We conclude this paper by summing up the argument that CCCs generate new technologies, higher productivity, and well-paid middle-class jobs that are sustainable over time. From this perspective, we contend that the problems that now confront workers with high levels of both education and experience relevant to high-tech employment that could be well paid are rooted in problems of corporate governance and corporate investment, and not in SBTC. Our approach calls for a research program that can test the CCC hypothesis and deepen our insights into the institutional conditions that support rather than undermine CCCs.

2. What is Wrong with SBTC?

The SBTC framework has captured the imagination of leading economists, policy makers and the general public as a tidy explanation for growing wage inequality and worsening job prospects for many American workers. It lays the blame for these troubling outcomes on the relentless path of technological change and the inexorable working of supply and demand in U.S. labor markets. Yet a growing amount of research by economists, sociologists, and other social scientists has found strong contradictory evidence. This research suggests that, at best, SBTC as a description of changes in employment and pay in the United States is full of holes, and that, at worst, SBTC ignores the critical determinants of the levels of inequality in employment and wages, and hence the distribution of income.

The counter-evidence to SBTC comes from the timing of wage movements and differentials among types of jobs, the changes in the distributions of jobs and occupations, changes in the measured content of skills in jobs and occupations, the educational requirements for jobs, and in the most

[17] Ibid., Ch. 2.
[18] William Lazonick, "Profits Without Prosperity: Stock Buybacks Manipulate the Market and Leave Most Americans Worse Off," *Harvard Business Review*, September 2014: 46-55.

believable reports from employers on the skills that they say need and that available candidates lack. In our view, as we discuss at length in Sections 3 and 4 of this paper, the strongest counter-evidence comes from the deteriorating employment situation facing members of the STEM labor force, the group of workers who should be benefitting from SBTC.

In this section, we survey the evidence that calls SBTC into question. First we will consider critiques of SBTC put forward by the "hole-pokers" – in this case researchers at the Economic Policy Institute, a labor-oriented think tank in Washington DC – who point out problems with the SBTC conclusions without, however, offering a coherent alternative perspective on the growth of inequality and the disappearance of middle-class jobs that can take its place.[19] We then elaborate upon the argument that such an alternative perspective must include at its center an analysis of the *career employment* of members of the U.S. labor force – and not just wages that attach to jobs at a point in time – including an explanation of why and how these careers have changed since the 1970s. We will then summarize our critique of SBTC, arguing that it is based on an exceptionally narrow view of the relation between employment and pay, even by the standards of mainstream economics.

The SBTC hypothesis argues that the juggernaut of technological progress continually increases the demand for workers who have the skills to work with advanced technology. The case of technological progress for which SBTC is thought to be of particular relevance is the computer revolution that has taken place since the 1970s. SBTC allegedly increases the demand for skilled workers while decreasing the demand for unskilled workers, causing the inequality gap between these two groups of workers to rise. Since SBTC identifies skill level by educational attainment, if a growing proportion of the labor force could attain higher levels of education, inequality would fall as more people compete for the skilled jobs and as relatively fewer people are left among the ranks of the unskilled.

As mentioned in the introduction to this paper, SBTC proponents have accommodated the growth of low-paid, low-skill personal services jobs that cannot be computerized by appending the job polarization hypothesis to SBTC. Computers replace the middle-skill jobs in areas such as manufacturing, banking, and retail, shrinking employment and reducing wages in these occupations. SBTC then generates predictions about changes in occupational wages, occupational job shares, and the relation between the two.[20]

Among the most piercing hole-pokers have been Shierholz, Mishel, and Schmitt (SMS) of the Economic Policy Institute. On the basis of thorough research on the job polarization hypothesis, they argue that the predictions of SBTC fail most of the tests.[21] SMS examine whether job polarization describes the observed changes in the distribution of employment and wage inequality.

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[19] Lawrence Mishel and Jared Bernstein, "Is the Technology Black Box Empty? An Empirical Examination of the Impact of Technology on Wage Inequality and the Employment Structure." Economic Policy Institute Technical Paper 1994; Lawrence Mishel, Jared Bernstein, and John Schmitt, *The State of Working America 1996–1997.* Economic Policy Institute, M.E. Sharpe, 1997; Lawrence Mishel and Jared Bernstein, "Technology and the Wage Structure: Has Technology's Impact Accelerated since the 1970s?" *Research in Labor Economics,* 17, 1998: 305–356; Heidi Shierholz, Lawrence Mishel, and John Schmitt, "Don't Blame the Robots: Assessing the Job Polarization Explanation of Growing Wage Inequality." Employment Policy Institute, November 2013, at http://www.epi.org/publication/technology-inequality-dont-blame-the-robots/

[20] Autor, Katz, and Kearney, "The Polarization of the U.S. Labor Market"; Acemoglu and Autor. "Skill, Tasks and Technologies"; and Acemoglu and Autor, "What Does Human Capital Do?"

[21] Shierholz, Mishel, and Schmitt, "Don't Blame the Robots"; Mishel, Schmitt and Shierholz, "Wage Inequality: A Story of Policy Choices".

SMS argue that the timing of changes in wages and employment contradicts SBTC. First, the biggest surge in inequality happened in the early 1980s before the computer revolution diffused into work places in a serious way. Second, the growth of high-wage occupations slowed in the 2000s, while the growth of the college wage premium slowed in the 1990s and was flat in the 2000s. Third, there is no sizeable difference in the growth of the employment shares of middle-wage and high-wage occupations in the 2000s, yet there is continued growth in the 90th percentile/50th percentile wage gap. Fourth, wages for service occupations grew in the late 1990s when employment did not, and wages for service occupations fell in the 2000s when employment grew. Fifth, wage inequality continued to rise in the 2000s while job polarization ceased.

SMS also scrutinize the argument implied by Acemoglu and Autor[22] that changes in the occupational employment distribution as a result of job polarization have generated observed changes in the distribution of wages. They focus on how well changes in the overall distribution of occupational employment predict changes in the overall wage distribution. Using regression analysis, they find that occupational employment changes are poor predictors of occupational wage changes. They also find that occupational wage changes are poor predictors of changes in overall wages. SMS then look at the variation in wages within detailed occupational categories compared to the variation in wages across these categories and find that a large and growing portion of the variation in wages (another measure of wage inequality) is occurring within occupational groups. This finding is a further blow to the hypothesis that SBTC is the driver of the growth in wage inequality.

Finally, SMS note that the most significant aspect of widening wage inequality is the meteoric rise in salaries at the very top of the distribution, the 0.1% or higher for which SBTC has no explanation. SMS use Social Security data, obtained from Kopzcuk, Saez, and Song, to analyze this stratum of the distribution. Autor, Acemoglu and other SBTC analysts had not analyzed these data.[23]

In this criticism of SBTC, SMS are joined by Piketty who rejects technology as the reason for the growth in income inequality.[24] Piketty bases his argument on data collected from federal income-tax returns, a crucial finding of which is that top level executives of financial and non-financial corporations dominate the 0.1% of the earnings distribution.[25] Apparently referring to a paper by Bakija, Cole, and Heim, Piketty states: "Recent research, based on matching declared income on tax returns with corporate compensation records, allows me to state that the vast majority (60 to 70 percent, depending on what definitions one chooses) of the top 0.1 percent of the income

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[22] Acemoglu and Autor. "Skill, Tasks and Technologies"; and Acemoglu and Autor, "What Does Human Capital Do?"

[23] Wojciech Kopczuk, Emmanuel Saez, and Jae Song, 2010. "Earnings Inequality and Mobility in the United States: Evidence from Social Security Data since 1937," *Quarterly Journal of Economics,* 125, 1, 2010: 91–128.

[24] Piketty, *Capital in the Twenty-First Century*, p. 24. He writes in his book: "One possible explanation of this is that the skills and productivity of these top managers rose suddenly in relation to those of other workers. Another explanation, which to me seems more plausible and turns out to be much more consistent with the evidence, is that these top managers by and large have the power to set their own remuneration, in some cases without limit and in many cases without any clear relation to their individual productivity, which in any case is very difficult to estimate in a large organization." Research on executive compensation shows that Piketty's latter hypothesis is indeed "much more consistent with the evidence." See William Lazonick, "Taking Stock: How Executive Pay Results in an Inequitable and Unstable Economy," Franklin and Eleanor Roosevelt Institute White Paper, June 5, 2014, at http://www.rooseveltinstitute.org/taking-stock-executive-pay

[25] Piketty, *Capital in the Twenty-First Century*, ch. 9. See also Thomas Piketty and Emmanuel Saez, "Inequality in the Long Run," *Science*, 344, 2014: 838-843. The data on the sectoral distribution of the top 0.1% are from "The World Top Incomes Database" at http://topincomes.g-mond.parisschoolofeconomics.eu/

hierarchy in 2000–2010 consists of top managers."[26] Besides its inability to explain the concentration of income at the top, Piketty argues that SBTC is naive and limited because "to understand the dynamics of wage inequality, we must introduce other factors, such as the institutions and rules that govern the operation of the labor market in each society. To an even greater extent than other markets, the labor market is not a mathematical abstraction whose workings are entirely determined by natural and immutable mechanisms and implacable technological forces: it is a social construct based on specific rules and compromises."[27]

One glaring problem with almost all of the SBTC literature is that it views skills as the result of one's level of education, without regard to the training that one gets on the job.[28] This limitation of SBTC is somewhat surprising, given that over a half century ago Jacob Mincer, often described as the founder of neoclassical labor economics, introduced the notion of on-the-job training into neoclassical labor economics.[29]

But to address the role of workplace experience as a determinant of productivity and pay, we have to delve into the rather non-neoclassical world of employment relations. In a very useful paper that comes from the management discipline of industrial relations rather than neoclassical labor economics, Cappelli confronts the popular argument, consistent with SBTC, that wage inequality is rising because the demand for technical skill is outstripping supply.[30] Cappelli is very critical of the idea that U.S. job candidates are deficiently equipped with relevant skills, and hence that the U.S. education and training system needs to become more effective in producing workers with the skills that employers want in the people they hire.[31]

Cappelli contrasts two different views of how worker skills meet employer needs, one based on the industrial-relations tradition of studying workplaces and the other derived from neoclassical economic theory with its focus on supply and demand in the labor market, given exogenously determined technological change. The industrial-relations approach, as he puts it, "suggests that matching skills to job requirements is an employer problem. Over time, employers have internalized the supply of labor, selecting for general abilities at entry-level positions and then training and developing employees over a working lifetime to meet their specific skill needs."[32]

In contrast, the neoclassical economics approach models the demand for skill as determined exogenously by technology. Workers present themselves on the labor market with available skills, and then prospective employees and prospective employers use the market to search for a match that results in a job. Workers can either have the skills to do the job or not be so endowed. In contrast, the industrial-relations approach recognizes that employers set up internal career

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[26] Piketty, *Capital in the Twenty-First Century*, p. 302. See Jon Bakija, Adam Cole, and Bradley T. Heim, "Jobs and Income Growth of Top Earners and the Causes of Changing Income Inequality: Evidence from U.S. Tax Return Data," working paper, April, 2012, at https://web.williams.edu/Economics/wp/BakijaColeHeimJobsIncomeGrowthTopEarners.pdf.

[27] Piketty, *Capital in the Twenty-First Century*, p. 308.

[28] In his discussion of SBTC in his book, Piketty refers to "training", but it is clear from the context that he is referring to the training that one receives in formal education.

[29] Jacob Mincer, "On-the-Job Training: Costs, Returns, and Some implications," *Journal of Political Economy*, 70, 5, 1962: 50-79. "Graduation from some level of schooling does not signify the end of a training process. It is usually the end of the more general and preparatory stage, and the beginning of a more specialized and more prolonged process of acquisition of occupational skill, after entry into the labor force." p. 50.

[30] Peter Cappelli, "Skill Gaps, Skill Shortages and Skill Mismatches: Evidence for the U.S.," Working Paper 20382, National Bureau of Economic Research, August 2014, http://www.nber.org/papers/w20382

[31] Cappelli provides a detailed review of both sides of the skill shortages debate. Here we summarize only his very broad findings and a few of the most relevant studies cited without doing justice to the breadth of his review.

[32] Cappelli, "Skills Gap," p. 6.

ladders (which many economists have incorrectly called "internal labor markets") to generate the types of skilled workers that they require. Once having trained these workers, the employer will want to retain them, in effect transforming labor from a variable cost to a fixed cost.[33]

To assess whether U.S. employers are facing a skill deficiency, Cappelli reviews major reports from government commissions and consultants, surveys of employers, and recruiters, and research by academics. While some of the government and consultant literature reports that we the need to produce high school and college graduates with more technical skills, Cappelli's review concludes that there is very little convincing evidence in support of the idea that U.S. job candidates present themselves to employers with insufficient technical skills.[34] As far as educational deficiencies, he shows that the most objective data from government and academic research suggests the opposite – that a large number of U.S. workers have more education than is needed to perform the jobs that they obtain.[35]

Nonetheless, the hypothesis that employers train workers on-the-job to obtain the skills that are needed is difficult if not impossible to document with quantitative data. Cappelli notes that accurate data on employer-provided training is very hard to come by. The Bureau of Labor Statistics collected data that showed a decline in training during the 1990s but that was 20 years ago.[36] Dramatic changes in employment relations that, as we document later, have occurred since the 1980s strongly suggest that since the 1990s employers have been investing in less on-the-job training than was previously the case.

While Cappelli notes that many surveys suggest that employers are facing difficulties in hiring for jobs in more advanced manufacturing and IT, he considers most of the evidence to be unreliable and contradictory. An exception is a study of manufacturing by Osterman and Weaver that he deems to be both reliable and relevant.[37] Cappelli, Osterman and Weaver share "results from their own survey and find that two-thirds of employers report having no vacancies and only 25 percent have had vacancies open long enough to suggest there was difficulty in filling them. The most common of their self-reported explanations as to why filling those long-term vacancies has been difficult was that candidates lacked industry-specific skills (41 percent), and the second most common explanation was that the wages they were offering were not sufficient to attract candidates (11 percent)."[38] Osterman and Weaver's finding about the deficiency of industry specific skills is consistent with our emphasis in this paper on the importance of careers for skill development. Further, their wage evidence hardly supports the SBTC hypothesis.

Cappelli offers a hypothesis that employers' reports of hiring difficulties are probably connected to their increased need for hiring caused by their decision to reduce investment in internal career ladders that enable promotion within the firm. Cappelli and others have written about the decline of job tenure among U.S. workers over the last several decades, particularly for male workers.[39] In

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[33] See Walter Y. Oi, "Labor as a **Quasi**-Fixed Factor, " *Journal of Political Economy*, 70, 6, 1962: 538-555.

[34] We have chosen not to list the many reports that he cites.

[35] Stephen Vaisey, "Education and Its Discontents: Overqualification in America, 1972–2002," *Social Forces,* 85, 2, 2006: 835-864.

[36] U.S. Department of Labor, Bureau of Labor Statistics, http://www.bls.gov/ept/home.htm

[37] Paul Osterman and Andrew Weaver, "Skills and Skill Gaps in Manufacturing, " in Richard Locke and Rachel Wellhausen, eds., *Production in the Innovation Economy*, MIT Press, 2014

[38] Ibid.

[39] Peter Cappelli, *New Deal at Work: Managing the Market-Driven Workplace*. Harvard Business School Press, 1995; Paul Osterman ed., *Broken Ladders: Managerial Careers in the New Economy*, Oxford University Press, 1996; Sanford M. Jacoby, "Are Career Jobs Headed for Extinction?," *California Management Review*, 42, 1, 1999: 123-145; Peter Cappelli, "Career Jobs are Dead," *California Management Review*, 42, 1, 1999: 146-167; Henry Farber, "Job Loss and the Decline

this paper, Cappelli cites Bidwell's research showing that job tenure has declined more at large firms, and notes that it is in the big firms that internal promotion had been most developed.[40] Employers have to hire externally for more levels of jobs in their firms, whereas in the past, career job ladders generated the relevant skills internally. Yet, given the decline of internal training, when employers seek to hire "skill-ready" workers in the labor market, they find that the candidates are, as the Osterman and Weaver study documents, deficient in industry skills.[41] Cappelli adds that employers are now demanding that new hires have more work experience and internships, citing evidence of the decline in the rates of hiring people fresh out of high school and college. These findings are consistent with a decline in employer investment in internal skill development as part of a widespread effort to make workers themselves responsible for making these investments in industry-specific skills on their own.

In a paper that also bears on the match of worker skills and employer job needs, Liu and Grusky conduct an analysis of the changes in the skill requirements of occupations and the changes in the compensation to workers in occupations with differing changes in skill requirements.[42] They argue that research on the effect of SBTC on inequality has concentrated on either education as the measure of skill[43] or on technical skills related to computerization as the primary skill that employers need,[44] neglecting other dimensions of higher-level skills, such as analytical and conceptual skills. Note, however, that while Liu and Grusky offer sociological explanations for "the payoff to skill," they accept unquestioningly the neoclassical economic model of wage determination.

Liu and Grusky state early in their paper: "The most obvious prerequisite for any increase in the payout to a particular type of skill is that demand for that skill exceeds the supply of labor that can provide it." To compound the irony of their acceptance of the neoclassical model while illustrating the kind of conceptual jumble that exists in research on the SBTC hypothesis, they then state, correctly from our point of view, that they are analyzing skills that are developed on the job and *not* skills that are supplied through the market. As they put it quite clearly: "The presumption underlying our approach is that workplace-based indicators [the data on skills that Liu and Grusky use] speak to the skills that occupational incumbents tend to develop as they carry out their occupational duties."[45]

Perhaps because they are sociologists who take the study of what goes on in organizations as normal science, they clearly understand that, while these incumbents may have arrived at employers' doorsteps with some types of skills, these workers develop the skills that they actually use on their jobs in the context of their employment. The implication, which they do not state, is that the differing levels of pay that they observe in their data reflect different levels of skill and capability that are the results of their on-the-job employment experience, including career tracks and lengths of tenure. Liu and Grusky's empirical findings support our hypothesis that, especially

of Job Security in the United States," in Katharine G. Abraham, James R. Spletzer, and Michael Harper, eds. *Labor in the New Economy*, University of Chicago Press, 2010: 223-262; Matissa Hollister, "Employment Stability in the U.S. Labor Market: Rhetoric vs. Reality," *Annual Review of Sociology,* 37, 1, 2011: 305-324.

[40] Matthew J. Bidwell, "What Happened to Long-Term Employment? The Role of Worker Power and Environmental Turbulence in Explaining Declines in Worker Tenure," *Organizational Science*, 24 4, 2013: 1061-1082.

[41] This irony is reminiscent of one definition of the Yiddish word, "chutzpah," which is the case of a child who murders his parents and then throws himself on the mercy of the court because he is an orphan.

[42] Yujia Liu and David B. Grusky, "The Payoff to Skill in the Third Industrial Revolution," *American Journal of Sociology*, 118, 5, 2013: 1330-1374.

[43] As in, for example, Goldin and Katz, *The Race Between Education and Technology*.

[44] For example, Acemoglu and Autor, "What Does Human Capital Do?"

[45] Yujia Liu and David B. Grusky, "The Payoff to Skill in the Third Industrial Revolution," p.15.

where sophisticated learning is necessary, the development of job-relevant skills depends on what we have called collective and cumulative careers.

Liu and Grusky's goal is to see how the skill content of jobs has changed in the last thirty years and how the payoff to different types of skill has changed during this period as well. They use the occupations held by respondents in the Current Population Survey from 1979 to 2000 to measure the distribution of occupations over time. Their measure of the skills required by occupations is generated from the O*NET data base. Liu and Grusky collapse the wide range of upper level skills (according to the O*NET ranking of skills) into a set of eight composite skill categories using a form of factor analysis similar to procedures used by previous researchers who have grouped skills in the O*Net data base. The resulting categories contain computer, and scientific and engineering skills, but also include, among some others, analytic skills, managerial skills, and creative skills.

They are able to estimate the changes in occupational skill requirements over time because the ratings of skill requirements for some of the occupations in the O*NET were done twice.[46] They find increases in the reported skill requirements in most categories. These increases incorporate changes in the composition of occupations as well as changes in occupations. None of the increases over the thirty-year period is large: cognitive skills (analytic, verbal and quantitative) show a four percent increase, computer skills an eight percent increase, and about six percent each for managerial and creative skills. As Cappelli notes in his citation of the paper, Liu and Grusky find "*computer skill requirements up eight percent, surprisingly small given the dramatic increase in the use of computers, and especially relevant for the STEM skills debate, no increase in science and engineering skill requirements.*"[47] The size of the increase in computer skill requirements and the lack of increase in technical skill requirements constitute clear evidence against the SBTC hypothesis.[48]

Using CPS data, Liu and Grusky then estimate the change in the payoff from 1979 to 2010 to the different types of skill by including their skill requirement categories for the jobs held by respondents in familiar-type wage regressions that they also report, controlling for the individual characteristics of the respondents. They find that the payoff to computer skills has increased very modestly, the payoff to scientific and engineering skills is essentially unchanged, the rise in the payoff to managerial skills is about 20% higher than for computer skills , and the largest increase

[46] O*NET was written in 2000 using the original Dictionary of Occupational Titles (DOT) occupational skill requirements from 1977 plus a set of new occupational skill requirements that were added in 1999 so that the O*NET could include all the occupational categories of the Standard Occupational Classification System (SOC), which was instituted in 2000. A portion of the occupational categories in the O*NET were updated between 2001 and 2008. The earlier ratings were done by analysis as in the DOT, but the later ratings were done through surveys of incumbent workers in the relevant occupations. Liu and Grusky make a number of assumptions and use several procedures to make compatible the ratings from analysts and incumbents and to generate a linear path of skill change from 1979 to 2000 out of the limited repeated skill measurements in the O*NET. It is beyond the scope of this paper to evaluate their methods.

[47] Cappelli, "Skills Gap," p. 26 (our emphasis).

[48] We should note that the use of computers is different than the requirement of computer skills. David Autor discusses this distinction in "Polanyi's Paradox and the Shape of Employment Growth," paper presented at the Federal Reserve Bank of Kansas City's economic policy symposium on "Re-Evaluating Labor Market Dynamics," August 21-23, 2014 (the paper that we cite immediately below). The distinction reflects the two pieces of the SBTC/Polarization hypothesis and how they together form a general story of jobs and wages. The first piece is that rising demand for technical and computer skill is a prime driver of the change in the distribution of wages. The second is that computers have replaced some job tasks and complemented the productivity of other job tasks, which in turn has affected the relative demand for people to do these different types of tasks and hence the wages that people in different types of jobs receive, based upon which types of tasks dominate the job.

has been in the payoff to analytical skills, over three times the increase to computer skills.[49] These results constitute further evidence contrary to the SBTC hypothesis.

A little caution is in order, perhaps. The occupations that appear under analytical skills contain two types of scientists, including computer scientists, and two types of engineers, including computer software engineers although computer software engineers also appear under computer skills along with most categories of upper level computer jobs, and the vast majority of scientists appear under scientific and technical skills. Although the data and procedures used cannot provide us with a sharp empirical accept/reject decision for the SBTC hypothesis, the results are unmistakably inconsistent with it. They add to the large slate of empirical inconsistencies that afflict SBTC. We should also note that these data indicate skill requirements, and do not tell us about how these skills are utilized on the job or how the skills were developed in the first place.

As a final observation on the Liu and Grusky paper, the largest increase in payoff to skill comes in the analytical skill category, which includes the occupations of chief executive and financial manager. The next biggest increase is for managerial skills under which these two occupations also appear. This finding reinforces the results of Saez and Piketty and others on the salaries of top executives and managers who dominate the top 0.1% of the earnings distribution, results that, as we have seen, are left unexplained by SBTC.

Autor has presented a paper recently in which he reports evidence that, contrary to the predictions of SBTC, there was no job polarization in the 2000s.[50] In particular, he observes that the top category of jobs did not grow in relative terms, and further that college-educated workers were getting fewer jobs in the higher abstract thinking job category and taking more in the bottom category of manual jobs. He concludes that at the top, job growth is slower than college-educated supply growth causing an oversupply of college-educated people.

In a major reversal, Autor also observes that in the 2000s job patterns did not correspond to wage patterns. Wage growth in general was anemic in the 2000s, and wages grew more at the top than the middle and more at the middle than the bottom. This pattern is particularly problematic for SBTC for the lower level jobs because the number grew but wages declined. He explains this result by saying the labor supply to low-level jobs is elastic. He cites and agrees with Beaudry, Green, and Sand who argue that that middle and higher skill [i.e. educated] people are not getting jobs commensurate with their education so they are bumping down the ladder, taking lower skill jobs, and thus swelling the supply to lower skill jobs and causing further difficulties for lower skilled job seekers.[51]

Mishel provides a useful summary of Autor's paper.[52] He does not, however, note a very interesting observation that Autor makes towards the end of his paper, and a hypothesis that he generates in

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[49] Liu and Grusky report the change in the payoff to various skills graphically, either as the trend line across the period in the coefficients from the log wage regressions for each year or as a bar graph of the percent effect on wages of a one standard deviation change in the level of requirement for that skill. It is hard to be precise in the comparisons across skills, both because the estimation procedure involves a number of assumptions about how to include the skill requirements and because of the graphical presentation of the results. But the general pattern from their research is clear.

[50] Autor, "Polanyi's Paradox and the Shape of Employment Growth".

[51] Paul Beaudry, David A. Green, and Benjamin M. Sand, "The Great Reversal in the Demand for Skill and Cognitive Tasks," NBER Working Paper No. 18901, March 2013; Paul Beaudry, David A. Green, and Benjamin M. Sand. "The Declining Fortunes of the Young since 2000," *American Economic Review*, 104, 5, 2014: 381-86.

[52] Lawrence Mishel, "Broadening Agreement That Job Polarization Wasn't Present in the United States in the 2000s," The Economic Policy Institute Blog, August 22, 2014.

response to this observation. Autor offers as an explanation for the declining fortunes of college-educated labor (an obvious anomaly for SBTC) that computer investment turned down sharply in 2000 after a surge in the prior five or so years. He first argues against two possible explanations for this decline in investment. One is that the productivity benefits of the computer revolution entered a stage of diminishing returns. The second is that both the demand for educated labor and computers declined because the initial demand for both, during the period when computers were a new technology, has slowed as use of computers has become more routine.

Instead, Autor opines that the fall off in computer investment was probably related in part to the bursting of the tech bubble in 2000. He then suggests the following, "Less appreciated, I believe, are the economic consequences beyond the technology sector: a huge falloff in IT investment, which may plausibly have dampened innovative activity and demand for high skilled workers more broadly."[53] Thus he is arguing that computer investment is necessary for innovative activity. With the decline in investment in computers, the demand for college-educated people to work with those computers also fell. This simultaneous reduction in innovative activity and the growth in the wages of college-educated workers occurred, in Autor's continued spinning of the neoclassical story, purely through the forces of supply and demand. Autor's latest speculation stands in sharp contrast to the causal story we tell below that rests on a theory of corporate resource allocation that in the 2000s weakened the earnings of even STEM workers, the high-tech members of the U.S. labor force who as a broad group should have been best positioned in the 2000s to benefit from the ongoing information-and-communication technology (ICT) revolution.[54]

Looking at the empirical findings that have been used to argue against SBTC and job polarization, we can summarize the key points. While the middle of the wage and job distribution has declined over the span of the last three decades, the pattern of employment and earnings changes appears to be different in the 1980s, the 1990s and the 2000s. Wages have stagnated, on average, through large segments of the earnings distribution below the top ten percent for the last three decades while those at the lowest end of the distribution have experienced periodic sharp declines in their incomes. The college wage premium has declined since 1995. The earnings of the 0.1%, about two thirds of whom are top executives, have increased meteorically, separating executives as a group away from the rest of the distribution.

If the prevailing view based upon SBTC and job polarization falls short, how then are the findings to be explained? Mishel, Shierholz, and Schmitt (MSS) argue, and cite research to support their claim, that a particular set of "policy choices" plus the growth of the financial sector and the ability of corporate CEOs and top executives to set their own salaries are the key elements of the explanation.[55] According to their argument, the gap between the middle and bottom of the wage distribution has been caused in large part by failure of the minimum wage to be raised adequately if at all over the period. A significant contributor to the rising gap between the middle and the top

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53 Autor "Polanyi's Paradox and the Shape of Employment Growth," p.23.

54 This hypothesis of what may have happened to college-educated workers over the course of the 2000s is ad hoc theoretical speculation based solely on the fact that both the college wage premium and investment in computer equipment declined during the period. It is not grounded in the actual changes in research and development activities or employment relations in actual companies in the sectors about which the hypothesis is speculating. William Lazonick reports the results of such deeply grounded research and presents the causal framework for which we are arguing in his book *Sustainable Prosperity in the New Economy?, Business Organization and High-Tech Employment in the United States* published in 2009 by the Upjohn Institute for Employment Research. This research has gained notice in some circles (Lazonick's book was awarded the 2010 International Schumpeter Prize) but to our knowledge has been uniformly ignored by the proponents of SBTC.

55 Lawrence Mishel, Heidi Shierholz, and John Schmitt," "Wage Inequality: A Story of Policy Choices.," published online 4 August 2014 http://s2.epi.org/files/charts/wage-inequality-a-story-of-policy-choices.pdf

has been the decline of unions, made worse by changes in labor law. International trade has contributed to the loss of jobs and the decline in wages in the middle of the distribution as well. Offshoring has decreased the demand for and the wages attached to middle-income jobs, but is now threatening jobs and wages further up the job ladder into white collar and some higher skill jobs. Deregulation in industries such as transportation, telecommunications and utilities have contributed to the decline in the wages of middle-income jobs in those industries. "A dysfunctional immigration policy" has depressed wages at the bottom and parts of the top of the wage distribution.

These policies, MSS maintain, have reduced the bargaining power of labor, as has the lack of a full employment macroeconomic policy particularly over the last 15 years. The erosion of the social safety net has only made matters worse. To explain the surge of salaries of the 0.1%, they cite the large growth of the financial sector and failures in corporate governance that have allowed top executives at non-financial and financial companies to set their own salaries. MSS do not explain this financialization of the economy within their "policy choices" framework. Nor do they make any connection between financialization and the wage-distribution among non-executive employees.

It is very hard to argue that the "policy choices" that MSS describe have not damaged the wages and the bargaining power of U.S. workers. Given the evidence, the effect of these policy choices appears to be a more persuasive explanation than SBTC. However most of the policies that MSS list do not address the employment situation of STEM workers. They do cite new developments in offshoring and immigration of foreign technology workers primarily through the H-1B program, but as we show below competition from foreign STEM workers is only part of the story. More importantly, MSS do not have a theoretical framework to explain how the corporate executives who make up most the top 0.1% have been able to engineer their extremely large salary increases or why the changes have been so dramatically large in the last few decades as compared to earlier. After all, the large managerial corporation has dominated the U.S. economy for over a century.[56] Finally, they do not have a theoretical framework that ties together the rocketing salaries of the 0.1% with the deteriorating situation of STEM and other high-wage white-collar workers, the erosion of middle income jobs, or the failure of SBTC to explain the difference in the pattern of job and wage changes over the three decades. In focusing on the decline of collective and cumulative careers (CCCs) among STEM workers, we build on Lazonick's already well-documented argument that the explosion of executive pay and the erosion of middle-class employment opportunities are integrally related.[57]

3. What Do We Know About STEM CCCs?

a) The STEM labor force

As outlined in the introduction to this paper, the rise to dominance of the New Economy Business Model (NEBM) put an end to employment relations based on the realistic expectation of a career with one company that in the post-World War II decades had become a U.S. corporate norm. But the rise of NEBM did not put an end to the need that high-tech workers had for access to careers over the course of their working lives. Like all other members of the labor force, high-tech workers

[56] Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business*, Harvard University Press, 1977; William Lazonick and David J. Teece, eds., *Management Innovation: Essays in the Spirit of Alfred D. Chandler, Jr.*, Oxford University Press, 2012.
[57] See Lazonick, "Labor in the Twenty-First Century".

need to support themselves and their families financially over the decades that they can expect to remain alive. Moreover, because the technologies with which they work are constantly undergoing change and because the learning that makes them productive in working with these technologies comes through experience accumulated in employment, each high-tech worker has to figure out how to pursue his or her career across different employing organizations, be they business, government, or civil society, now that the norm of a career with one company is gone.

Under OEBM, companies valued experienced workers because of the roles that they could play in making productive contributions to proprietary technology systems. In sharp contrast, the open technology systems that underpinned the rise of NEBM placed the livelihoods of high-tech workers in jeopardy when they reached their 40s or 50s, ages when their cumulated experience should have enabled them to make highly productive contributions to the further development and utilization of technology. Some younger actual or prospective high-tech workers have coped with the heightened riskiness of pursuit of high-tech careers by selling their minds to the financial sector in which from the mid-1980s there was a possibility that they might “earn” in a few years what they could not hope to make over the course of a lifetime as a high-tech employee on a “normal” (i.e., OEBM-like) career path. Alternatively, with the rise of NEBM, a young high-tech employee might hope to strike it rich by working for stock options with a startup that might do an IPO or be acquired by an established company. Increasingly from the 1980s high-tech members of the U.S. labor force came from low-wage developing companies, and a viable way for them to pursue their careers after acquiring work experience in the United States was to return back home. Taking advantage of the emergence of global value chains with the globalization of NEBM, these high-tech employees can pursue CCCs through what Saxenian has called the “brain circulation” process.[58]

Recognizing the problems of pursuing CCCs under NEBM, how then can we characterize the U.S. high-tech labor force and the productive capabilities that they possess? In this paper we provide an analysis of the U.S. STEM labor force under NEBM, in essence examining the workforce outcomes of the changes in business strategy and employment practices that have come to dominate U.S. high-tech fields over the past quarter century. Our analysis of the STEM labor force in this section focuses on the quantitative dimensions of wage levels and labor supply because these are the key data used in the SBTC analyses, and hence these data enable us to poke some new holes in the fragile SBTC fabric. More than that, however, we provide this quantitative overview of the U.S. STEM labor force as an essential step in an analysis of the possibilities and problems for members of the U.S. STEM labor force in pursuing CCCs in a world of open systems.

The analysis in this section also examines the policy response to changes in firm employment strategy that have affected STEM workforce supply and career outcomes. Have these policy responses supported or undermined the prospects for STEM workers to pursue CCCs? As we shall see, evidence suggests that in direct response to changes in firm strategy (and often at the behest of industry through lobbying), policymakers have enacted legislative and funding changes that have had direct effects on STEM workforce supply, employment conditions, and the potential for CCCs.

The STEM workforce is a central focus of national policy debates because the availability of an adequate supply of scientists and engineers is considered to be critical to economic growth, public

[58] AnnaLee Saxenian, “From Brain Drain to Brain Circulation: Transnational Communities and Regional Upgrading in China and India,” *Studies in Comparative International Development*, 40, 2, 2005: 35-61.; see also Lazonick, *Sustainable Prosperity*, ch. 5.

health, national security, and environmental sustainability. But what constitutes an adequate supply of STEM workers? Investments in human capital are costly, entailing expenditures by households, governments and businesses.[59] To secure an adequate labor supply, employers need to be able and willing to pay STEM workers sufficiently to motivate them to pursue careers in their chosen fields and to exert the quality and quantity of effort at their places of work to make the productive contributions that employers expect of them.

An "adequate" supply of STEM workers cannot be measured simply by adding up the number of STEM workers who are, by virtue of their education and experience, available in the economy. For a given level of pay, it is the productive contribution of the STEM worker that is of critical importance to his or her employer. And, in principle at least, it is the enhanced productive contributions of the employee that makes the employer able and willing to pay him or her higher wages. *These "productivity bargains" that determine the levels of productivity and pay do not take place in the labor market. They are negotiated in the workplace (broadly speaking) through a set of institutions and norms that constitute a prevailing "business model".*

In effect, the demand for and supply of STEM workers are integrally related precisely because, for the STEM labor force to be in "adequate supply", the productivity and pay conditions of employment are determined in the high-tech workplace, not in the high-tech labor market.[60] In considering the available statistics on the number of STEM workers in the U.S. labor force and the remuneration that they receive, we must keep this fundamental analytical difference between the SBTC and TIE approaches in mind. We will then be better positioned to explore the implications of the TIE approach for the operation and performance of the economy in the last two sections of this paper.

The STEM workforce, as defined by Bureau of the Census and by other agencies as the "Core-STEM" workforce, is composed of computer workers, engineers, mathematicians and statisticians, life scientists, and physical scientists but excludes social scientists and healthcare workers.[61] As shown in Table 2 the "Core-STEM" workforce is quite small as a proportion of the total workforce at 4.5%. The education level of the STEM workforce is much higher than the overall workforce, with 70% holding at least a bachelors' degree, as compared to only 27% of the entire workforce

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[59] Matt Hopkins and William Lazonick, "Who Invests in the High-Tech Knowledge Base?" Institute for New Economic Thinking Working Group on the Political Economy of Distribution Working Paper No. 6, September 12, 2014 (revised December 4, 2014).

[60] For this principle of workplace-centered wage determination more generally, see William Lazonick, *Competitive Advantage on the Shop Floor*, Harvard University Press 1990. Inadvertently, this principle gained a certain amount of recognition among mainstream economists in the late 1970s and early 1980s with the popularity of the notion of "efficiency wages". See George A. Akerlof and Janet L. Yellen, eds., *Efficiency Wage Models of the Labor Market*, Cambridge University Press 1986. But the notion of efficiency wages was put forward primarily to explain Keynesian-style "wage stickiness" in the 1970s when real wages in the U.S. economy rose at an average rate of 1.0% per year, despite high rates of inflation and high levels of unemployment. For mainstream economists, the microeconomics of the "efficiency wage" phenomenon was only a by-product of their macroeconomic focus on the relation between unemployment rates and earnings levels, and interest in efficiency wages largely disappeared from mainstream discussions over the course of the 1980s as, largely because of what Lazonick has called "rationalization" (see below) "wage-stickiness" among blue-collar workers dissipated. In a sense, among liberal mainstream economists, SBTC took the place of the efficiency-wage hypothesis without recognizing that, empirically, the former debate was about wage determination in the labor process, not in the labor market. Of course, the title of the Akerlof-Yellen collection of essays cited above indicates that they themselves perceived of "efficiency wages" as being determined in the "labor market", which from a microeconomic perspective is a nonsensical notion.

[61] As discussed below, this is a somewhat arbitrary delineation of occupations, with no particular empirical basis, but has been widely adopted. For example, see, Liana Christin Landivar, "The Relationship Between Science and Engineering Education and Employment in STEM Occupations," *American Community Survey Reports, ACS*-23, U.S. Census Bureau, 2013.

with at least a bachelors' degree. Only 12% of the workforce with at least a bachelors' degree hold a "Core-STEM" job and only 27% of "Core-STEM" degree graduates are in a "Core-STEM" occupation.

Table 2. U.S. STEM workforce, numbers and education, 2012

Employment Category	No. of workers	% share
Total US Workforce	155,959,000	100.0
US workforce with BA+	41,640,630	26.7
BA+ grads with STEM degree in the workforce	13,294,435	8.5
Core-STEM workforce (all workers)	6,970,442	4.5
All BA+ grads in Core-STEM job (excluding social science & health)	4,932,525	3.2
Core-STEM BA+ graduates in a Core-STEM occupation	3,571,240	2.3
Proportion of *"Core-STEM" BA+ graduates in "Core-STEM" occupations* within BA+ grads with STEM degree in the workforce		*26.9*
Proportion of *all BA+ workforce in "Core-STEM" occupation* within *US workforce with BA+*		*11.9*

Sources: U.S. Census Bureau, 2012 American Community Survey; "Where do college graduates work? A special focus on Science, Technology, Engineering and Math" July 10, 2014 https://www.census.gov/dataviz/visualizations/stem/stem-html/ (calculations by authors); Landivar, "The Relationship Between Science and Engineering Education and Employment in STEM Occupations".

The STEM acronym has replaced the earlier "S&E" (scientists and engineers) over the past half-dozen or so years. Tabulations of scientists and engineers, and including mathematicians, was first done in the 1960s as an assessment of the stock of workers who were working on, or could be engaged to work on, science and technology that was important to the national interest. At the time, the primary interest was military development in the context of the Cold War and the Space Race, although it was acknowledged that innovation in a broader range of fields was important for the nation.

The rationale for which groups were included in S&E, and those which were excluded, appears to have been largely a matter of bureaucratic jurisdiction, with NSF surveying its constituency and NIH surveying theirs (although some occupations were surveyed by NSF at the request of the NIH). Thus, "S&E" included social scientists but excluded most health professions unless they were directly and substantially involved in medical research. One rationale for making the S&E delineation, discussed within NSF and other agencies, was that "R&D", or generating new knowledge, differentiated S&E occupations from those that were "practitioners": thus, a physician as practitioner was not considered to be generating new knowledge unless he or she worked in a laboratory or formally in research.[62] One problem with this delineation is that many scientists and most engineers are working as practitioners. Another problem is that new knowledge generation through the performance of R&D is not limited to the science and engineering workforce. Importantly, this initial data collection effort was a census of the workforce and of graduates but was not initially designed as an overall assessment of the transition from college into S&E careers.

The original definition of the S&E workforce does not appear to have been questioned until the late 1990s. At this point, following the presumptive end of the Cold War, R&D investments were more generally recast as in the economic general interest rather than just the national defense

[62] This discussion draws from work-in-progress by Hal Salzman.

interest at a time when large military cuts were contemplated as the "peace dividend" for "winning the Cold War." It was also during the 1990s that the ICT workforce grew rapidly. The majority of the ICT workforce did not consist of formally trained scientists or engineers (see below for composition of the ICT workforce).

Adding "T" (technology) to the mix in the past decade achieved the objective of explicitly including the ICT workforce in S&E discussions and tabulations. And it brought the newly developing ICT industry groups and lobbying efforts into the previously rarified S&E policy arena populated by the beneficiaries of widespread support across the aisle, still under the only slightly tarnished NASA and "Science" halos. Adding the "M" formally acknowledged the inclusion of mathematicians but they were only three percent of the STEM workforce, or a fraction of one percent of the entire workforce.[63]

Even with the widespread adoption of "STEM" as the accepted acronym, there is still no standard definition of STEM, nor is there a clear rationale for establishing its delineation from other occupations or fields of study. Nor is there consistency in whether "STEM" refers to educational field, occupation, or industry. For example, the longstanding definition of S&E as used by NSF and nearly all government agencies (e.g., Census, GAO) and statistical analyses include social scientists but exclude health practitioners.

Thus, as just one example, a biology major who becomes a physician is not considered to be in a STEM occupation and, when educational pathways are examined, is considered to have left the STEM field. This biology major turned physician is therefore considered a "loss" from the STEM pipeline and one of those students who is part of the statistic of having been "diverted" away from a STEM field. If the rationale is that a physician is not "doing science" as a practitioner, then it raises the question of why a civil engineer reviewing building plans for a local government (one of the major employers of engineers) is considered part of the STEM workforce and the intended STEM outcome of the engineering field. These particulars illustrate the larger point that focusing on the STEM workforce is an arbitrary construct, created without reference to the activities in which these workers are employed and the types of organizations for which they work. This definition of the STEM workforce has political and policy implications, including adhering to an explanation of the "adequacy" of the STEM workforce as the sum total of household decisions mediated by markets rather than institutional factors that may be shaping the strategies and structures of the government agencies, business enterprises, and civil society organizations in which these STEM workers may be employed.[64]

The growth of the ICT industry appears to have driven the redefinition of S&E to STEM. The need for a new category of "T" that is neither science nor engineer (nor math) is because ICT, which is about half of the entire STEM workforce population, has only a quarter of its workforce with a four-year degree in computer science and only one-third have a college degree in any ICT-related or S&E/Math field.[65] The use of STEM rather than S&E has further complicated workforce and

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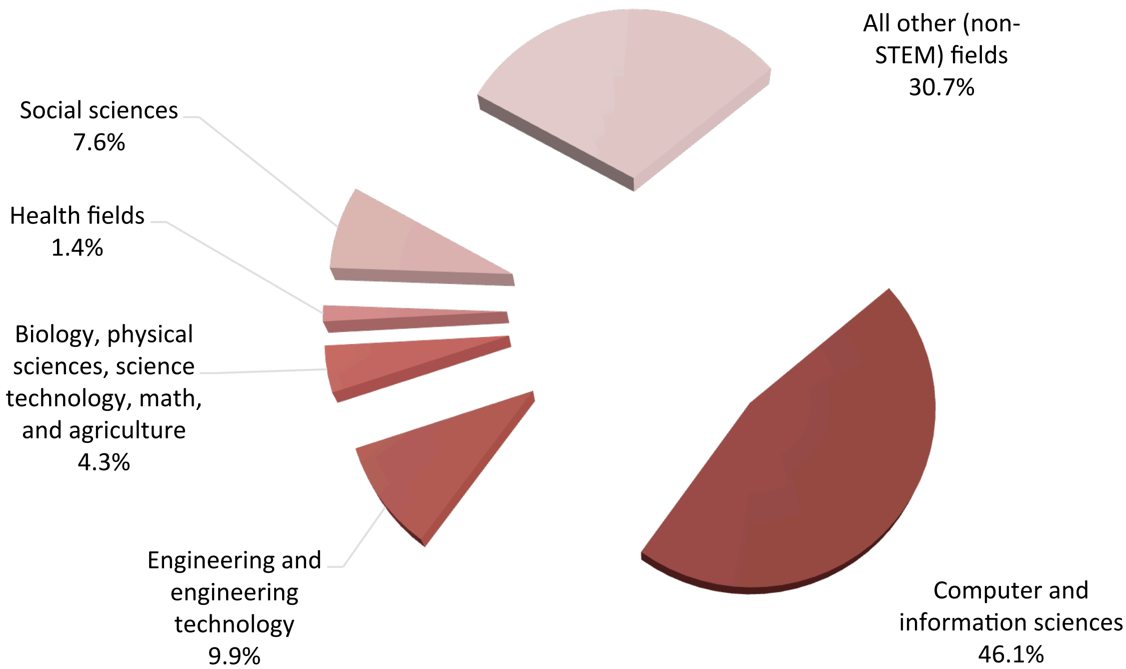
[63] Although OES doesn't specify location of employment for mathematicians in government beyond "Federal Executive Branch industry," the NSA seems to be the largest employer of mathematicians according to some sources. See Harvey A. Davis, "Statement for the Record before the Governmental Affairs, Subcommittee on International Security, Proliferation, and Federal Services Hearing on Critical Skills for National Security and the Homeland Security Federal Workforce Act," United States Senate, Washington D.C., March 12, 2002, at https://www.nsa.gov/public_info/speeches_testimonies/12mar02.shtml

[64] See Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?"

[65] See Hal Salzman, Daniel Kuhn, and B. Lindsay Lowell, "Guestworkers in the High-Skill U.S. Labor Market: An Analysis of Supply, Employment, and Wage Trends," EPI Briefing Paper #359, Economic Policy Institute, April 24, 2013, at

education analyses. Among a cohort of bachelors' degree graduates, about half do not have a computer science degree and nearly 40 percent have a non-STEM degree (see Figure 1 for breakout of the segment of the ICT workforce with at least a bachelors' degree).

Figure 1. Majors of college graduates (2003–2004 freshman cohort) in ICT jobs one year after graduation, 2009



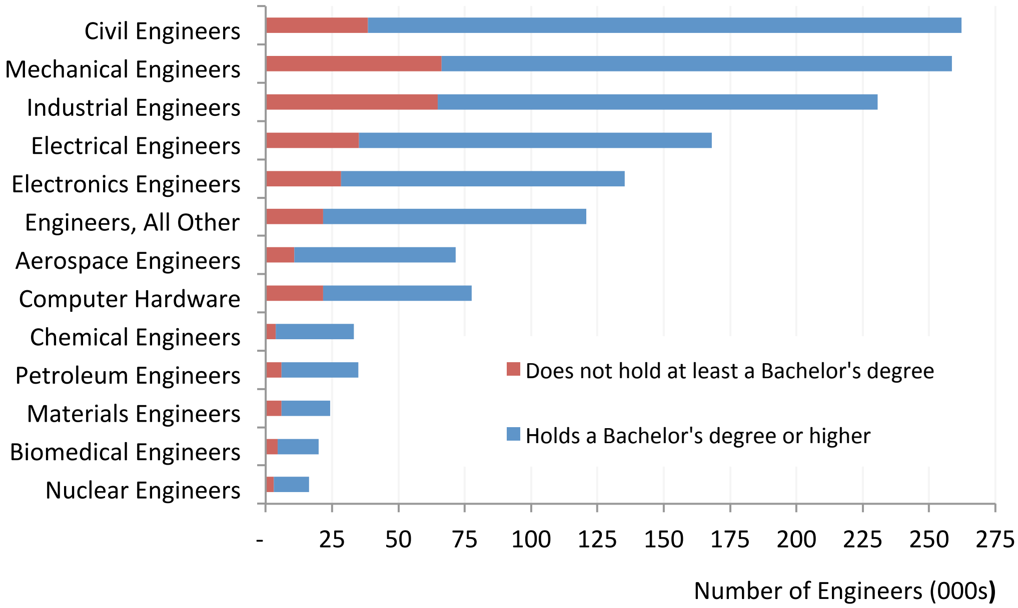
Source: Authors' analysis of National Center for Education Statistics (2013); Salzman et al., "Guestworkers in the High-Skill U.S. Labor Market."

Yet, at the upper reaches of the T category, these workers are at a technical level comparable to at least some fields in engineering. The nature of the ICT field, in terms of both the content of the work and the evolution of its occupations, led to professional status without the licensure or other formalization of qualifications of other fields such as engineering in which the vast majority (ranging from 69% to 89%) of workers in the various engineering occupations hold at least a four-year degree (see Figure 2). Although the upper reaches of the ICT field can be said to have technical skills comparable with formally defined S&E fields, at the lower levels of the ICT field (network support; help desk) it might be more appropriate to compare these ICT workers to mechanics or machinists (in fact, the technical and math content of these latter occupations is, in many instances, much higher than in many ICT occupations).[66]

http://www.epi.org/publication/bp359-guestworkers-high-skill-labor-market-analysis/

[66] See M. M. Kleiner, *Licensing Occupations: Ensuring Quality or Restricting Competition*? Upjohn Institute for Employment Research, 2006.

Figure 2. Number of engineers with bachelor's degree and higher, 2011



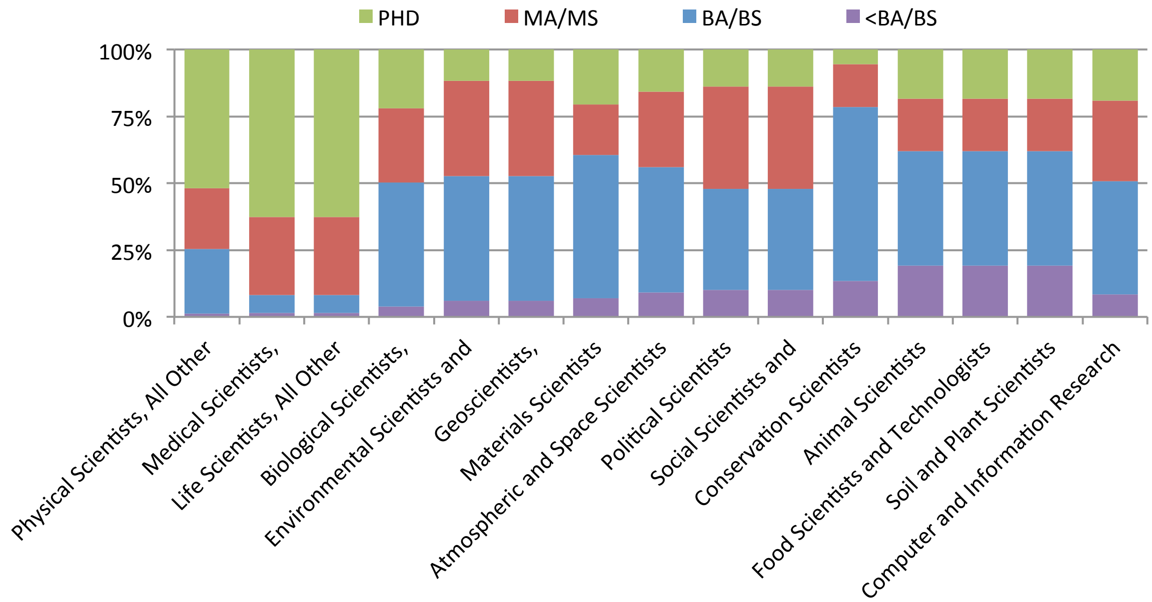
Source: Bureau of Labor Statistics Employment Projections program 2012 employment data available at http://www.bls.gov/emp/tables.htm

The STEM classification further loses coherence when considering the educational pathways for each of its component occupational groups: scientists, technologists, engineers, and mathematicians. There are a negligible number of students who pursue a four-year technical degree path to technologist/technician, other than computer scientists (CS) who we include in engineering fields; most of the other four-year ICT fields are already within the engineering classifications, such as electrical engineering (EE), with some exceptions and variation by college department structure. The "technology" workforce with a post-secondary education outside of CS and engineering is nearly all produced by two-year colleges.[67] When considering engineering fields, as shown in Figure 2, we can see that the vast majority of engineers have at least a bachelor's degree and it appears that in many fields an "engineer" without a degree is an occupational title that workers attain through on-the-job experience and career advancement. In contrast, over a third of the ICT workforce has no four-year degree and two-thirds do not have a STEM degree.

In the Science workforce, the non-BA/BS population is negligible in all but a few small fields. And in many of the science fields, half or more have at least a Masters' degree, as shown in Figure 3.

[67] For an ICT case study of the importance of workers with two-year community college certificates, see William Lazonick and Steven Quimby, "Transitions of a Displaced High-Tech Labor Force," in Tom Juravich, ed., *The Future of Work in Massachusetts*, University of Massachusetts Press, 2007: 111-134.

Figure 3. Science occupations by educational attainment for workers 25 years and older, 2010-2011



Source: BLS Employment Projections based on 2010 and 2011 American Community Survey Public Use Microdata, U.S. Department of Commerce, U.S. Census Bureau, at http://www.bls.gov/emp/ep_table_111.htm

In summary, there is little coherency in the STEM definitions: the different occupations have very different functions within the economy and even within an occupational grouping there can be quite different functions in terms of technology and innovation. For example, consider the difference between a civil engineer working as an inspector in a building department of a municipal government and one working in a large construction or engineering firm. At the same time, career and knowledge development are essential to achieving higher productivity in all high-tech fields. The expansion of "S&E" into "STEM" cannot be explained by any substantive rationale based on occupational, educational, or substantive work content.[68] Nevertheless, given the widespread usage of the STEM classification as a proxy for the high-tech labor supply, it is useful to disaggregate STEM to get picture of the range and types of employment activities in which their members are engaged. In the remainder of this section, we consider STEM employment in the information-and-communication technology (ICT) industrial sector in which NEBM first emerged as the dominant business model,[69] and in the pharmaceutical drug development sector that includes both "big pharma" (including companies such as Pfizer, Merck, and Johnson & Johnson) that became dominant on the basis of OEBM, and "biopharma" that, incongruously as it turns out,

[68] In fact, in the face of research that shows STEM workers are in ample supply, some researchers have redefined STEM so broadly, to *reductio ad absurdum*, that STEM, by virtue of including "T" in the definition, should include all workers with technical skills such as HVAC technicians; or even extending the "math" category to include some retail clerks (because they require numeracy). See Jonathan Rothwell, "The Hidden STEM Economy," *Brookings Institution Report*, June 10, 2013, at http://www.brookings.edu/research/reports/2013/06/10-stem-economy-rothwell . In such definitions, demand for STEM is shown to be large and rapidly growing with the conclusion drawn that neither the education system nor firms are capable of meeting this demand, and thus guestworker supplies must be increased.

[69] Lazonick, *Sustainable Prosperity*.

emerged on the basis of NEBM and has had a profound effect on employment practices in the entire medical drug development industry.[70]

b) STEM employment and earnings in ICT

Given its focus on the impact of the impact of the computer revolution on earnings inequality, SBTC should be able to explain what has happened to employment and earnings in ICT industries that carried out this revolution. As we have seen, the SBTC argument is that the machine technologies made possible by the computer revolution have automated away the relatively lower-level skills that high-school-educated workers provided to the production process coming into the 1980s while creating new demand for the higher-level skills of college-educated workers. As Lazonick has shown in his book *Sustainable Prosperity in the New Economy? Business Organization and High-Tech Employment in the United States*, as an in-depth application of the TIE approach, since the 1970s ICT has been a key sector in which three fundamental transformations in employment have occurred since the 1980s. In subsequent work, he summarizes these transformations as “rationalization”: permanent plant closings that diminished the employment opportunities for (primarily) high-school-educated production workers; “marketization”: the end of the widely prevailing U.S. norm of a career with one company among (primarily) college-educated professional, technical, and administrative workers; and “globalization”: the offshoring by U.S.-based companies of an increasing range of employment opportunities to qualified high-school-educated and college-educated workers in lower wage areas of the world, with India and China in the forefront since the turn of the century. But as we shall demonstrate here, the ways in which employment in ICT was transformed and the implications for income distribution, employment stability, and economic growth cannot be explained by SBTC. Rather we put forth the TIE approach as a far more powerful mode of analysis.

As we have seen, SBTC emerged at the end of the 1980s in an attempt to explain the loss of blue-collar manufacturing jobs and the widening premium to a college education during that decade. It is clear that in the 1980s the microelectronics revolution greatly increased the demand for college-educated workers with computer-related skills. But the notion that it was SBTC that threw blue-collar employees out of work in the 1980s has little empirical basis. Rather, from the beginning of the decade it was Japanese competition that precipitated the plant closings that became endemic in the United States, resulting in the transformation of shop-floor employment relations that Lazonick has summarized as “rationalization.” Instead of confronting the new competition by upgrading the knowledge and capabilities of blue-collar workers through a strategy of retain-and-reinvest, increasing numbers of senior executives of established U.S. corporations imbibed the new ideology that corporations should be run to maximize shareholder value (MSV) – an ideology that legitimized downsize-and-distribute.[71]

As for “skill-biased” technologies, in the 1980s and beyond it was in Japan, with its focus on retain-and-reinvest, not the United States, with its new creed of downsize-and-distribute, that emerged as the world leader in factory automation. Japan was in the forefront in introducing flexible manufacturing systems and robotics. Both the development and adoption of factory automation depended on the existence of a blue-collar labor force with *a high degree of employment security as well as a high level of integration into their companies’ organizational learning processes*, two key characteristics of Japanese employment relations. Japanese production workers, virtually all of

[70] William Lazonick and Öner Tulum “US Biopharmaceutical Finance and the Sustainability of the Biotech Business Model,” *Research Policy*, 40, 9, 2011: 1170-1187;
[71] Lazonick, “Labor in the Twenty-First Century”.

them with only high-school educations, were much more willing and much more able than their American counterparts to cooperate with engineers in their companies in the development and utilization of flexible manufacturing systems and robotics.[72]

As a result Japan, not the United States, became the world leader in factory automation, a position that it still holds by a wide margin,[73] even as the institution of lifetime employment has remained largely intact in Japan.[74] In the new digital age, U.S.-style rationalization reflected a weakness, not a strength, of U.S. manufacturing, especially when the elimination of previously well-paid blue-collar jobs transformed from a reaction to formidable Japanese competition to a finance-driven quest for higher profits in the name of MSV.[75] Invoking this ideology to legitimize their actions, U.S. corporate executives terminated millions of previously well-paid and stable blue-collar jobs without bearing any responsibility for reinvesting corporate profits to help create new middle-class employment opportunities for an upgraded blue-collar labor force. Rather these corporations turned to using billions, and in aggregate trillions, of dollars of corporate cash to manipulate their companies' stock prices.[76]

It should be noted that the Japanese challenge came in industries such as automobiles, consumer electronics, machine tools, steel, and microelectronics in which the United States was a world leader.[77] The critical source of Japan's competitive advantage over the United States was "organizational integration": through the hierarchical integration of shop-floor workers and the functional integration of technical specialists into processes of collective and cumulative learning, the Japanese perfected, and outcompeted, the U.S. "Old Economy" business model.[78]

As Lazonick shows in *Sustainable Prosperity in the New Economy?*, OEBM had provided a large measure of stable and equitable growth to both blue-collar and white-collar male workers in the United States in the post-World War II decades. Yet, even though unionized blue-collar workers had a high degree of job security in this era, they had historically been excluded from the processes of organizational learning within the corporation, reflecting a uniquely American hierarchical segmentation between "management" and "labor."[79] In the face of Japanese competition, this exclusion of shop-floor workers from the processes of organizational learning proved to be the Achilles heel of U.S. manufacturing, precipitating the permanent loss of U.S. manufacturing jobs in the 1980s and beyond.

An institutional pillar of Japan's economic development in the last half of the twentieth century was permanent salaried employment for male workers at both the blue-collar and white-collar

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[72] Lazonick, "Organizational Learning and International Competition," in Jonathan Michie and John Grieve Smith, eds., *Globalization, Growth, and Governance*, Oxford University Press, 1998: 204-238, and references therein.

[73] See the website of the International Federation of Robotics, at http://www.ifr.org/industrial-robots/statistics/. See for example Hitoshi Narita, "Advances in Vessel and Aircraft Technologies," Report to Asian Office of Aerospace Research and Development, May 25, 2010, at https://www.researchgate.net/publication/235193962_Advances_in_Vessel_and_Aircraft_Technologies

[74] See Ryo Kambayashi and Takao Kato, "Long–term Employment and Job Security over the Last Twenty-five years: A Comparative Study of Japan and the U.S., Institute for the Study of Labor, Bonn, Germany, IZA DP 6183, December 2011, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1973912

[75] Lazonick "Labor in the Twenty-First Century".

[76] William Lazonick, "The Financialization of the U,S. Corporation: What Has Been Lost, and How It Can Be Regained," *Seattle University Law Review*, 36, 2013: 857-909; Lazonick, "Profits Without Prosperity".

[77] William Lazonick, "Innovative Business Models and Varieties of Capitalism: Financialization of the US Corporation," *Business History Review*, 84, 4, 2010: 675-702.

[78] Lazonick, "Organizational Learning".

[79] Lazonick, *Competitive Advantage on the Shop Floor*.

levels.[80] The prime source of Japanese competitive advantage was the extension of organizational learning – which is the essence of innovative enterprise – from the managerial structure populated by college-educated professional, technical, and administrative employees to shop-floor production workers, almost all with high-school educations, so that both groups working together could contribute to productivity improvements. Complementing this hierarchical integration of the learning of white-collar and blue-collar workers was the collaboration of Japanese technical specialists in solving productivity problems in manufacturing. The functional integration of their skills and efforts contrasted with the relatively high degree of functional segmentation of technical specialists in the United States.[81] In sum, it was a more hierarchically and functionally integrated system of organizational learning based on employment security that from the 1970s enabled Japanese manufacturers to outcompete U.S. manufacturers in a range of industries in which U.S. companies had previously been world leaders. Or to put it more succinctly, collective and cumulative learning based on CCCs was the source of Japanese competitive advantage.

The particular impacts of Japanese competition varied markedly across U.S. industries. It virtually wiped out the U.S.-based consumer-electronics industry. For example, in 1981, RCA, with 119,000 employees, was one of the leading consumer-electronics companies in the world and the 44th largest U.S. industrial company by revenues.[82] By 1986, General Electric had taken over RCA and sold it off in pieces. During the 1980s, U.S. automobile manufacturers attempted to learn from the Japanese, but three decades later, the U.S. companies were still producing lower-quality, higher-cost cars and, not surprisingly, had lost significant market share.[83] In the machine-tool industry, the overwhelming success of the Japanese against the major U.S. companies was followed in the 1990s by the emergence of export-oriented, small- and medium-sized enterprises producing for specialized niche markets.[84] In the steel industry, the innovative response of the United States was the emergence of minimills, using electric arc furnaces and scrap metal, as distinct from the traditional vertically integrated mills that converted iron ore into crude steel before making finished products. In the 1980s, the minimills had the technological capability to manufacture only long products such as bars and rails, but the introduction of compact strip-production technology, led by Nucor in 1989, enabled the minimills to compete with integrated mills in flat products such as plates and sheets as well.[85]

The most perilous, but ultimately successful, U.S. response to Japanese competition was in the semiconductor industry, which was at the heart of the computer revolution. By the middle of the 1980s, the Japanese had used their integrated skill bases to lower defects and raise yields in the production of memory integrated circuits, transforming one of the most revolutionary technologies in history into mass-produced goods known as "commodity chips". This development

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[80] William Lazonick, "The Institutional Triad and Japanese Development" [translated into Japanese] in Glenn Hook and Akira Kudo, eds., *The Contemporary Japanese Enterprise*, Yukikaku Publishing, 2005, Volume 1: 55-82.

[81] Kim B. Clark and Takahiro Fujimoto, *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*, Harvard Business School Press, 1991; Lazonick, "Organizational Learning"; Lazonick, "Innovative Business Models".

[82] Alfred D. Chandler, Jr., *Inventing the Electronic Century: The Epic Story of the Consumer Electronics and Computer Industries*, Free Press, pp. 13-49.

[83] Michaela D. Platzer and Glennon J. Harrison, "The U.S. Automotive Industry: National and State Trends in Manufacturing Employment," Congressional Research Service, R40746, 2009, at http://digitalcommons.ilr.cornell.edu/key_workplace/666.

[84] Ronald V. Kalafsky and Alan D. MacPherson, "The Competitive Characteristics of U.S. Manufacturers in the Machine Tool Industry," *Small Business Economics*, 19, 4, 2002: 354-369.

[85] Frank Giarratani, Gene Gruver, and Randall Jackson, "Clusters, Agglomeration, and Economic Development Potential: Empirical Evidence Based on the Advent of Slab Casting by U.S. Steel Minimills," *Economic Development Quarterly*, 21, 2, 2007: 148 -164.

forced major U.S. semiconductor companies to retreat from the memory segment of the market, with Intel, a key U.S. chip company, facing the possibility of bankruptcy in the process.[86] In 1971, however, Intel had designed the first "computer on a chip," and in 1974 launched its microprocessor production in Oregon. Those moves positioned Intel to secure the franchise on supplying microprocessors for the IBM PC and its clones, and on this basis emerged by the beginning of the 1990s Intel as the world's leading chip manufacturer. More generally, during the 1980s, as the Japanese (and then the South Koreans) were taking over the memory-chip market, U.S. companies became world leaders in the production of logic integrated circuits, where value was added through chip design rather than manufacturing yield, the area in which the Japanese now excelled. Indeed, relying on the Intel microprocessor and the Microsoft operating system, the rapid emergence of the IBM PC as the industry "open systems" standard in the years after its launch in 1981 was the basis for the rise of NEBM, which, as we shall see, would have profound impacts on the character and viability of CCCs in the ICT industries and even beyond.[87]

The adverse impact on U.S. employment of Japanese competition in consumer electronics, automobiles, steel, and machine tools became particularly harsh in the double-dip recession of 1980–1982 when large numbers of blue-collar jobs permanently disappeared from U.S. industry.[88] Previously, in a more stable competitive environment, U.S. manufacturing companies would lay off workers with the least seniority in a downturn and re-employ them when economic conditions improved. In the 1980s, however, it became commonplace for companies to shutter whole plants.[89] From 1980 to 1985, employment in the U.S. economy increased from 104.5 million to 107.2 million workers, or by 2.6%. But employment of operators, fabricators, and laborers fell from 20 million to 16.8 million, a decline of 15.9%.[90]

As Daniel Hamermesh observed, "[e]ach year during the eighties, plant closings in the U.S. displaced roughly one-half million workers with three-plus years on the job."[91] Over the course of the 1980s, the stock market came to react favorably to permanent downsizings of the blue-collar labor force.[92] As secure middle-class jobs for high-school-educated blue-collar workers permanently disappeared, there was no commitment on the part of those who managed U.S. industrial corporations, or the Republican administrations that ruled in the 1980s, to invest in the new capabilities and opportunities required to upgrade the quality, and expand the quantity, of well-paid employment opportunities in the United States on a scale sufficient to reestablish conditions of prosperity for these displaced members of the labor force.

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86 Robert A. Burgelman, "Fading Memories: A Process Theory of Strategic Business Exit in Dynamic Environments," *Administrative Science Quarterly*, 39, 1, 1994: 24-56; Daniel I. Okimoto and Yoshio Nishi. "R&D Organization in Japanese and American Semiconductor Firms," in Masahiko Aoki and Ronald Dore, eds., *The Japanese Firm: The Sources of Competitive Strength*, Oxford University Press, 1994: 178–208.

87 Lazonick, *Sustainable Prosperity*.

88 Robert W. Bednarzik, "Layoffs and Permanent Job Losses: Workers' Traits and Cyclical Patterns," *Monthly Labor Review*, September, 1983: 3-12.

89 Daniel S. Hamermesh, "What Do We Know About Worker Displacement in the U.S.?" *Industrial Relations*, 28, 1, 1989: 51-59; Candee S. Harris, "The Magnitude of Job Loss from Plant Closings and the Generation of Replacement Jobs: Some Recent Evidence," *Annals of the American Academy of Political and Social Science*, 475, 1984: 15-27.

90 U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1984*, 104th edition, U.S. Government Printing Office, 1983, p. 416; U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1987*, 107th edition, U.S. Government Printing Office, 1986, p. 386.

91 Hamermesh, "What Do We Know," p. 53.

92 John M. Abowd, George T. Milkovich, and John M. Hannon, "The Effects of Human Resource Management Decisions on Shareholder Value," *Industrial and Labor Relations Review*, 43, Special Issue: 1990: 203S-233S; Oded Palmon, Huey-Lian Sun, and Alex P. Tang, "Layoff Announcements: Stock Market Impact and Financial Performance," *Financial Management*, 26, 3, 1997: 54-68.

Among blue-collar workers, blacks were extremely hard hit by the rationalization of employment in the 1980s. They were overrepresented in the declining mass-production sectors of the Old Economy, such as steel, autos, and consumer electronics, and underrepresented in the rising sectors of the New Economy related to the microelectronics revolution. Besides losing jobs when plants were closed, many blacks had recently moved into unionized jobs, so that when some workers in an establishment were laid off, blacks, who were more likely to have been the last hired, were the first fired.[93] The disappearance of these middle-class jobs had devastating impacts on the abilities and incentives of blacks to accumulate the education and experience required to position themselves for the types of well-paid employment opportunities that the microelectronics revolutions helped create.[94]

In retrospect, we now know that the recoveries that followed the recessions of 1990–1991, 2001, and 2007–2009 were "jobless": macroeconomic growth was not accompanied by job growth. Technically, the recovery from the recessionary conditions of 1980–1982 was not "jobless" because employment opportunities created by the microelectronics boom in the first half of the 1980s offset the joblessness that remained in the traditional manufacturing sectors as the U.S. economy began to grow. For example, from 1980 to 1985, employment of mathematical and computer engineers increased from 330,000 to 571,000, or by 73%, and employment of computer programmers increased from 318,000 to 534,000, or by 67.9%.[95] In the expansion of 1983–1985, however, workers in traditional manufacturing industries, who typically held only high-school diplomas, experienced the first of four jobless recoveries of the last three decades. And, in the 1980s, it was Japanese competition that extended organizational learning to the shop floor combined with the financialization of the U.S. industrial corporation that resulted in the permanent elimination of the blue-collar jobs. There is no evidence that these lost employment opportunities and the stagnating wages for blue-collar workers, which we have summed up as "rationalization", had anything to do with "skill-biased technical change".

If the proponents of SBTC misunderstand the rationalization movement of the 1980s, they completely ignore the "marketization" of U.S. employment relations that occurred from the early 1990s. The shift from proprietary technology systems to open technology systems associated with the rise of NEBM represented a pronounced "skill-bias" that favored *younger employees over older employees among the college educated*. The computer revolution was central to this shift. During the first half of the 1980s IBM, which already controlled over 70% of the global mainframe computer market, had led the way in the transition from proprietary systems to open systems through the success of its launch of its personal computer – the PC – with its "Wintel" architecture, based on Microsoft's operating system and Intel's microprocessor.[96] In 1982 IBM's PC sales were

[93] Lori Kletzer, "Job Displacement," *Journal of Economic Perspectives*, 12, 1, 1998: 115-136; Ronald Fairlie and Lori Kletzer, "Jobs Lost, Jobs Regained: An Analysis of Black/White Differences in Job Displacement in the 1980s," *Industrial Relations*, 37, 4, 1998: 460–477; Rochelle Sharpe, "Unequal opportunity: Losing ground on the employment front," *Wall Street Journal*, September 14, 1993.

[94] William Julius Wilson, "When Work Disappears," *Political Science Quarterly*, 111, 4, 1996-97: 567-595.

[95] U.S. Department of Commerce, *Statistical Abstract 1984*, p. 416; *Statistical Abstract 1987*, p. 386.

[96] Michael Borrus and John Zysman, "Wintelism and the Changing Terms of Global Competition: Prototype of the Future?" BRIE Working Paper No. 96B, University of California, Berkeley, 1997. The IBM PC and its clones created the open-systems architecture around the Microsoft operating system and the Intel microprocessor despite Apple Computer's advantage from the early 1980s in having a graphical user interface on its Macintosh computer (which Apple had obtained from nearby Xerox PARC). Microsoft's launch of Windows 95 in 1995, however, definitively settled the issue of the dominant computer architecture. Indeed, according to a Factiva search, the term "Wintel" was first used by Apple Computer executive Ian Diery in 1994 as Apple formed an alliance with IBM to try to undo the dominant position of Microsoft and Intel as the industry standards. See Andrew Gore and Jon Swartz, "Diery: Apple will crack Windows," *MacWeek*, August 1, 1994.

$500 million. Just two years later, sales had soared to eleven times that amount – more than triple the 1984 revenues of Apple, its nearest competitor, and about equal to the revenues of IBM's top eight rivals. Subsequently, the very success of the IBM PC, combined with open access to the Microsoft operating system and the Intel microprocessor, meant that in the last half of the 1980s and beyond IBM lost market share to lower priced PC clones produced by New Economy companies such as Compaq, Gateway, and Dell.[97] Competition based on open systems had become the norm.[98]

The recession and recovery of the early 1990s witnessed the marketization of the employment relation and marked the beginning of the end of the career-with-one-company norm, as, in effect, long-established companies made the transition from OEBM to NEBM. Although in absolute terms, blue-collar workers suffered more unemployment than white-collar workers during the recession of the early 1990s, the extent to which professional, technical, and administrative employees were terminated was unprecedented in the post-World War II decades. Hence the downturn of 1990–1991 became known as the "white collar recession."[99] Increasingly over the course of the 1990s, including during the Internet boom in the second half of the decade, the career-long employment security that people in their forties and fifties had come to expect under OEBM vanished as employers replaced more-expensive older workers with less-expensive younger workers.[100]

Given its size, reputation, and central position in ICT industries, the dramatic changes at IBM in the early 1990s marked a fundamental juncture in the transition from employment security to employment insecurity in the U.S. corporate economy. The open-systems PC revolution that IBM led meant that the company increasingly placed less value on older employees whose decades of experience at IBM were required to add software and services to the company's mainframe based proprietary technologies. As open systems became more important to IBM's future it placed greater emphasis on employment of younger people who came to the company with "Wintel" skills. Moreover during the 1980s companies such as Intel and Microsoft as well as the hundreds of NEBM startups that sought to develop applications for the Wintel standard competed for high-tech talent, not through the Old Economy offer of a career with one company, which as young companies they were unable to promise, but with the inducement of stock options as a portion of the total pay package.

Intel had shown as early as 1971, when it was the first company to list its shares on the newly created NASDAQ stock exchange, that these stock options could become very valuable when a company did an initial public offering (IPO), a lesson that was proven again and again in the ICT industries, especially once Apple had done its IPO in 1980. Indeed, the prime reason why in 1986 Microsoft listed on NASDAQ was to enable its employees, numbering about 1,000, to cash in on their vested stock options. Increasingly during the 1980s, lured by stock-based pay, younger professional, technical, and administrative employees eschewed the security of a career with one company at IBM, Hewlett-Packard, Motorola, or Texas Instruments for the sake of pursuing their

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[97] Chandler, *Inventing the Electronic Century,* pp. 118-119, 142-143.

[98] Henry Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, 2006. In its 1984 *Annual Report* (p. 11), Hewlett-Packard explicitly articulated its strategic decision to manufacture its computer products, including its printers, to conform to "an 'open systems' concept whereby computer makers design their systems so that computers can 'talk' with those of other makers." See Lazonick, *Sustainable Prosperity*, p. 92.

[99] Randall W. Eberts and Erica L Groshen, "Is This Really a 'White-Collar Recession'?" *Economic Commentary*, Federal Reserve Bank of Cleveland, 1991; Jennifer M. Gardner, "The 1990-91 Recession: How Bad Was the Labor Market?" *Monthly Labor Review*, June 1994: 3-11.

[100] Lazonick, *Sustainable Prosperity*, pp. 81-113, 249-279

careers with startups and young New Economy companies, with stock-based pay as a major incentive.[101]

It was in this changing competitive environment that through the 1980s IBM continued to tout its practice of "lifelong employment" as a source of its competitive success.[102] Yet, more than any other company, IBM had created the open-systems architecture through the success of its PC. As a result, as already mentioned, it began to place more value in employing younger (and less expensive) people with the latest programming, design, and marketing skills rather than its older (and more expensive) "lifetime" personnel whose in-house experience had been irreplaceable in an internal proprietary-systems environment. Moreover, during the 1980s, IBM found that in recruiting new employees it had to compete with the stock-based incentives under NEBM while some of the employees that it had trained, and hence hoped to retain, were jumping ship, opting to take a chance with a New Economy company.

In recognition of these changed industrial conditions, from 1990 to 1994, IBM cut its employment from 373,816 to 219,839. This net reduction of 154,000 jobs dropped its labor force to only 59% of its year-end 1990 level.[103] During 1991 and 1992 almost all IBM's downsizing was accomplished by making it attractive for its employees to accept voluntary severance packages, including early retirement at age fifty-five. But in 1993 and 1994, after the recruitment from RJR Nabisco of Louis V. Gerstner, Jr. as IBM's CEO, many thousands of IBM employees were fired outright. In 1995, IBM rescinded the early-retirement offer that had helped downsize its labor force. The offer had accomplished its purpose, and in any case IBM no longer wanted to encourage all employees to remain with the company even until the age of fifty-five.

Of IBM's losses of $15.9 billion in 1991–1993 (including an $8.1 billion deficit in 1993, the largest annual loss in U.S. corporate history to that time), 86% came from workforce-related restructuring charges, including the cost of employee separations and relocations. This loss was, in effect, the cost to the company of ridding itself of its once-hallowed tradition of lifelong employment. Ignoring restructuring charges, IBM recorded positive net incomes before taxes of $939 million in 1991, $2.619 billion in 1992, and $148 million in 1993. Although IBM continued to downsize at a torrid pace in 1994, most of the layoffs were done outside the United States and without voluntary severance provisions. During 1994, the company booked no restructuring charges and had after-tax profits of $3.021 billion. By that time, lifelong employment at IBM was a thing of the past. Subsequently, other Old Economy ICT companies followed IBM's example, and by the end of the 1990s, the previous norm of a career with one company had all but disappeared.[104]

In line with the IBM transition in the first half of the 1990s, John Abowd and his co-authors found a general shift in U.S. employment from older experienced workers to younger skilled workers from 1992 to 1997 as companies adopted computer technologies.[105] Using Current Population Survey data, Charles Schultze discovered that "[m]iddle-aged and older men, for whatever reason, are not

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[101] Ibid., Ch. 2.

[102] Joel Kotkin, "Is IBM good for America?" *Washington Post*, October 6, 1985; Thomas J. Watson, Jr., and Peter Petrie, *Father, Son, and Company: My Life at IBM and Beyond*, Bantam, 1990, pp. 288-289.

[103] The following account is based on Lazonick, *Sustainable Prosperity*, pp. 85-89.

[104] See, for example, William Lazonick and Edward March, "The Rise and Demise of Lucent Technologies," *Journal of Strategic Management Education*, 7, 4, 2011.

[105] John Abowd, John Haltiwanger, Julia Lane, Kevin L. McKinney, and Kristin Sandusky, "Technology and the Demand for Skill: An Analysis of Within and Between Firm Differences," NBER Working no.13043, National Bureau of Economic Research, 2007.

staying as long with their employers as they once did."[106] He went on to show, moreover, that the job displacement rate for white-collar workers relative to blue-collar workers had risen substantially in the 1980s and 1990s, starting at 33% in 1981–1982 and increasing to about 80% in the 1990s. Lori Kletzer wrote in a 1998 survey article on "job displacement":

> Job loss rates fell steadily from the 1981–83 rate, which encompassed the recession of 1981–82, through the expansion period of 1983–89. Job loss rates then rose again in 1989–91 as the economy weakened. The latest job loss figures are surprising. In the midst of a sustained (if uneven) expansion, 1993–95 job loss rates are the highest of the 14-year period: about 15 percent of U.S. workers were displaced from a job at some time during this three-year period. These high rates of job loss are consistent with public perceptions of rising job insecurity.[107]

In a survey of changes in job security from the 1970s to the 2000s, Henry Farber stated that "[t]here is ample evidence that long-term employment [with one company] is on the decline in the United States."[108] Using Current Population Survey data, Farber found that

> mean tenure for males employed in the private sector has declined substantially, particularly for older workers. For example, mean tenure for private sector males at age fifty declined from 13.5 years in the 1973 to 1983 period to 11.3 years in the 1996 to 2008 period. The pattern in the public sector is the opposite. For example, mean tenure for public sector males at age fifty increased from 13.6 years in the 1973 to 1983 period to 15.8 years in the 1996 to 2008 period.[109]

Moreover, it appears that education as a guarantor of employment security weakened significantly from the 1980s to the 2000s. Using Displaced Worker Survey data to analyze rates of job loss, Farber found that

> [i]n 1981 to 1983, the private-sector three-year job loss rate was 16 percent for high school graduates and 9.4 percent for college graduates. By 2001 to 2003 (also a period of weak labor markets), the gap had fallen to virtually zero, with a private-sector three-year job loss rate of 10.7 percent for high school graduates and 11 percent for college graduates. Interestingly, the education gap in job loss rates increased in the 2005 to 2007 period with 8.3 and 10.0 percent job loss rates for high school and college graduates, respectively.[110]

In the jobless recovery subsequent to the "white collar" recession of 1990-1991, earnings of college-educated workers stagnated. At the beginning of 1996, AT&T announced that, as part of its planned spinoff of Lucent Technologies and NCR, it would lay off 40,000 employees, most of them middle managers.[111] For the following months, the media ruminated on "the downsizing of America," including in a seven-part series of front-page articles in the *New York Times* that was subsequently published as a book.[112]

Over the course of 1996, however, talk of downsizing disappeared as the initial surge of what would become the Internet (or New Economy) boom became evident. In December 1996 Fed chairman Alan Greenspan shifted the focus of concern from labor to capital, asking whether "irrational exuberance" in the booming financial markets might be setting the stage for

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106 Charles L. Schultze, "Downsized & Out: Job Security and American Workers," *Brookings Review*, 17, 4, 1999: 9-17.
107 Kletzer, "Job Displacement".
108 Henry Farber, "Job Loss and the Decline of Job Security in the United States," in Katharine G. Abraham, James R. Spletzer, and Michael Harper, eds. *Labor in the New Economy*, University of Chicago Press, 2010: 223-262.
109 Ibid., p. 230.
110 Ibid., p. 253.
111 Abby Goodnough, "A crack in the bedrock," *New York Times*, January 14, 1996. See also Tim Jones, "Amid uproar about layoffs, AT&T retreats," *Chicago Tribune*, March 16, 1996.
112 New York Times, *The Downsizing of America*, Three Rivers Press, 1996.

"unexpected and prolonged contractions", as had indeed happened in Japan.[113] As it turned out, there was a lot of "irrational exuberance" left in the U.S. economy, as the New Economy stock-market boom swept the nation for the next three-plus years.[114]

During the boom of the 1997-2000, wages rose rapidly, especially for college-educated members of the U.S. labor force. For substantial numbers of high-tech employees, this run-up in wages reflected the rise of the New Economy business model, with its broad-based stock-option plans that, as we have seen, had functioned since the 1970s to lure professional, technical, and administrative personnel from secure career employment in Old Economy companies to insecure employment in New Economy startups. An analysis of the role of stock options as a component of pay for a broad base of employees is of utmost importance for understanding the relation between productivity and "wages" for employees at high-tech companies.

As young firms facing a highly uncertain future, New Economy companies could not attract labor away from Old Economy companies by promises of career employment. Instead, New Economy startups used the inducement of employee stock options to attract and retain employees – very high proportions of whom were college educated. As the successful New Economy companies grew large, most, if not all, employees were partially compensated in stock options. For example, Cisco Systems had 250 employees in 1990, the year in which it became publicly traded. After it had come to dominate the Internet router market a decade later, it had over 34,000 employees, virtually all of whom received stock options as part of their compensation.[115]

So that stock options would perform a retention function as well as an attraction function, the practice evolved in New Economy firms of making option grants annually, with 25% of an annual block of option grants vesting at the end of each of the first four years after the grant date. Once the options are vested, they can typically be exercised for a period of ten years from the grant date, so long as the employee remains with the company. Without creating the Old Economy expectation among employees of lifelong careers with the company, the perpetual pipeline of unvested options functions as a tangible retention mechanism. Indeed, for most employees, the amount of options that an individual can expect to receive is tied to his or her position in the firm's hierarchical and functional division of labor, so that the retention function of stock options is integrally related to the employee's career progress within the particular company.[116]

Nevertheless, it is important to emphasize that the original labor-market function of broad-based employee stock-option programs from the early 1980s was to induce high-tech personnel to leave secure employment in established "Old Economy" corporations for insecure employment in "New Economy" startups. When New Economy companies such as Dell, Microsoft, and Cisco grew to be large, the Old Economy norm of a career with one company did not reappear. Rather during the 1990s the norm of a career with one company disappeared at Old Economy corporations as well.[117]

An advantage of stock-based pay for the company is that the funding of these gains comes not from its internal cash flow but rather from stock-market traders who have bid up the company's stock

[113] "Allan Greenspan, Chairman of the Federal Reserve Board, delivers remarks at the American Enterprise Institute dinner," *NBC Professional Transcripts*, December 5, 1996.
[114] It was in March 2000, at the peak of the Internet boom, that Robert Shiller published his book *Irrational Exuberance*, Princeton University Press, 2000.
[115] Lazonick, *Sustainable Prosperity*, pp. 39-79.
[116] Ibid., pp. 39-79, 115-147.
[117] Ibid., ch. 3.

price. Obviously, the gains from exercising stock options depend on the trajectory of a company's stock price. If a company's stock price reflected *only* the company's innovative success, one might argue that an employee's gains from exercising stock options represent a way in which he or she shares in that success. The problem is that, besides, *innovation*, a company's stock price may also reflect *speculation* or *manipulation*. As a result, the gains from exercising stock options become detached from the performance of the firm.

Indeed, Lazonick's research suggests that the extreme stock-market speculation of the Internet boom enabled large numbers of high-tech employees of New Economy firms to make so much money from the exercise of stock options that they no longer needed their jobs, but instead could leave to seek additional fortunes with dot.com startups or as angel investors. Or they could simply retire at an early age. Then when the boom to turned to bust, and the stock market crashed, the gains from exercising stock options disappeared, and people who happened to join a company, say, a year later than their now-rich peers found that their stock options, issued at peak market prices, were "under water", i.e. valueless. Such disparities in income, unrelated to education, function or even experience were destructive of collective and cumulative learning.

One response of companies to this problem of inequitable remuneration was to pursue corporate research-allocation policies designed to boost stock prices, not the least of which was to do massive stock buybacks. In the late 1980s and 1990s top corporate executives had become inured to this mode of resource allocation by their own stock-based pay.[118] Led by many ICT companies such as Microsoft, Cisco, Intel, IBM, and Hewlett-Packard (HP), after 2001 stock-market manipulation through billions of dollars in buybacks per year became a basic fact of corporate resource allocation.[119]

Figure 4 shows the stock-price movements for Intel, Microsoft, and Cisco as well as the NASDAQ Composite Index, in which all three companies are included, from April 1990, two months after Cisco did its IPO, to the present, with April 1990 set at 100 for all four indices. The spectacular rise and then fall of Cisco's stock price in the Internet boom of 1998-2000 and bust of 2001-2002 makes the stock-price movements of the other two companies and the NASDAQ Index look like mere blips when measured on the same scale as Cisco. Figure 5 therefore excludes Cisco, revealing that the rise and fall of the stock prices of Intel and Microsoft were also substantial in those years.

Broadly speaking, it can be argued that in the first half of the 1990s the stock-price movements of the three companies mainly reflected innovation, but then speculation became a major factor, especially at the end of the decade. With the crash in stock prices in 2001 and 2002, all three companies became major repurchasers of stock, the purpose of which, as Lazonick has shown, is to manipulate a company's stock price. Actually for Intel, which did $20.1 billion in buybacks from 1996 to 2000 and for Microsoft, which did $14.7 billion, there was an important element of manipulation even in the Internet boom, perhaps as these older New Economy companies sought to keep pace with Cisco, which did $508 million in buybacks from 1995 through 1997, but none from 1998 through 2001. From 2001 through 2013, Intel's repurchases totaled $70.2 billion (76% of net income); Microsoft's $132.0 billion (71%); and Cisco $79.8 billion (108%).

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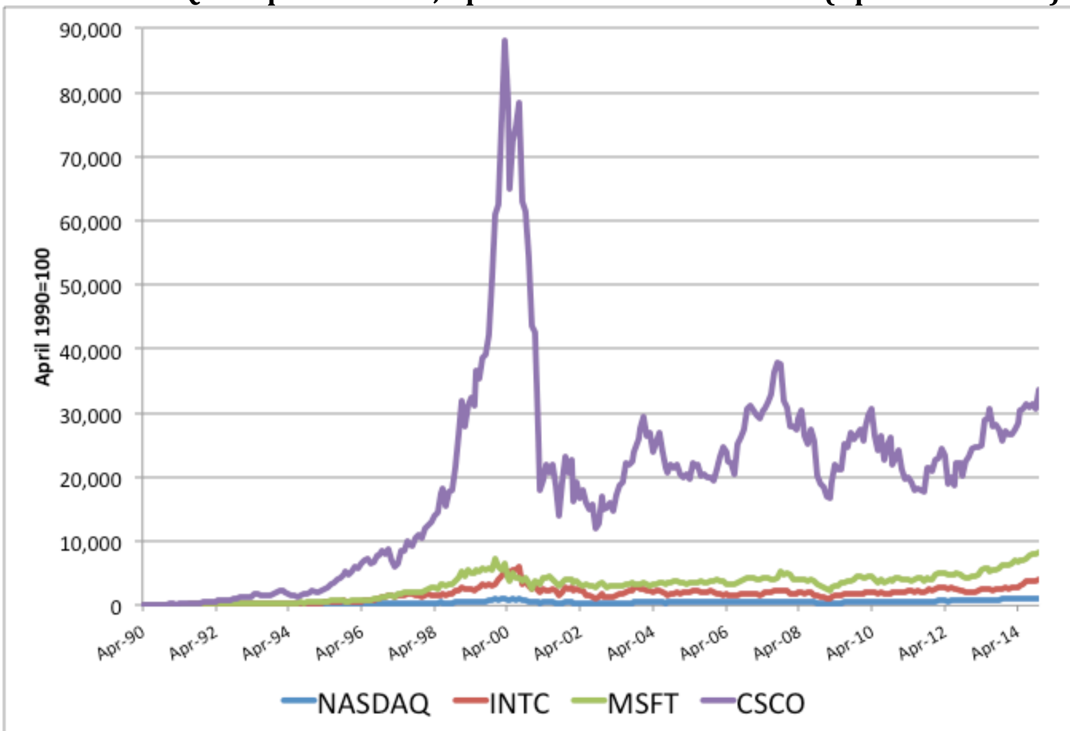
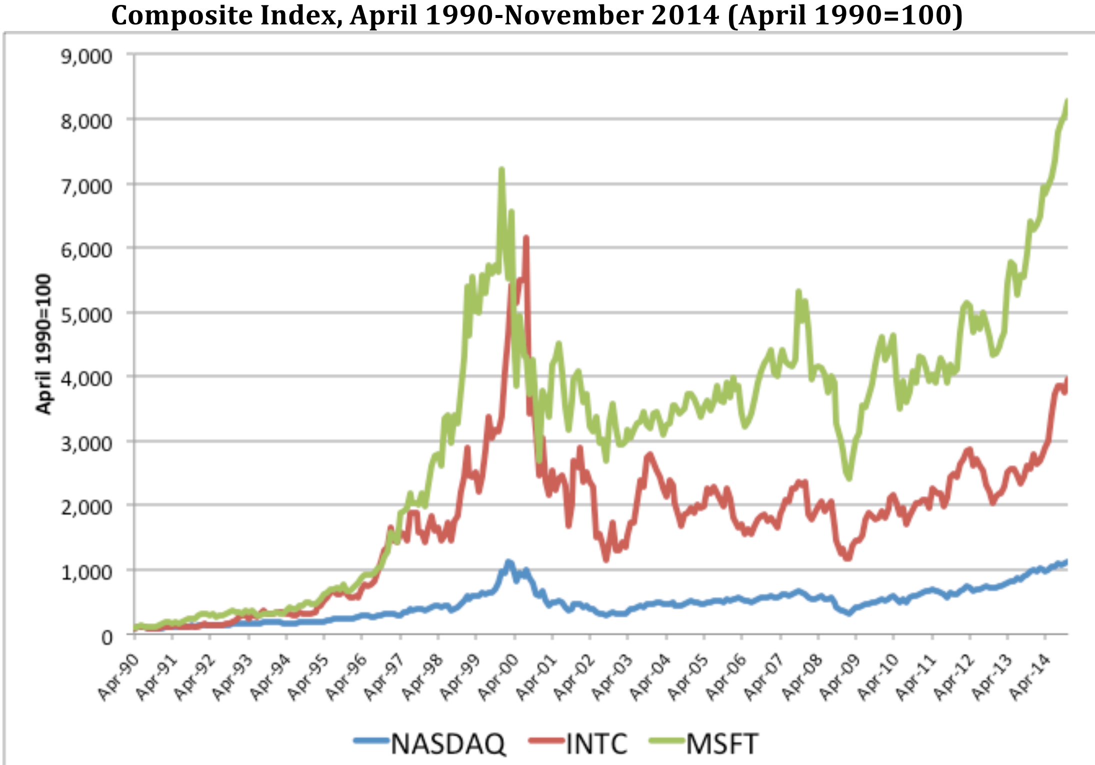
[118] Lazonick, "Taking Stock".
[119] Lazonick, "Labor in the Twenty-First century"; Lazonick, "Profits Without Prosperity".

Figure 4. Stock-price movements, Intel (INTC), Microsoft (MSFT), and Cisco (CSCO), and the NASDAQ Composite Index, April 1990-November 2014 (April 1990=100)



Source: Yahoo! Finance

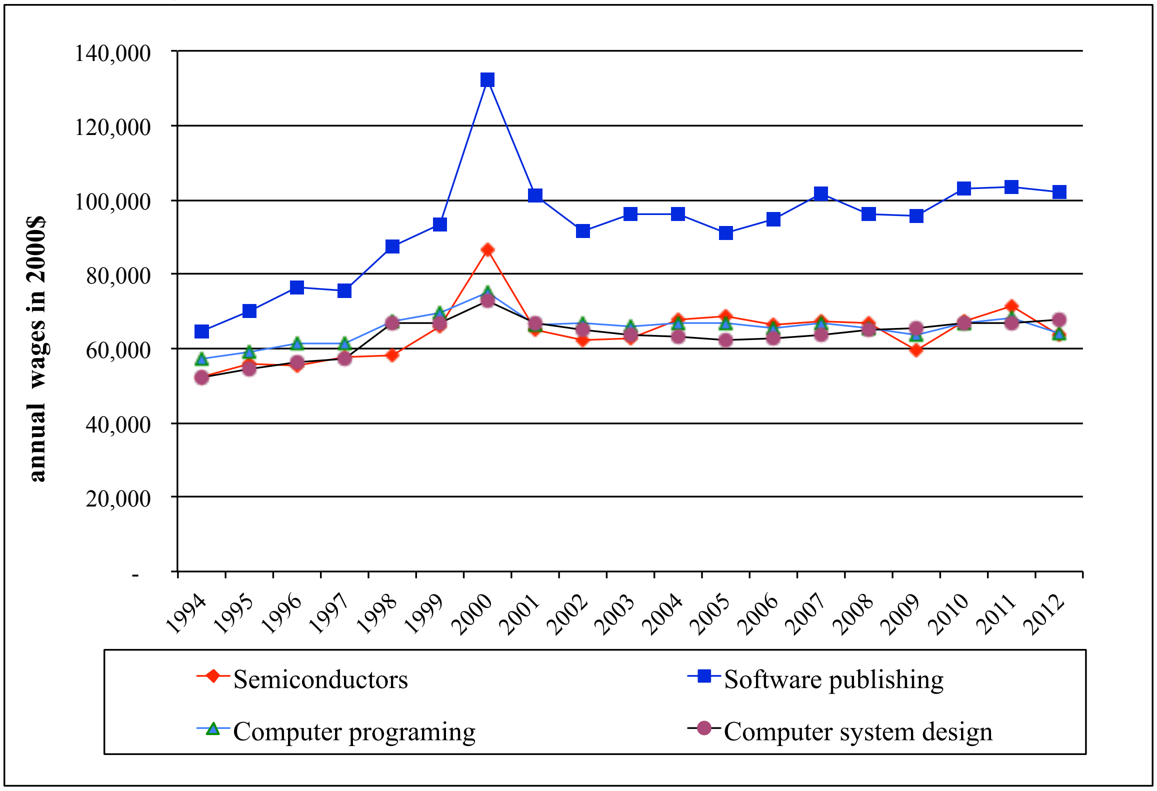
Figure 5. Stock-price movements, Intel (INTC) and Microsoft (MSFT) and the NASDAQ Composite Index, April 1990-November 2014 (April 1990=100)



Source: Yahoo! Finance

Obviously, in companies such as Intel, Microsoft, and Cisco that have had broad-based stock option plans, for a given allocation of stock options, these fluctuations in stock prices will have considerable impacts on employee earnings. The substantial impacts of broad-based employee stock options on increases in earnings are visible in Figure 6, which shows real wages (in 2000 dollars) from 1994 to 2012 for U.S. employees at companies engaged in semiconductors, software publishing, computer programming, and computer system design. Together in 2000 these four ICT fields employed 1,554,000 people in the United States, more than double the number in 1994, and a total that would rise by 6.5% to 1,656,000 in 2012.[120]

Figure 6. Annual earnings in 2000 dollars of full-time U.S. employees in four high-tech fields, 1994-2012



Source: County Business Patterns Data, U.S. Census Bureau. http://censtats.census.gov/.

Note the spikes in earnings in 2000, especially in software publishing in which annual earnings went from $64,700 in 1994 to $75,600 in 1997, then exploded to $132,100 in 2000 before falling to $91,400 in 2002. Starting from a lower 1994 base, movement in semiconductor earnings was similar to software publishing. Figures 7 and 8, which disaggregate the U.S.-level data into selected high-tech industries, show that the most dramatic income spikes were in software publishing in Washington State, where real earnings went from $112,600 in 1996 (almost double 1994 earnings) to $380,000 in 2000, and in semiconductors in Silicon Valley, where the increase was from $79,600 in 1996 to $156,300 in 2000.

[120] These data are from County Business Patterns Data (SIC & NAICS), U.S. Census Bureau. http://censtats.census.gov/. We are grateful to Yue Zhang for continually updating these time series as well for calculating the average gains per employee from exercising stock options at the company level, to which we refer below.

Figure 7. Annual earnings (2000 dollars), full-time U.S. employees in software publishing, 1994-2012

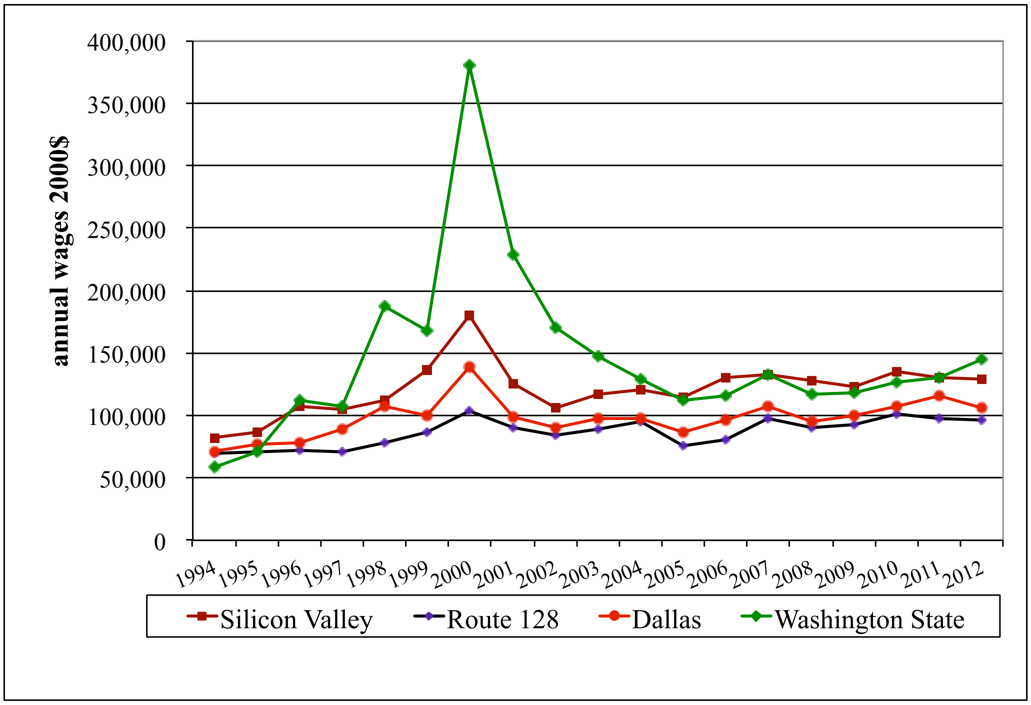
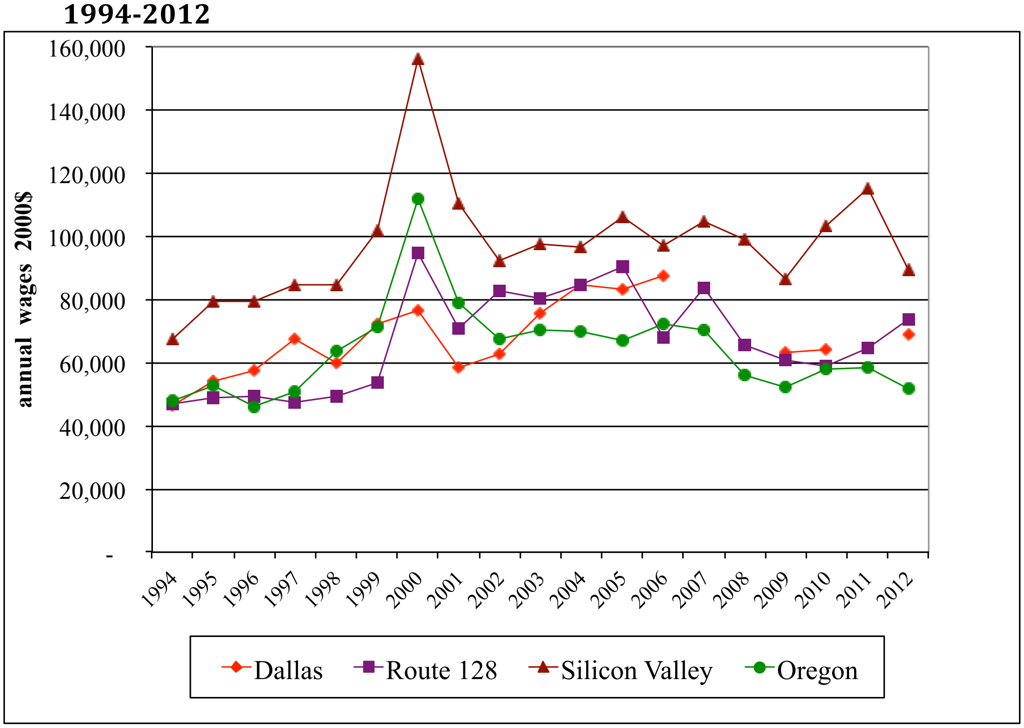


Figure 8. Annual earnings (2000 dollars), full-time U.S. employees in semiconductors, 1994-2012



The County Business Patterns (CBP) data, on which Figures 6, 7, and 8 are based, do not actually tell us that these spikes are the result of broad-based stock-option plans, since all the data are reported simply as earnings. But since 1994 in the notes to their financial statements in 10-K annual filings to the SEC, companies have provided data on their employee stock-option plans, including the total options exercised in the year and the average weighted exercise price.[121] From this information, we can estimate the average gains per employee from exercising stock options at the company in a given year. Except for the five executives named in proxy statements for whom individual data on stock-option gains are available, we do not know the distribution of these gains across a company's employees. The most extreme case, and one that corroborates the stock-based interpretation of the remarkable spike in the CBP data for Washington State in Figure 7, was for Seattle-based Microsoft where (excluding the five named executives) the average gains from exercising stock options were $79,000 across 19,200 employees in 1996 before soaring to *a peak of $449,100* across 35,200 employees in 2000 and then falling back to $80,300 across 52,800 employees in 2003. Table 3 shows the estimates of the average gains from exercising stock options at Intel, Microsoft, and Cisco from 1994 to 2013.

Table 3. Average gains from exercising stock options, Intel, Microsoft, and Cisco, 1994-2013

	INTEL		MICROSOFT		CISCO	
	ave. gains, $	employees	ave. gains, $	employees	ave. gains, $	employees
1994	**15,599**	31,050	**43,573**	14,844	**44,202**	1,947
1995	**18,746**	37,100	**51,829**	16,529	**60,894**	3,265
1996	**16,010**	45,050	**79,022**	19,181	**93,399**	6,434
1997	**25,295**	56,100	**154,196**	21,397	**85,159**	9,891
1998	**75,890**	64,100	**238,377**	24,644	**92,947**	13,000
1999	**56,589**	67,350	**369,693**	29,226	**193,476**	18,000
2000	**112,018**	78,150	**449,142**	35,248	**290,870**	27,500
2001	**18,235**	84,750	**143,772**	43,350	**105,865**	36,000
2002	**10,413**	81,050	**95,310**	49,050	**13,596**	37,000
2003	**10,406**	79,200	**80,283**	52,750	**8,917**	35,000
2004	**8,405**	82,350	**50,690**	56,000	**32,804**	34,000
2005	**8,347**	92,450	**14,500**	59,000	**24,432**	36,207
2006	**3,396**	97,000	**6,208**	66,000	**25,487**	44,170
2007	**6,915**	90,200	**14,991**	75,000	**73,004**	55,731
2008	**1,471**	85,100	**7,766**	85,000	**12,533**	63,832
2009	**136**	81,850	**189**	92,000	**2,153**	65,840
2010	**500**	81,150	**2,359**	91,000	**12,975**	68,125
2011	**2,303**	91,300	**1,542**	89,500	**4,153**	71,263
2012	**3,805**	102,560	**1,200**	92,000	**4,167**	69,232
2013	**2,547**	106,300	**579**	96,500	**6,120**	70,844

Sources: Company annual reports and proxy statements. Calculations by Yue Zhang for The Academic Industry Research Network.

As can be seen, the amounts over the past decade are small relative to those in the last half of the 1990s, when stock-based pay on broad-based stock-option plans surged out of control. It has been

[121] See Lazonick, *Sustainable Prosperity*, pp. 16-28

estimated that there were 10,000 millionaire employees at Microsoft in 2000, and our research suggests that the consequent departures of key employees from the company undermined its new product-development efforts.[122] In 2001 Microsoft sought to deal with the sharp fall in its stock price by doubling the number of stock options it gave to its employees under its broad-based program, now with low exercise prices. As shown in Table 3, the average gains from exercising stock options at Microsoft were still almost $51,000 in 2004, but then fell off sharply as Microsoft stopped making stock-option grants, opting instead for restricted shares, doled out in smaller amounts but with some gains on vesting assured. A prime reason why Microsoft decided to do away with its stock-option program was a ruling from the Financial Accounting Standards Board that, as of 2004, required companies to expense stock-option awards, thus lowering reported earnings with a potentially negative impact on a company's stock price, even though there would be no change in pre-tax cash flow and the added recorded expense would lower the company's tax bill.

One thing is for certain: These dramatic changes in "wages" cannot be attributed to SBTC. Rather they reflect the fact that in using stock options to lure professional, technical, and administrative personnel from secure employment in established companies to insecure employment in startups, the New Economy companies in effect "outsourced" a substantial portion of the pay of these employees to the wildly volatile stock market. Indeed, we have seen no hint of a recognition in the SBTC literature that its proponents recognize that in certain periods substantial portions of the pay of college-educated personnel in high-tech industries have been determined in the stock market, not the labor market, and that given its volatility the level of stock-based pay has little to do with worker productivity. Nor is it on their intellectual radar screen that this volatility in earnings can be highly destructive of collective and cumulative learning.

The marketization of employment relations in the New Economy business model, reflected in the use of broad-based stock-option plans, created problems for technological development in the United States more generally. In the United States the disruption to organizational learning caused by the movement of high-tech personnel from Old Economy to New Economy companies bears a substantial part of the responsibility for the precipitous decline, beginning in the late 1980s, of the corporate research labs that over the course of the twentieth century had helped to make the United States the world's most technologically advanced economy.[123] Proponents of MSV within the top executive ranks and on Wall Street were then better positioned to ask why the company was wasting its money on basic and applied research that might not result in commercial products. Meanwhile "open system" companies that, in large part through mobile high-tech labor, could tap into the ostensibly proprietary technologies of the Old Economy companies could focus on product development to generate, in relatively short order, product revenues.

At a 1993 conference at Harvard Business School that sought to understand the decline of the corporate research lab, Gordon Moore, the co-founder of Intel and its long-time chairman of the board, clearly articulated this relation between basic and applied research done in Old Economy companies and product development done in New Economy companies:

> Running with the ideas that big companies can only lope along with has come to be the acknowledged role of the spin-off, or start-up. Note, however, that it is important to

[122] The arguments in this paragraph are based on work in progress at The Academic-Industry Research Network. See also William Lazonick, "The New Economy Business Model and the Crisis of US Capitalism," *Capitalism and Society,* 4, 2, 2009: Article 4.

[123] See Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?".

> distinguish here between exploitation and creation. It is often said that start-ups are better at creating new things. They are not; they are better at *exploiting* them. Successful start-ups almost always begin with an idea that has ripened in the research organization of a large company. Lose the large companies, or research organizations of large companies, and start-ups disappear.[124]

This intense focus on product development spurred high-tech companies to cut costs by offshoring the more routine activities in the value chain to areas of the world where low-wage but literate labor was available. In 1963 Fairchild Semiconductor, the 1957 Palo Alto start-up that bred the personnel who through spin-offs would create "Silicon Valley," opened an assembly and testing facility in Hong Kong, and over the course of the 1960s virtually every semiconductor company in the United States offshored these operations to East Asia.[125] The high value and low weight of semiconductor chips meant that, as an alternative to sourcing production in the expanding *maquiladora* of northern Mexico, transportation costs posed no barrier to offshoring to far-off places such as Hong Kong, Singapore, South Korea, and Taiwan. These Asian nations had much lower wages and far more literate female labor forces than Mexico could offer. From the early 1970s Malaysia also became a location of choice for the offshored activities of U.S. companies engaged in microelectronics. Meanwhile U.S. tariff policy facilitated the offshoring movement: Sections 806.30 and 807 of the Tariff Schedule of the United States permitted goods that had been exported from the United States for foreign assembly to be imported with duty charged only on the value added abroad.[126]

As the offshored Asian factories expanded their employment of female operatives, with at most high-school educations, they also increased the employment of college-educated managers and engineers. They needed the college-educated personnel to run the facilities, upgrade process technologies, and move into the fabrication of various electronics components. That is, in the presence of digitization of production processes, the Asian microelectronics industries experienced a complementarity between the employment of high-school-educated and college-educated labor to generate higher quality, lower cost products.[127]

Meanwhile, companies such as Motorola, Texas Instruments, HP, and Intel that were offshoring their more routine work to Asian factories were increasing their employment of college-educated labor at home. Indeed, a New Economy company such as Cisco Systems, which grew to dominate the Internet equipment market in the 1990s while outsourcing all of its manufacturing (be it in the United States or abroad), increased its U.S. employment from 244 in 1990 (the year of its initial public offering) to 27,000 in 2001, while its rest-of-world employment grew from 10 to 11,000.[128]

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124 Gordon E. Moore, "Some Personal Perspectives on Research in the Semiconductor Industry," in Richard Rosenbloom and William Spencer, eds., 1996, *Engines of Innovation: U.S. Industrial Research at the End of an Era*, Harvard Business School Press, 1996, p. 171.

125 Charles E Sporck with Richard L. Molay. *Spinoff: A Personal History of the Industry That Changed the World,* Saranac Lake Publishing, 2001, p. 95; Y. S. Chang, "The Transfer of Technology: Economics of Offshore Assembly, The Case of the Semiconductor Industry," UNITAR Research Report no. 11. Geneva: United Nations Institute for Training and Research, 1971; Warren E. Davis and Daryl G. Hatano, "The American Semiconductor Industry and the Ascendancy of East Asia." *California Management Review,* 27, 4, 1985: 128–143; Lazonick, *Sustainable Prosperity*, ch. 5.

126 Kenneth Flamm, "Internationalization in the Semiconductor Industry," in Joseph Grunwald and Kenneth Flamm, eds., *The Global Factory: Foreign Assembly in International Trade*, Brookings Institution, 1985: 38-136.

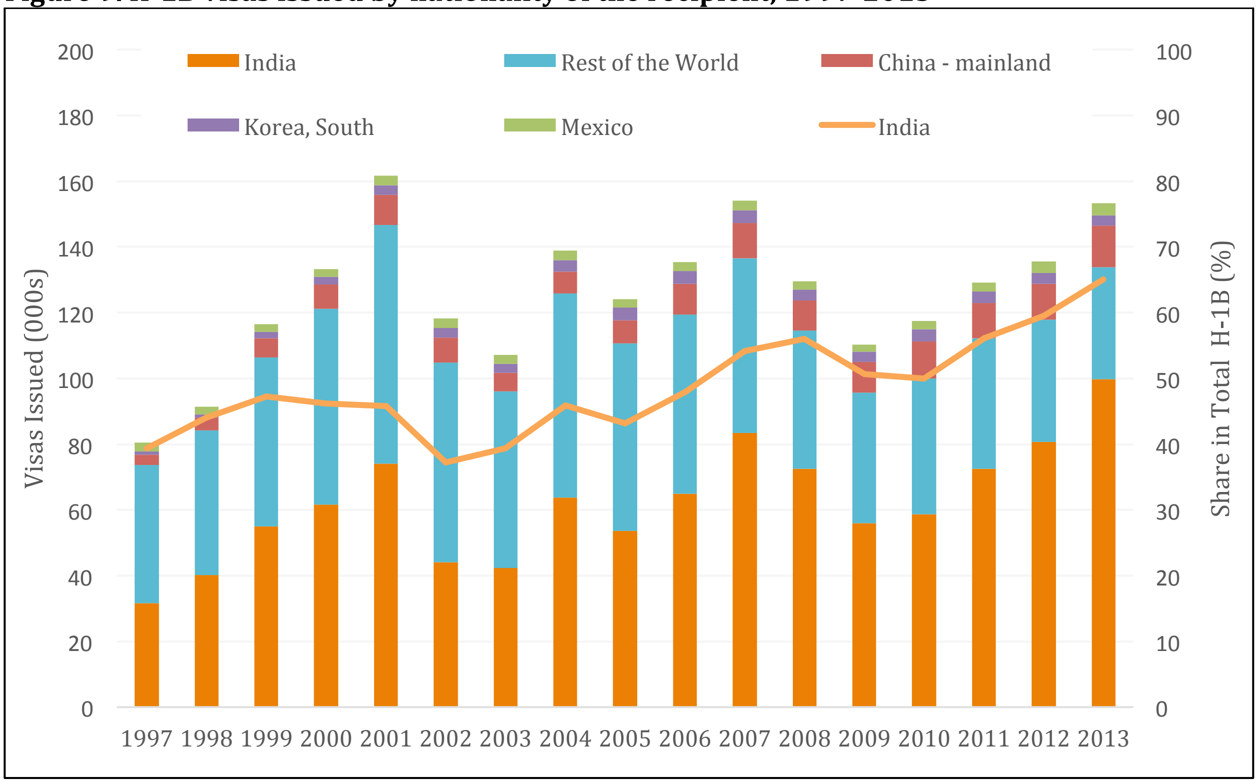
127 Lazonick, *Sustainable Prosperity*, ch. 5.

128 Cisco Systems annual 10-K filings to the SEC, 1990-2013. The proportion of Cisco labor force in engineering increased from 21% in 1990 to 28% in 1996 and to 34% in 2001, and since then has ranged from 29% in 2009 to 36% in 2002 and 2005. In 2012 Cisco changed the "engineering" classification to "R&D". We do not know the distribution of these engineering employees between the United States and rest of world.

In the period 1990-2001, when Cisco did a relatively small amount of buybacks (21% of net income in 1995-1997) and paid no dividends, the company added 15,800 more U.S. employees than rest-of-world employees. But from 2002 to 2013, when Cisco expended 106% of its net income on buybacks and another 7% on dividends, it added 16,500 more rest-of-world employees than U.S. employees. In 2013 for the first time, rest-of-world employees surpassed US employees at Cisco, and in 2014 the percentage of rest-of-world employees moved slightly higher.

While U.S. companies have been offshoring high-tech jobs to Asia, Asians have been coming to the United States for high-tech jobs. Since the 1990s vast numbers of college-educated Asians, first and foremost from India, have found employment in the United States under H-1B and L-1 temporary immigrant visa programs (see Figures 9 and 10).[129] Since the late 1990s, Indians have represented about 65% of H-1B visa recipients and 30% of L-1 visa recipients. U.S. companies value these foreign employees for their educational backgrounds. Almost all, with the notable exception of most H-1B fashion models, are college-educated, and the majority have computer-related college degrees. Furthermore, many of them have acquired further higher education in high-tech fields in the United States before being employed on an H-1B or L-1 visa.[130]

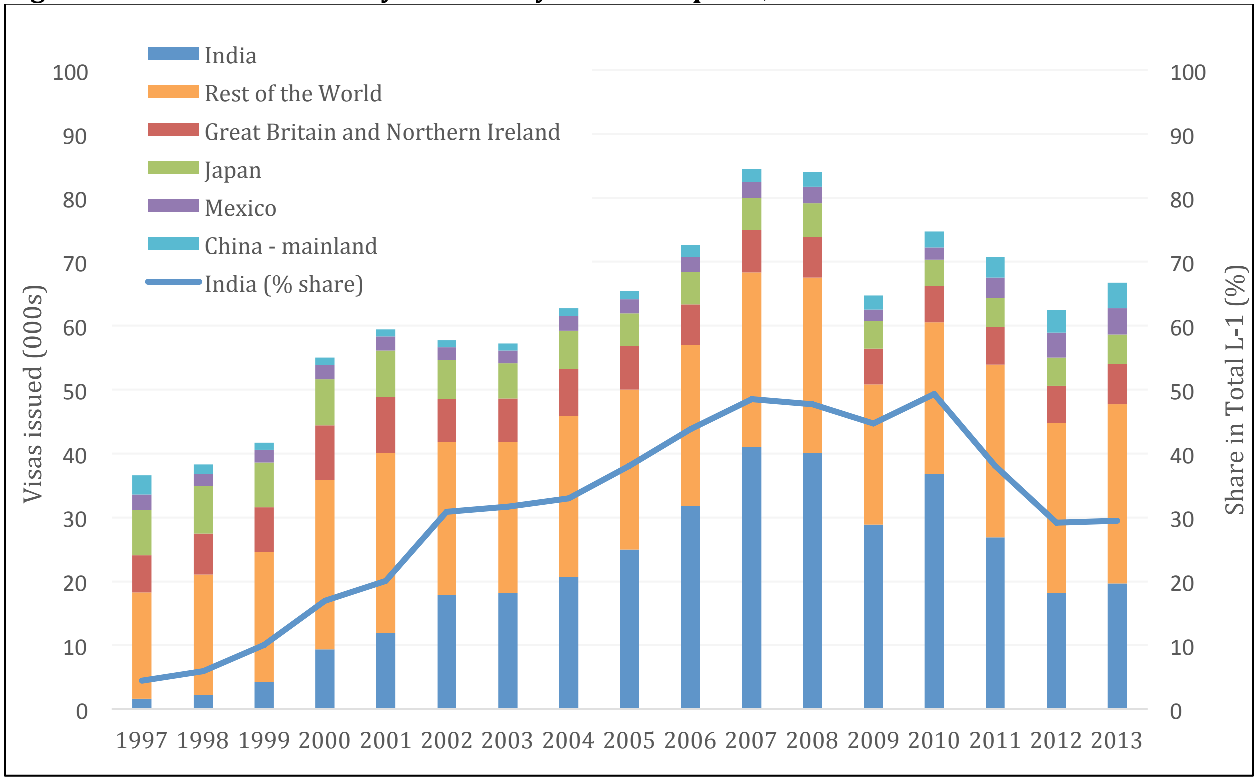
Figure 9. H-1B visas issued by nationality of the recipient, 1997-2013



Source: Bureau of Consular Affairs, U.S. Department of State, Nonimmigrant Visa Issuances by Visa Class and by Nationality, FY1997-2013 NIV Detail Table, at http://travel.state.gov/content/visas/english/law-and-policy/statistics/non-immigrant-visas.html

[129] Lazonick, *Sustainable Prosperity*, ch. 5. See the website of Norm Matloff: http://heather.cs.ucdavis.edu/h1b.html.
[130] Lazonick, *Sustainable Prosperity*, pp. 157-159.

Figure 10. L-1 visas issued by nationality of the recipient, 1997-2013



Source: Same as Figure 9.

Employers value not only the educational backgrounds of non-immigrant visa recipients, but also their lack of labor mobility within the United States.[131] These employees are beholden to the particular companies that provide them with their temporary visas in industrial sectors where labor mobility can give workers who are citizens or permanent residents considerable bargaining power. Obviously, this inability of H-1B and L-1 visa recipients to exit their current jobs, even when their capabilities are in high demand is an invitation to their employers in the United States to abuse the employment relation through low pay and adverse work conditions. But this labor immobility may also increase the confidence of these U.S. employers that they can invest in the capabilities of these non-immigrant employees and retain them over a period of up to seven years in their non-immigrant status, sponsoring them for permanent residency in the seventh year. Ironically, U.S. employers may have more of an incentive to invest in the capabilities of non-immigrant high-tech personnel than in those of their counterparts who, as permanent residents or citizens, are regular members of the U.S. labor force.

Many employees on H-1B and L-1 visas transition to permanent immigration visas in the United States, but most have gone back to their countries of origin with enhanced education and experience that are extremely valuable for developing innovative capabilities there.[132] Indeed, Indian IT companies such as TCS, Infosys, and Wipro have been among the largest users of H-1B and L-1 visas, employing Indians in the United States to acquire more sophisticated capabilities that can be "near-shored" back to India to support the movement of their companies up global

[131] See Norman Matloff, "On the Need for Reform of the Nin-Immigrant Work Visa in Computer-Related Occupations," *University of Michigan Journal of Law Reform*, 36, 4, 2003: 1-99.

[132] Ron Hira, "Bridge to Immigration or Cheap Temporary Labor? The H-1B & L-1 Visa Programs Are a Source of Both , *EPI Briefing Paper #257*, February 17, 2010, at http://s4.epi.org/files/page/-/pdf/bp257.pdf

value chains.[133] A thorough investigation of CCCs may well show that these members of the *global* high-tech labor supply who gain many years of work experience in the United States before taking their cumulated capabilities back to the places from whence they came have superior opportunities to engage in collective and cumulative learning compared to regular members of the U.S. high-tech labor force, who have the advantage of far more individual labor mobility within the United States.

As with the rationalization and marketization of employment relations, SBTC has little to offer as an explanation of how, why, and in which industries globalization has been eroding ICT employment opportunities in the United States.[134] Like all well-trained neoclassical economists, the proponents of SBTC look for the determination of wages in labor markets. People compete for entry-level jobs through labor markets. But the earnings that result in higher standards of living are determined in business organizations, with wages serving as both inducements for contributing to a company's productivity and rewards for prior contributions to a company's profitability. Rationalization, marketization, and globalization represent fundamental structural changes in employment relations that disrupted the "Old Economy" relation that, through long-term employment relations, linked productivity and pay within companies. In the United States, in the ICT industries, NEBM has done a good job living off the legacy of productive capabilities accumulated under OEBM. Some individuals may gain from the mobility of high-tech labor under NEBM. But there is considerable evidence that supports the TIE argument that the individual mobility of labor itself can be destructive of CCCs.

3) STEM employment and earnings in medical technology

Among STEM workers, no group should be better positioned to take advantage of so-called skill-biased technical change than the scientists who are engaged in biomedical research, including the development of biopharmaceutical drugs. More than half of the members of the biomedical segment of the STEM labor force hold PhDs. Scientists in the biomedical field are employed in a dynamic industry that has undergone substantial change in the past twenty to thirty years, and particularly in the past decade.

The defining event in the biomedical industry in the last two decades is the "NIH Doubling", referring to the massive increase in the size of the budget of the National Institutes of Health between 1998 and 2003. Figure 11 shows the budget of the NIH in 2013 dollars from 1938 through 2013. Although the NIH budget declined somewhat in real terms from its peak in 2003 and 2004, in recent years it has still been double its level in the early 1990s and triple its level in the early 1980s.

Figure 3 above, based on 2010-2011 *American Community Survey* (ACS), shows that 63% of the medical and other life scientists hold doctoral and professional degrees. Universities appear to be

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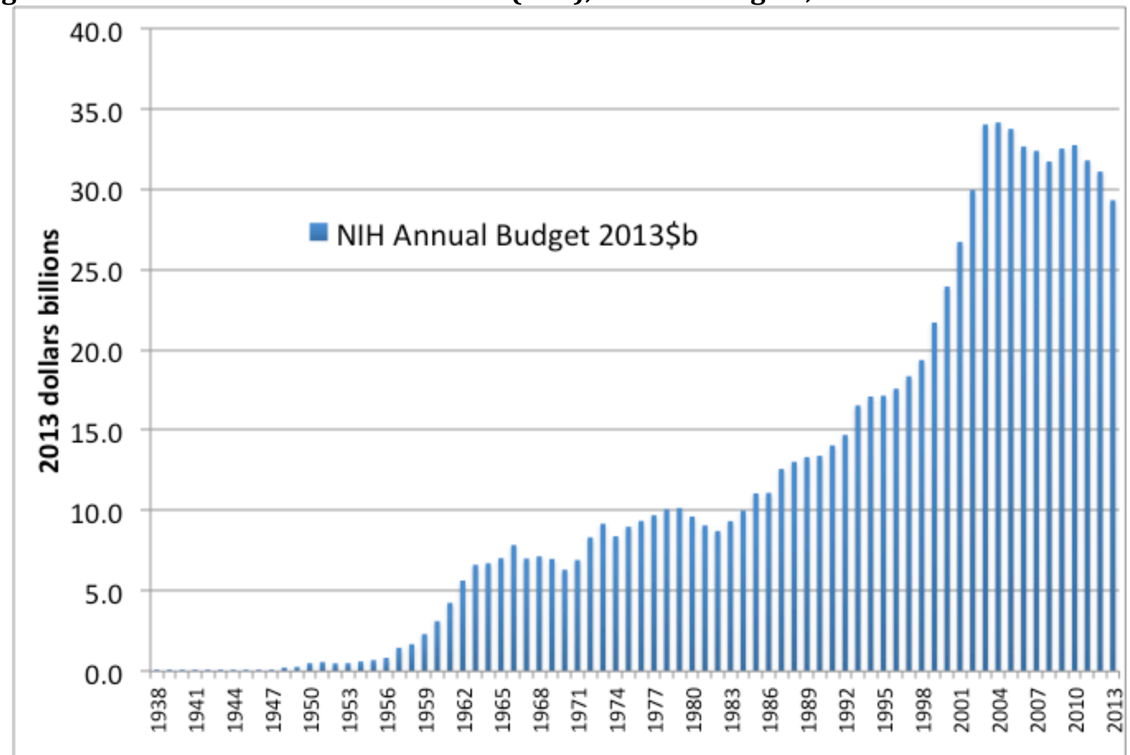
133 For the top H-1B visa holders in 2014, see http://www.myvisajobs.com/Reports/2014-H1B-Visa-Sponsor.aspx; for L-1 visas, see Deepak Chitnis, "USCIS to increase scrutiny of Indian IT firms, L-1 visa holders will be under the scanner," *The American Bazaar*, January 28, 2014, at http://www.americanbazaaronline.com/2014/01/28/uscis-increase-scrutiny-indian-firms-l-1-visa-holders-will-scanner/.

134 For recognition by SBTC proponents of the impact of Chinese manufacturing on U.S. employment in the 2000s, see David H. Autor, David Dorn, and Gordon H, Hanson, "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, 103, 6, 2013: 2121-2068. But this paper offers no analysis of the roles of key organizations – the developmental state and the innovative enterprise – in driving China's remarkable development. For an analytical framework, see William Lazonick and Yin Li, "China's Path to Indigenous Innovation," AIR Working Paper, August 2014 (revision forthcoming).

the largest employers of doctoral biomedical scientists. As illustrated in Figure 12, the National Science Foundation (NSF) Survey of Doctorate Recipients (SDR) surveys show that four-year educational institutions employed 27,520 and 27,600 doctoral biological scientists in 1997 and 2013 respectively. These figures represent 50% of employed doctoral biological scientists in 1997 and 41% in 2013. The business sector appears to be the second largest employer, with 14,800 doctoral biological scientists in 1997 and 20,300 in 2013.

Figure 11. National Institutes of Health (NIH), annual budgets, 1938-2013 in 2013 dollars

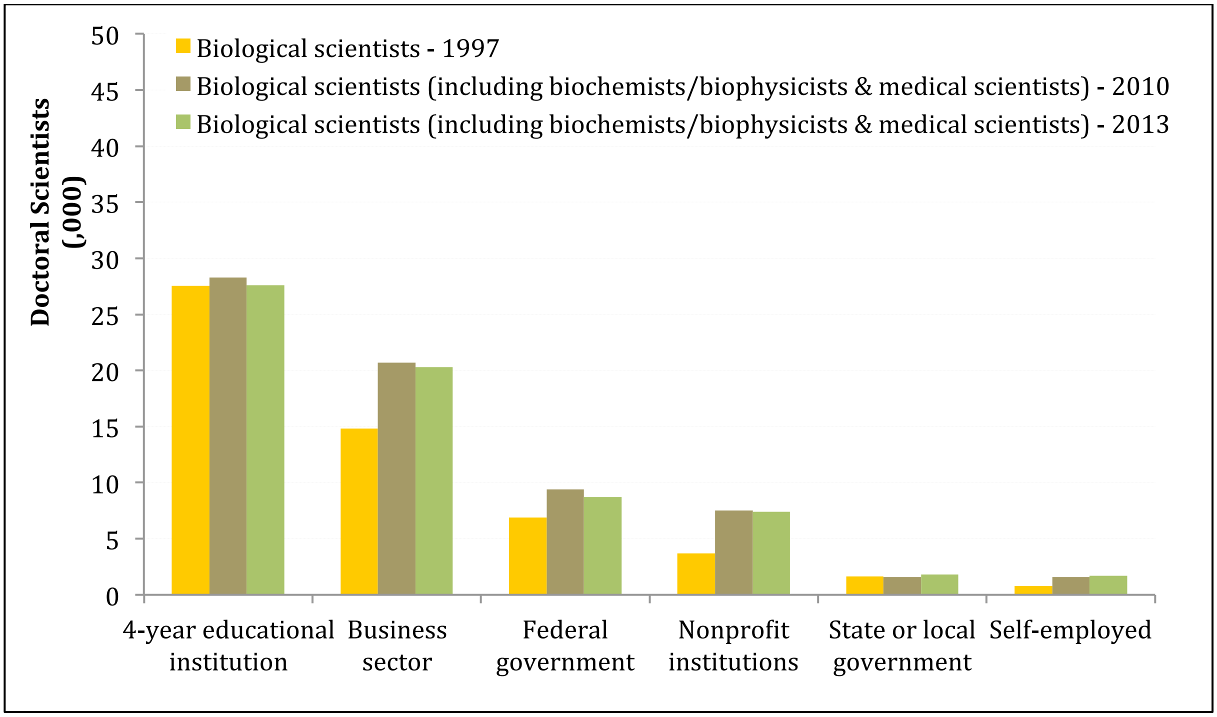


Source: National Institutes of Health, "NIH Budget" at http://www.nih.gov/about/budget.htm

As the largest employers of doctoral biological scientists, changes in the business models of educational institutions and business enterprises can have profound effects on the career prospects of biomedical scientists. Although these effects can only be documented through micro-level organizational analysis (as we shall explain in Section 4 of this paper), the results of these changes can be illustrated using wage trends in industries that employ biomedical scientists with various educational attainments.

Figure 13, based on Current Employment Statistics (CES) from monthly establishment surveys from 1990 to 2014, shows that for all workers in NAICS 54171 (Biotechnology Research), growth in employment began during the NIH doubling and continued until the Great Recession. Increased employment of Production & Non-Supervisory (P&N) workers dominated this growth up to 2008. In the Great Recession, employment fell, but $10.4 billion in extra NIH funding under the American Recovery & Reinvestment Act undoubtedly dampened this decline. Since 2010 employment has been increasing, dominated this time by Non-Production and Supervisory (N&S) workers, scientists with PhDs among them.

Figure 12. Employed doctoral biological scientists by employment sector, 1997, 2010 & 2013



Source: National Science Foundation/Division of Science Resources Studies*, 1997, 2010 and 2013 Surveys of Doctorate Recipients.*

Real earnings of P&N workers rose modestly from 1990 to 1998, declined somewhat during the first years of the "doubling", and then rose substantially from 2002 to 2009 (at which time they were 33% greater than in 1998) before declining in recent years. As can be seen in Figure 13, earnings of N&S workers are about double those of P&N workers, and have recently moved upwards after declining from 2009 to 2012.

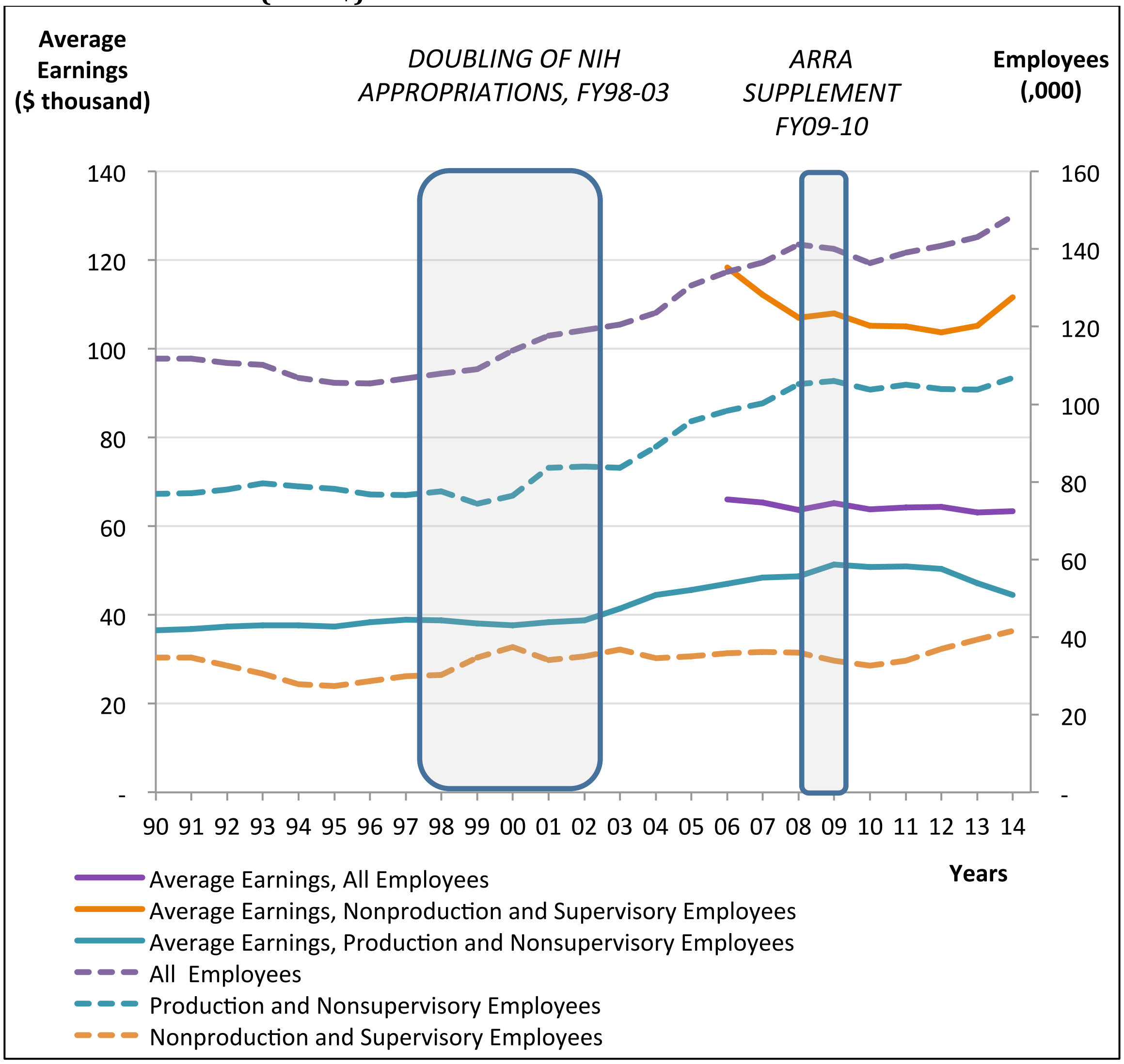
Overall, for N&S workers there has been no significant employment expansion since 2000, although the numbers have been trending up since 2010. N&S wages reached a peak in 2006, but then fell before starting to increase again in 2012. P&N wages have stagnated since 2009, while employment has fallen. Note that while these data provide an overview of the employment and earnings results for biotech workers, they cannot offer insights into the career paths that produce these results. Nor do these past trends provide a basis for predicting how future employment and earnings outcomes will unfold. As discussed in Section 4 of this paper, this type of analysis can only be addressed through company-level studies, possibly aided by the collection of survey data on careers from companies' HR and R&D managers.

Preceding the NIH doubling, a 1998 National Research Council report had found that the supply of PhDs in the United States "exceeded the availability of jobs in academe, government and industry where they can use their training as independent scientists."[135] The NIH doubling enabled and induced an expansion of an already large supply of PhD students in the biomedical field, with the

[135] Commission on Life Sciences, *Trends in the Early Careers of Life Scientists,* National Academy Press, 1998 at http://www.nap.edu/catalog.php?record_id=6244, cited in "Biomedical Research Workforce Working Group Report", NIH June 14, 2012, p.15 at http://acd.od.nih.gov/bwf.htm.

consequent outcome, now widely acknowledged, of producing a supply of biomedical graduates far in excess of the stable employment positions in which they could do research.[136]

Figure 13. Employment and average annual earnings in NAICS 54171 Biotechnology Research (2000$)



Source: Bureau of Labor Statistics, Employment, Hours, and Earnings from the Current Employment Statistics Survey (National) / 1990-2014

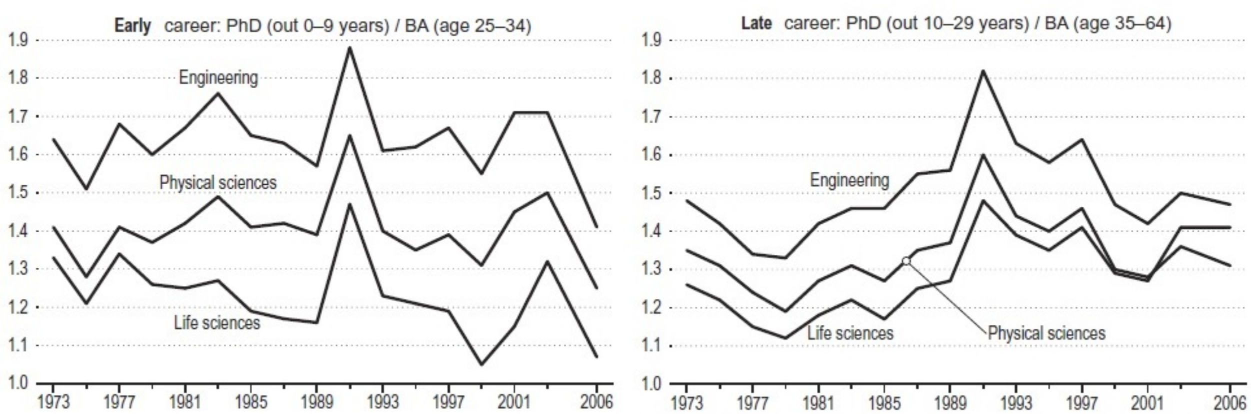
[136] See Michael Teitelbaum, "Structural Disequilibria in Biomedical Research" *Science*, 321, 5889, 2008: 644-645; David Cyranoski, Natasha Gilbert , Heidi Ledford , Anjali Nayar and Mohammed Yahia "Education: The PhD factory: The world is producing more PhDs than ever before. Is it time to stop?" *Nature,* 472, 2011: 276-279 http://www.nature.com/news/2011/110420/full/472276a.html; "Biomedical Research Workforce Working Group Report" National Institutes of Health, June 14, 2012 at Paula Stephan, *How Economics Shapes Science,* Harvard University Press, 2012; Michael Teitelbaum, *Falling Behind? Boom, Bust, and the Global Race for Scientific Talent*, Princeton University Press, 2014.

As described in a 2012 NIH report:

> [T]here are aspects of the biomedical workforce that make it less attractive to potential graduate students. The overall length of training in the biomedical sciences (PhD plus postdoctoral research) is longer than in comparable scientific disciplines such as chemistry, physics and mathematics. For PhDs graduating in 2001, the median age for biomedical scientists was 32 and the median age for starting a tenure track position was 37; comparable ages for chemistry doctorates were 30 and 33. Furthermore, academic salaries at public research institutions for assistant professors in biomedical fields are low compared to other fields. According to the Oklahoma State University survey of public research institutions; average starting salaries in fiscal year 2011 for biomedical assistant professors were approximately $68,000 compared to $69,000 for chemistry, $79,000 for clinical and health fields and over $100,000 for economists. The long training period, together with disparities in earnings, may make a career in biomedical research less attractive than one in other scientific disciplines and professional careers.[137]

Stephan has done detailed analyses of all aspects of the education supply and earnings of PhD scientists. Of particular note as a summary measure of these outcomes is her analysis of the earnings of PhDs relative to those with bachelor degrees in their field, as shown in Figure 14.[138]

Figure 14. Mean earnings of PhDs relative to mean earnings of terminal baccalaureate recipients, by field, 1973-2006, early career and late career



Note: All data are in 2009 dollars and are for full- time and part- time workers. Analysis is restricted to men. PhD salary is adjusted for twelve months.
Source: Survey of Doctorate Recipients, National Science Foundation at http:// www .nsf .gov/ statistics/ srvy doctoratework/; Current Population Survey, U.S Census Bureau and U.S. Bureau of Labor Statistics, http://www.census.gov/cps/data/

[137] *Biomedical Research Workforce Working Group Report,* p. 3.
[138] See Stephan, *How Economics Shapes Science*, pp. 154-155. See Fig 7.2, p.155 for more information about the source of data and disclaimers. Stephan attributes the spike in 1991 to a slight increase in salaries coupled with a sharper decrease in the wages of the overall BA reference groups, and the early 2000s increase to the dot-com build up and the NIH doubling, both of which led to increases in salaries. Stephan is a professor of economics at Georgia State University, and also a member of the NIH working group that issued the *Biomedical Research Workforce Working Group Report* cited above.

Overall, Stephan notes: "…seven-plus years of training less than doubles one's pay….in the case of life sciences, the premium is never more than 50 percent and generally 30 percent or less."[139] Stephan estimates, moreover, that a PhD in biological sciences in a research university will have lifetime earnings more than one million dollars less than an MBA.[140] As these graphs show, among CORE-STEM PhDs it is life sciences that are notable for their low pay levels relative to baccalaureates. The period of the NIH doubling may have contributed to an improvement in the pay of early career PhDs of all types relative to baccalaureates, but if so that boost was dissipated by the mid-2000s, according to Stephan's findings.

The work of Levin, Teitelbaum, Cyranoski et al., and Stephan suggests diminished career prospects for biomedical scientists.[141] In summary assessments of the adverse impact of the NIH doubling on the employment and earnings of life sciences PhDs, the conclusion is often that these outcomes were unintended consequences of a well-meaning effort to fund science that would cure diseases such as cancer. Once the funding stream was established, universities restructured their operating plans, academic programs, and budgets based on this level of federal funding with large cohorts of graduate students, large numbers of extended post-doctoral fellowships, and diminished long-term employment opportunities, and a steeper hierarchy in jobs, grant awards, and other factors that affect the career prospects of scientists. That is, the NIH doubling had the effect of expanding jobs with limited CCCs within the framework of university-based research.

It is important to note that the statement from Stephan quoted above focuses only on university employment. But what about the quality and quantity of CCCs for life science PhDs in business enterprises? And how have the strategies and structures of biotech business enterprises influenced the organization of research in universities?[142] The TIE hypothesis is that, even as massively more government funding of research has been made available to the industry through the NIH doubling, a marketized and financialized *biomedical business model* has undermined the availability of CCCs for PhDs in the biomedical field. We contend that, as a marketized and financialized business model transferred from ICT, NEBM is the root of the problem.[143] Based on our existing research on the U.S. biotechnology business model, our purpose here is to raise the most salient issues involved in this TIE hypothesis as a foundation for future focused research on what has been happening to the employment opportunities available to PhD scientists in life sciences in business enterprises, government agencies, universities and other civil society organizations in the United States.

In the late 1970s and early 1980s venture capitalists in combination with "star" university scientists (a number of them Nobel Prize winners) transferred NEBM from the ICT industry to the

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139 Stephan, *How Economics Shapes Science*, p. 154.

140 Ibid., p. 157

141 Yuval Levin "Reforming the National Institutes of Health," *The New Atlantis*, 16, Spring 2007: 107-111, and others for the evidence of diminishing career prospects for biomedical scientists documented in the numbers such as declining long-term contracts or tenure-track jobs within biomedical occupations offered by universities, increasing time-to-employment period after the completion of a PhD in biomedical science, increasing the lengths of post-doctoral positions with rather stagnant salaries, and decreasing grant awards among the early career doctoral scientists. Also Teitelbaum, "Structural Disequilibria"; Teitelbaum, *Falling Behind?*; Cyranoski et al., "Education: The PhD Factory"; Stephan, *How Economics Shapes Science*.

142 For the importance of these interactions, see Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?'

143 Lazonick and Tulum "US Biopharmaceutical Finance"; William Lazonick and Mustafa Erdem Sakinç, "Do Financial Markets Support Innovation or Inequity in the Biotech Drug Development Process?," paper presented at the Conference on Innovation and Inequality: Pharma and Beyond, Pisa, Italy, May 15, 2010; Mustafa Erdem Sakinç and Öner Tulum, "Innovation versus Financialization in the Biopharmaceutical Industry: The PLIPO Business Model," paper presented at the at the Ford Foundation Conference on Finance, Business Models, and Sustainable Prosperity, New York City, New York, December 6 and 7, 2012

newly emerging biopharmaceutical industry, with the visible successes of companies such as Genentech, Amgen, Biogen, and Genzyme inducing further venture-capital funding of firms in a highly uncertain, high fixed cost, human-capital-intensive industry. Many observers have attributed the success of these early companies in developing "blockbuster" drugs to the plucking of "the low-hanging fruit" of years, if not decades, of NIH-funded research.[144] Aiding these companies in reaching for the fruit and ripening it into commercial drugs were regulatory and legal changes in the early 1980s including the Bayh-Dole Act of 1980 that facilitated the commercialization of federally funded research; the 1980 Supreme Court ruling in Diamond v. Chakrabarty that permitted the patenting of a gene; the Stevenson-Wydler Act of 1980 that required federal research labs to engage in technology transfer activities; and the Orphan Drug Act of 1983 that provided government support and intellectual property protection to companies for the development of commercial drugs for rare and genetic diseases.[145]

As these early commercial successes, almost all of which originating with NIH grants and further supported under the Orphan Drug Act reinforced the willingness of venture capitalists to invest in biopharma startups,[146] it became increasingly possible to list a young biomedical company on NASDAQ even though it was just a research entity seeking to discover its first product. Lazonick, Sakinç, and Tulum have called such a publicly listed company a product-less IPO, or PLIPO.[147] As of December 2013, the United States had 2,349 biotech companies of which 339 companies were publicly listed on NASDAQ.[148] PLIPOs can raise funds through primary and secondary stock issues because of the willingness of stock-market traders, including hedge fund managers, to speculate on publicly traded biomedical shares, buying and selling them on "news" such as that generated by clinical trials, but without any concern about whether a commercial drug is ever actually produced.[149]

From the TIE perspective, this funding model is very disruptive of CCCs. The collective and cumulative learning that can result in a successful drug requires "patient" capital.[150] The stock-market speculation that creates opportunities for PLIPOs to issue public equity ebbs and flows, and at times even comes to a complete stop, as was the case in 2008-2010 when, given the financial crisis, there were virtually no biotech IPOs. In the process, employment in these companies is also volatile, and learning ceases to be either collective or cumulative.

Yet, as Pisano has emphasized, in this "science business", product development times can extend for a decade or longer, largely because of the three phases of clinical trials before the Food and Drug Administration will approve a drug as safe to use.[151] If there is any industry in which

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144 Jack W. Scannell, Alex Blanckley, Helen Boldon, and Brian Warrington "Diagnosing the Decline in Pharmaceutical R&D Efficiency," *Nature Reviews Drug Discovery,* 11, 3, 2012: 191-200; Bernard Munos "Can Open-Source R&D Reinvigorate Drug Research?," *Nature Reviews Drug Discovery,* 5, 9, 2006: 723-729; Paul Nightingale and Paul Martin, "The Myth of the Biotech Revolution." *TRENDS in Biotechnology*, 22, 11, 2004: 564-569.

145 Susan Wright, "Recombinant DNA Technology and Its Social Transformation, 1972-1982," *Osiris,* 2nd ser., 2: 303-360; Lazonick and Tulum, "U.S. Biopharmaceutical Finance".

146 Lazonick and Tulum, "U.S. Biopharmaceutical Finance".

147 Gary Pisano, *Science Business: The Promise, the Reality, and the Future of Biotech*, Harvard Business School Press, 2006; Lazonick and Tulum, "U.S. Biopharmaceutical Finance".

148 Ernst & Young, *Beyond Borders: Unlocking Value*, The Global Biotechnology Report 2014 http://www.ey.com/Publication/vwLUAssets/EY-beyond-borders-unlocking-value/$FILE/EY-beyond-borders-unlocking-value.pdf . Sakinç and Tulum are currently creating a comprehensive database of publicly listed biopharmaceutical companies to determine the extent to which these companies did an IPO without a product as well as the length of time that they are publicly listed without a product.

149 Lazonick and Sakinç, "Do Financial Markets Support Innovation or Inequity".

150 See William Lazonick, "Patient capital is a virtue," *Financial Times* Alphaville, July 24, 2014.

151 Pisano, *Science Business*; Lazonick and Tulum, "U.S. Biopharmaceutical Finance".

collective and cumulative learning by highly educated people is essential, it is in the biomedical industry. Yet the industry's business model caters to short-term financial performance, and publicly listed firms in the industry have received much of their funding from speculative traders who are the antithesis of patient capitalists. The TIE hypothesis is that this funding model does not support, and may even be highly disruptive of, the long, coherent and stable CCCs that are essential for developing new medical drugs.

To some extent this problem can be overcome by the participation of big pharma in funding the growth of biotech startups until a commercial product emerges, and in the 40-year history of the biopharmaceutical industry such big pharma funding has often been the case. The potential for such funding need not be limited to U.S. big pharma companies. Many of the large European and Japanese pharmaceutical companies have funded U.S. PLIPOs, either through outright acquisition or through large research contracts that include equity stakes and rights to sell the drug in certain parts of the world if it is ever produced.[152] Likewise U.S. big pharma has also at times provided patient capital to PLIPOs, helping to bring new drugs to market.[153]

Over the last decade, however, the R&D investments of U.S. big pharma have not been generating new blockbuster drugs even as the 20-year patents on the last generation of drugs have been running out. In 1994, at a time when most U.S. Old Economy research labs in industries other than pharmaceuticals had all but disappeared, Henderson touted the exemplary corporate research of big pharma, arguing that "the longevity of pharmaceutical companies attests to a unique management competency: the ability to foster a high level of specialized knowledge within an organization, while preventing that information from becoming embedded in such a way that it permanently fixes the organization in the past, unable to respond to an ever-changing competitive environment."[154] Yet over the past decade there has been a discussion of the "productivity crisis" in drug discovery.[155] A major part of the problem is that leading U.S. pharmaceutical companies such as Merck and Pfizer have been spending the last two decades living off their patented drugs, with very little to replace them in the pipeline.[156]

The deterioration in the research capabilities of U.S. drug companies has occurred despite the fact that pharmaceutical drug prices are double in the United States what they are in any other advanced nation. When Congress and the media have challenged the drug companies on this

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[152] Matthieu Montalban and Mustafa Erdem Sakinç "Financialization and Productive Models in the Pharmaceutical Industry." *Industrial and Corporate Change*, 22, 4, 2013: 981-1030; Maki Umemura "Reconsidering Japan's Underperformance in Pharmaceuticals: Evidence from Japan's Anticancer Drug Sector," *Enterprise and Society*, 11, 3, 2010: 560-593; Tord Andersson, Pauline Gleadle, Colin Haslam, and Nick Tsitsianis "Bio-Pharma: A Financialized Business Model," *Critical Perspectives on Accounting*, 21, 7, 2010: 631-641.

[153] Lazonick and Tulum , "U.S. Biopharmaceutical Finance".

[154] Rebecca Henderson, "Managing Innovation in the Information Age," *Harvard Business Review*, January-February 1994: 100-107, quoted at p. 100. This paragraph and the two that follow are from Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?".

[155] See Gary Pisano, *Science Business:: The Promise, the Future, and the Reality of Biotech*, Harvard Business School Press, 2006; Iain Cockburn, "Is the Pharmaceutical Industry in a Productivity Crisis?," in Josh Lerner and Scott Stern, eds., *Innovation Policy and the Economy*, Volume 7, MIT Press 2007: 1-32; Fabio Pammolli, Laura Magazzini, and Massimo Riccaboni, "The Productivity Crisis in Pharmaceutical R&D," *Nature Reviews, Drug Discovery*, 10, 6, 2011: 428-438; Ish Khanna, "Drug Discovery in Pharmaceutical Industry: Challenges and Trends," *Drug Discovery Today*, 17, 19/20, 2012; Jack DeRuiter and Pamela J. Holston, "Drug Patent Expirations and the 'Patent Cliff'," *U.S. Pharmacist*, 37, 6, 2012: 12-20 at http://www.uspharmacist.com/content/s/216/c/35249/.

[156] David J. Phillips, "Pfizer's pipeline story begins to unravel," *YCharts*, August 30, 2013, at http://finance.yahoo.com/news/pfizer-pipeline-story-begins-unravel-143509405.html; Maggie McGrath, "Drug patent expirations continue to hit Pfizer revenue," *Forbes*, January 28, 2014; Maggie McGrath, "Merck sales slide on expiring drug patents but shares lifted by cancer-fighting collaboration," *Forbes*, February 5, 2014;

pricing policy, they have responded that they need to charge high prices in the United States to fund the high levels of R&D that they do in this country.[157] As we shall discuss more generally in Section 4 of this paper, the fact is that these companies have been spending a very high proportion of their profits on stock buybacks to prop up their stock prices.

For the two decades 1994-2013 Pfizer, no. 51 on the 2014 Fortune 500 list with $53.8 billion in revenues, expended 66% of net income on buybacks and another 60% on dividends, including in the decade 2004-2013 60% on buybacks and 63% on dividends. Over the two decades, Merck, no. 65 on the 2014 Fortune 500 list with $44.0 billion in revenues, distributed 42% of net income as buybacks and 58% as dividends, including 35% as buybacks and 71% as dividends in 2004-2013. Amgen, the largest independent biopharmaceutical company and no. 154 on the 2014 Fortune 500 list with $18.7 billion in revenues, expended 103% of net income on buybacks and another 7% on dividends over the two decades 1994-2013, including 100% on buybacks and 8% on dividends in the decade 2004-2013. Meanwhile these drug companies are able to avail themselves of the knowledge generated by research funded by the NIH, with its annual budgets of $29 billion to $31 billion in recent years, as well as subsidies and intellectual-property protection under the Orphan Drug Act. Companies such as Pfizer, Merck, and Amgen are not using high drug prices to conduct more R&D in the United States. On the contrary, the profits from high drug prices are being used to do buybacks to boost give short-term boosts to the companies' stock prices and bolster dividend yields to shareholders.

What accounts for this financialized corporate behavior? In February 2011, *Wall Street Journal* ran an article headlined "Pfizer, Merck take different R&D tacks."[158] Although the article did not use this terminology, the observation was that Pfizer was engaged in "downsize-and distribute" while Merck was trying to engage in "retain-and-reinvest". As the article summed it up:

> Merck & Co. CEO Ken Frazier took steps Thursday that are sure to anger Wall Street, saying the company won't make the cuts necessary to meet its long-term forecasts. Instead, it will focus on investing in drug development to drive growth. By contrast, in his first major public remarks since taking the helm of Pfizer Inc., Ian Read pleased shareholders by vowing to slash the company's spending on drug research and development by a third and to spend an additional $5 billion to buy back its stock.

In Merck's quarterly conference call with analysts,[159] Frazier explained that European austerity, global pressures for lower drug prices, U.S. health reform, and the recent termination of a clinical trial on one of its drugs because of safety issues, the company was taking the unusual step of withdrawing its 2013 EPS (earnings per share) target. In Frazier's own words:

> it is clear that the only way to achieve our 2013 EPS target would be through deeper, short-term-oriented cost cutting. That would result in significant under investment in our longer-term growth prospects, and could limit our ability to pursue external opportunities. Instead, I have decided that investing in our growth is the best long-term strategy for the business and our shareholders.[160]

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[157] Lazonick and Tulum, "US Biopharmaceutical Finance."

[158] Jonathan D. Rockoff, "Pfizer, Merck take different R&D tacks," *Wall Street Journal*, February 4, 2011; Peter Loftus, "New Pfizer, Merck CEOs take different tacks in research costs," *Dow Jones News Service*, February 3, 2011.

[159] The transcript of the conference call is available at http://seekingalpha.com/article/250621-merck-and-co-s-ceo-discusses-q4-2010-results-earnings-call-transcript?part=qanda

[160] Jim Edwards, "Merck 'disingenuous' for stopping earnings guidance, Wall Street says," *CBS Money Watch*, February 4, 2011, at http://www.cbsnews.com/news/merck-disingenuous-for-stopping-earnings-guidance-wall-street-says/

When Frazier made this statement on February 3, Merck's stock price fell by 3%, but over the following months it rose by almost 16%, reaching a peak on May 18. In mid-July, with its stock price still 12% up from February 3, Frazier reiterated his commitment to invest in Merck's future. In an interview with *Wall Street Journal* and *Dow Jones Newswires*, Frazier said, "I'm trying to run the company in a way that I can satisfy the short- and intermediate-term needs of investors without sacrificing really what we're about. Science and innovation are in the DNA of the company. The science will lead us to another big breakthrough."[161]

The article that reported this interview with Frazier noted that "Merck expects to spend up to $8.4 billion on research in 2011, adjusted to exclude certain costs, up from about $8.1 billion last year. Pfizer plans to cut research spending to about $6.5 billion to $7 billion in 2012, down from about $9.3 billion in 2010."[162] About two weeks later, on a conference call with analysts in which Frazier announced that Merck would cut 13,000 jobs, or 13% of its labor force by 2015, he portrayed the layoffs as part of Merck's strategy to restructure for the sake of investing in innovation. As he put it:

> These planned job reductions will come disproportionately from the elimination of non-revenue-generating positions such as administrative and headquarters personnel, consolidation of office facilities, and ongoing sale or closure of manufacturing sites including animal health facilities. Importantly, at the same time as we are reducing our overall employee base we have been hiring, and will continue to hire, in key areas like emerging markets where we have significant growth opportunities before us. . . .
>
> For our people this won't be easy, but the realities of our environment dictate the need to operate more flexibly and nimbly from a lower cost base. We are taking these difficult actions now so that we can grow profitably and continue to deliver on our mission well into the future. By improving the effectiveness and efficiency of our operations and focusing on ways to deliver customer value through innovation, we are positioning Merck for sustained, profitable growth.[163]

Frazier told the analysts that, in cutting its labor force, "we are not in a business-as-usual mode when it comes to managing our investments in R&D. We continue to improve the decision process by which we either commit to or discontinue projects, and we are being more aggressive about prioritizing the programs as well as the therapeutic areas where we will invest.[164]

There was no discussion of stock buybacks in the conference call. Yet Table 4 shows that since Frazier informed the analysts that Merck was not eschewing a "retain-and-reinvest" strategy as far as R&D effort is concerned, it has been "downsize-and-distribute" that has "business-as-usual" at Merck, just as at Pfizer. As it happens, in April 2011 Merck's board had approved a new $5 billion stock repurchase program, in addition to $1.4 billion remaining from a 2009 program.[165] On May 1, 2013 Merck's board authorized an additional stock repurchase program of $15 billion. In May the company also did a $6.5 billion debt issue, a "substantial proportion" of which, according to

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[161] Peter Loftus, "Merck CEO: Spending on research crucial for long-term success," *Dow Jones News Service,* May 15, 2011.
[162] Ibid.
[163] Q2 2011 Merck & Co Inc Earnings Conference Call – Final," *CQ FD Disclosure*, July 29, 2011; see also Jonathan D. Rockoff and Peter Loftus, "Merck to cut 13,000 more jobs as patents expire," *Wall Street Journal*, July 30, 2011.
[164] "Q2 2011 Merck & Co Inc Earnings Conference Call – Final," *CQ FD Disclosure*, July 29, 2011.
[165] Matt Jarzemsky, "Merck board authorizes co to buy back $5b more in stock," *Dow Jones News Service,* April 27, 2011.

Merck's annual report, was used to repurchase the company's stock.[166]

As can be seen in Table 4, from 2011 through the first half of 2014, Pfizer did a total of $36.0 billion in stock buybacks, even as it distributed $22.7 billion in dividends to shareholders, while slashing both its labor force and R&D spending. Pfizer had been a large-scale stock repurchaser throughout the 2000s, but from 2000 through 2009 had maintained R&D spending at 17.8% of sales. Table 4 shows Merck trying to catch up with Pfizer in the realm of downsize-and-distribute, cutting R&D spending, laying off workers, paying more than ample dividends to shareholders, and doing debt-financed buybacks that represented 268% of net income in 2013. During the first half of 2014, Merck's $6.1 billion in buybacks almost matched its total for the whole previous year.

Table 4. Repurchases (RP) and Dividends (DV) as % of Net Income and R&D spending as a % of Sales, 2011-2014Q2

Fiscal Year	Sales, $m.	NI, $m	RP, $m	DV, $m	R&D, $m	RP/ NI %	DV/ NI %	(RP+DV) /NI %	R&D/ Sales %	Change in R&D %	Employees
MERCK											
2011	48,047	6,272	1,921	4,811	8,467	30.6	76.7	107.3	17.6	-23.0	86,000
2012	47,267	6,168	2,591	5,236	8,168	42.0	84.9	126.9	17.3	-3.5	83,000
2013	44,033	4,404	6,516	5,277	7,503	148.0	119.8	267.8	17.0	-8.1	76,000
2014*	22,198	3,709	6,105	2,638	3,238	164.6	71.1	235.7	14.6	-19.2	73,000
PFIZER											
2011	67,425	10,009	9,000	6,234	9,112	89.9	62.3	152.2	13.5	-4.5	103,700
2012	58,986	14,570	8,228	6,534	7,870	56.5	44.8	101.3	13.3	-13.6	91,500
2013	51,452	22,003	16,290	6,580	6,678	74.0	29.9	103.9	13.0	-15.1	77,700
2014*	24,126	5,241	2,520	3,320	3,382	48.1	63.3	111.4	14.0	-4.2	73,000

* 2014 figures for the first six months of fiscal year ending June 30. Pfizer employment for 2014 is estimated using first and second quarter financial results for the same year.
Note: % change in R&D is annual for 2011-13 and compared with the first six months of 2013 for the first six months of 2014.
Source: S&P Compustat database, Merck 2014 10-Q, June 29, 2014; Pfizer 2014 10-Q, June 29, 2014.

Awaiting further study of drug companies like Merck and Pfizer, the TIE hypothesis is that this quest for shareholder value is destroying CCCs, and with them the future of drug development in the United States. We cannot imagine how SBTC would address the employment implications of this financialized mode of the allocation of the economy's resources for PhD scientists, let alone less educationally endowed members of the U.S. labor force.

4. The Great Marketization

a) From retain-and-reinvest to downsize-and-distribute

As argued in the introduction to this essay, the fundamental point of departure for any discussion of employment and wages in the United States is the employment relations that prevail in large companies in the U.S. economy. The centrality of the large corporation in the operation and performance of the economy is nothing new. The now classic oeuvre on the rise of the large industrial corporation in the United States is Alfred D. Chandler's aptly titled *The Visible Hand: The Managerial Revolution in American Business*, a book that covers the last decades of the 19th century

[166] Merck, *2013 10-K*. p. 63.

and concludes around 1920 when, according to Chandler, the "managerial revolution" was complete.[167]

In the boom years of the 1920s, the major industrial corporations found that they could increase productivity by providing employment stability to both blue-collar workers and white-collar workers while sharing the productivity gains with them.[168] At the leading companies, many of the white-collar workers were engaged in developing new technologies in corporate labs such as those at General Electric, AT&T, Eastman Kodak, and DuPont that were among the foremost research facilities in the world.[169] In mass-production consumer goods industries such as automobiles and appliances that burgeoned in the 1920s, as well as in related capital-goods industries such as rubber and steel, blue-collar workers became known as "semi-skilled" because they did repetitive work that could be quickly learned but that required their constant attention to the work that they did to achieve high rates of throughput (i.e., output per unit of time) while avoiding wastage of valuable materials.[170]

The resultant "economies of speed", as Chandler called them, were essential for reducing unit costs. Moreover the quality of the work effort that these blue-collar workers supplied was important to reducing waste in production through damage to machines and materials. As a result, semi-skilled blue-collar workers were paid on time rates, not piece rates, and, even without the intervention of labor unions, companies sought to provide attentive and consistent workers with stable employment from year to year. For blue-collar workers, as for white-collar workers, in the 1920s this employment stability was accompanied by rising wage incomes as they shared in the productivity that they helped to create.

For blue-collar workers, however, these emergent employment relations broke down in the early 1930s as major corporations that had lost their mass markets did mass layoffs.[171] As a result, mass-production workers turned to industrial unions to help restore stable work and rising pay. With the critical support of New Deal labor legislation, the new industrial unions began to gain recognition in the late 1930s, and in the 1940s collective bargaining over wages combined with union protection of seniority became permanent dimensions of employment relations in a wide range of major U.S. industrial corporations. By the 1950s job security through seniority, bargained cost-of-living allowances, and company-funded defined-benefit pensions had become the norm among unionized blue-collar workers, almost all of whom were white males. Called "hourly workers" by virtue of their eligibility under the Fair Labor Standards Act of 1938 to be paid "time and a half" when working more than 40 hours per week, in the generally prosperous decades of the 1950s and 1960s the norm of a career with one company became a reality for unionized employees of major U.S. industrial corporations.

The career-with-one company norm also held in the post-World War II decades for male white-collar workers who could be counted under the general occupational category of professional,

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[167] See William Lazonick, "Alfred Chandler's Managerial Revolution: Developing and Utilizing Productive Resources," in Morgen Witzel, and Malcolm Warner, eds., *Oxford Handbook of Management Theorists*, Oxford University Press, 2012: 361-384.

[168] Sanford Jacoby, *Employing Bureaucracy: Managers, Unions, and the Transformation of Work in American Industry*, Columbia University Press, 1985, ch. 6; Lazonick, *Competitive Advantage on the Shop Floor*, chs. 7 and 8.

[169] See Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?", where specific references can be found.

[170] Lazonick, *Competitive Advantage on the Shop Floor*, Part II.

[171] Lester V. Chandler, *America's Greatest Depression, 1929-1941*, Harper & Row 1970, pp. 23, 36 for evidence on reduced capital utilization and employment in the most concentrated industrial sectors. See more generally, Richard J. Jensen, "The Causes and Cures of Unemployment in the Great Depression," *Journal of Interdisciplinary History*, 19, 4, 1989: 553-583.

technical, and administrative personnel. From the first decade of the 20^{th} century, these employees were increasingly recruited from four-year colleges, and by virtue of the impact of land-grant universities on the spread of higher education in engineering, institutions such as MIT, Cornell, and Purdue prepared growing numbers of their graduates to join the ongoing managerial revolution.[172] When a company recruited these graduates and trained them in the lines of business in which the company was engaged, they then put in place career tracks to retain them through promotion around and up the managerial hierarchy.[173] The boom of the 1920s served to solidify these white-collar employment practices.[174]

During the 1930s, many white-collar workers lost their seemingly secure jobs, but by virtue of the companies' stake in their cumulated experience not nearly on the same enormous scale as the terminations of blue-collar workers. Indeed, even as the national unemployment rate reached 25% in 1933 and never fell below 15% during the 1930s, technology-oriented companies expanded their employment of research personnel considerably. As a result, the depression decade was one of great advance for corporate research.[175] U.S. involvement in World War II greatly deepened the investment in corporate research capabilities, and in the postwar decades, with the Cold War taking center stage, R&D at U.S. industrial corporations became integral to what would become known as "the military-industrial complex." More generally, during the postwar decades, the growth of U.S. corporations, and as a consequence the growth of the U.S. economy, was driven by the organizational integration of professional, technical, and administrative employees, the vast majority of whom were white male, into what we have called collective and cumulative careers.[176]

It is because of the centrality of CCCs to the growth of the firm, in the post-World War II decades that the guiding principles of corporate resource allocation can be summed up as "retain-and-reinvest".[177] Business corporations retained earnings and reinvested them in productive capabilities, including the capabilities of employees who, in helping to make the enterprise more competitive, benefited in the forms of higher incomes and greater employment security. Retain-and-reinvest is a resource-allocation regime that supports *value creation* at the business level and implements a process of *value extraction* through which the firm shares the productivity gains with a broad base of employees.[178]

Indeed, given the importance of large corporations to the operation and performance of the economy, retain-and-reinvest, rather the forces of demand and supply, underpinned the shared prosperity of the post-World War II decades. Figure 15a below shows that from the late 1940s to the late 1970s changes in real wages tracked changes in productivity in the U.S. economy. Lazonick has argued that the retain-and-reinvest employment policies of major U.S. corporations largely

[172] Louis Ferleger and William Lazonick, "Higher Education for an Innovative Economy: Land-Grant Colleges and the Managerial Revolution in America," *Business and Economic History*, 23, 1, 1994: 116-128.

[173] William Lazonick, "Strategy, Structure, and Management Development in the United States and Britain," in K. Kobayashi and H. Morikawa, eds., *Development of Managerial Enterprise*, University of Tokyo Press, 1986: 101-146.

[174] Jacoby, *Employing Bureaucracy,* Ch. 6.

[175] David C. Mowery and Nathan Rosenberg, *Technology and the Pursuit of Economic Growth*, Cambridge University Press, 1989, pp. 61-74.

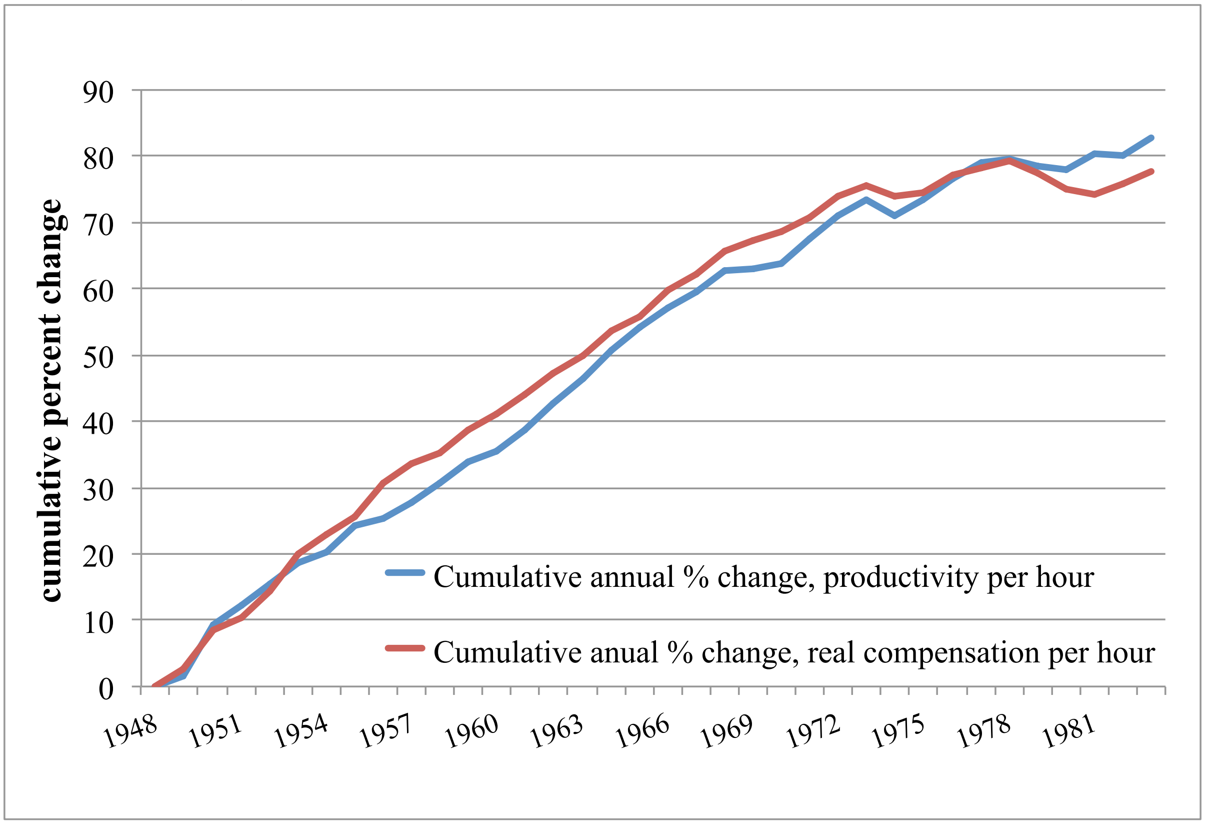
[176] On the recognition by labor economists of the widespread existence of lifetime employment in the United States coming into the 1980s, see Robert B. Hall, "The Importance of Lifetime Jobs in the U.S. Economy," *American Economic Review*, 72, 4, 1982: 716-724; Katharine G. Abraham and Henry S. Farber, "Job Duration, Seniority, and Earnings," *American Economic Review*, 77, 3, 1987: 278-297; Susan B, Carter, "The Changing Importance of Lifetime Jobs, 1892-1978," *Industrial Relations*, 27, 3, 1988: 287-300;

[177] Lazonick and O'Sullivan, "Maximizing Shareholder Value".

[178] Lazonick, *Sustainable Prosperity*. See also Lazonick, *Competitive Advantage on the Shop Floor.*

accounted for this result.[179] The sharing of the gains of productivity growth with white-male career employees, including both unionized blue-collar workers with high-school educations and non-union white-collar workers with college educations, provided the foundation for the postwar trend toward less income inequality in the United States.[180]

Figure 15a. Cumulative annual percent changes in productivity and real wages in the United States, 1948-1983



Source: http://www.econdataus.com/wagegap12.html

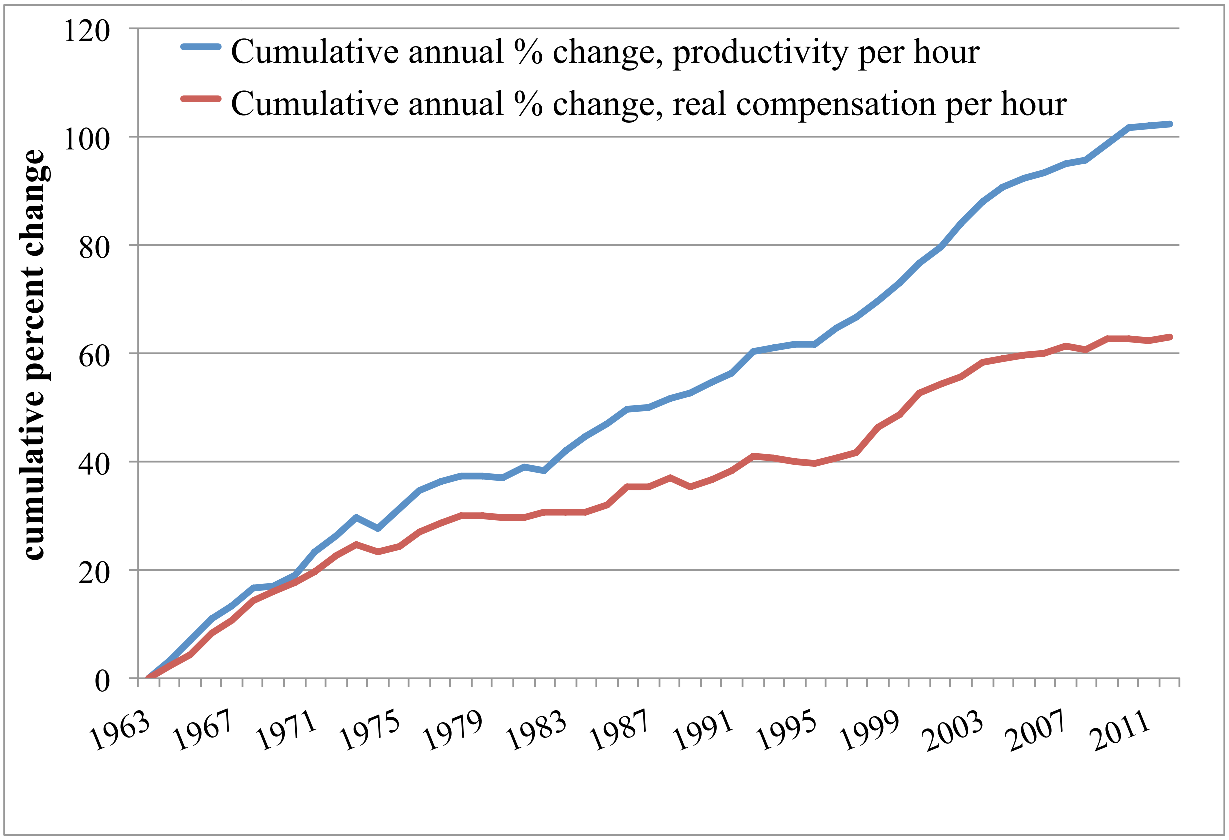
As shown in Figure 15b, however, since the late 1970s there has been a widening gap between the growth in productivity and the growth in real wages. As discussed in Section 3, Lazonick has argued that the key drivers of this divergence of productivity growth from wage growth were changes in the employment relations of major U.S. corporations, summarized as "rationalization", "marketization", and "globalization", that put an end to CCCs combined with the increasingly financialized character of corporate resource allocation that diverted American society – and not just the business corporations – from restructuring its employment institutions to put new CCCs in place. As we have seen, from the early 1980s, rationalization, characterized by plant closings, terminated the jobs of high-school educated blue-collar workers, most of them well-paid union members. From the early 1990s, marketization, characterized by the end of the norm of a career with one company, placed the job security of middle-aged white-collar workers, many of them college educated, in jeopardy. From the early 2000s, globalization, characterized by the movement

[179] Lazonick, *Sustainable Prosperity*, ch. 3; Lazonick, "Laboring in the Twenty-First Century.

[180] For evidence of the trend toward more equality in the post-World War Ii decades, see, for example, the historical changes in the Gini coefficient at .S. Census Bureau, *Historical Income Tables Families*, Table F-4, at http://www.census.gov/hhes/www/income/data/historical/families/.

of employment offshore to lower-wage areas of the world, left all members of the U.S. labor force, even those with advanced educational credentials and substantial work experience, vulnerable to displacement.

Figure 15b. Cumulative annual percent changes in productivity and real wages in the United States, 1963-2012



Source: http://www.econdataus.com/wagegap12.html

Initially, each of these structural changes in employment could be justified as a business response to major changes in industrial conditions related to technologies, markets, and competition. During the onset of the rationalization phase in the early 1980s, the plant closings were a reaction to the superior productive capabilities of Japanese competitors in consumer-durable and related capital-goods industries that employed significant numbers of unionized blue-collar workers.[181] During the onset of the marketization phase in the early 1990s, the erosion of the one-company-career norm among white-collar workers was a response to the dramatic technological shift from proprietary systems to open systems, integral to the microelectronics revolution. This shift favored younger workers with the latest computer skills, acquired in higher education and transferable across companies, over older workers with many years of company-specific experience with systems integration.[182] During the onset of the globalization phase in the early 2000s, the sharp acceleration in the offshoring of jobs was a response to the emergence of large supplies of highly capable, and lower-wage, labor in developing nations such as China and India

[181] Lazonick, "Innovative Business Models".
[182] Lazonick, *Sustainable Prosperity*, chs. 2-4,

which, linked to the United States through global value chains and inexpensive communications systems, could take over U.S. employment activities that had become routine.[183]

Once U.S. corporations transformed their employment relations, however, they often pursued rationalization, marketization, and globalization to cut current costs rather than to reposition themselves to produce competitive products. That is, they closed manufacturing plants, terminated experienced workers, and offshored production to low-wage areas of the world simply to increase profits, often at the expense of the companies' long-term competitive capabilities and without regard for displaced employees' long years of service. As this new approach to corporate resource allocation became embedded in the new structure of U.S. employment, business corporations failed to invest in new, higher-value-added capabilities on a scale sufficient to create middle-class employment opportunities that could provide a new foundation for equitable and stable growth in the U.S. economy.

On the contrary, from the mid-1980s, with superior corporate performance defined as meeting Wall Street's expectations for ever-higher quarterly earnings per share, corporations turned to massive stock repurchases to "manage" their own stock prices. Trillions of dollars that could have been spent on innovation and job creation in the U.S. economy over the past three decades have instead been used to buy back stock for the purpose of manipulating stock prices. In 1997, buybacks surpassed dividends as a dominant mode of distribution to shareholders, even with dividends generally rising.[184] For the decade 2004-2013 alone, an annual average of about 9,000 companies included in the Compustat database expended $6.9 trillion on buybacks, representing 43% of their combined net income before extraordinary items, while dividends absorbed another 47% of net income. Companies included in the S&P 500 Index, which account for more than 70% of total market capitalization of companies publicly listed in the United States, did about half of the buyback total of $6.9 trillion. The 454 companies included in the Index in March 2014 that were publicly listed from 2004 through 2013 expended $3.4 trillion on buybacks, equal to 51% of net income, and another $2.3 trillion on dividends, 35% of net income.[185]

Legitimizing this financialized mode of corporate resource allocation has been the ideology that a business corporation should be run to "maximize shareholder value."[186] It is an ideology of corporate resource allocation that only rose to dominance from the late 1980s, and that has been both cause and effect of the explosion of executive pay.[187] Through their stock-based compensation received in the form of stock options and stock awards, corporate executives who make these resource-allocation decisions are themselves prime beneficiaries of this focus on rising stock prices as the sole measure of corporate performance. The 500 highest paid corporate executives in the ExecuComp database in 2012 averaged total remuneration of $30.3 million, of which 42% came from exercising stock options and another 41% from vesting of stock awards. As Lazonick

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[183] Ibid., ch. 5.

[184] Although high dividend payout ratios may cut into funds that are needed to pursue a retain-and-reinvest strategy, at least dividends reward shareholders for continuing to hold the company's stock whereas stock repurchases reward shareholders for becoming sharesellers. Dividend yields are high in a stable stock market whereas buyback yields are high in a volatile stock market. And most buybacks are in fact done to manipulate stock prices. See Lazonick, "Profits Without Prosperity".

[185] William Lazonick, "Cash Distributions to Shareholders (2004-2013) & Corporate Executive Pay (2006-2012)," Research Note, The Academic-Industry Research Network, at http://www.theairnet.org/v3/home/1009-2/; research by Mustafa Erdem Sakinç for The Academic-Industry Research Network.

[186] William Lazonick and Mary O'Sullivan, "Maximizing Shareholder Value: A New Ideology for Corporate Governance," *Economy and Society*, 29, 1, 2000: 13-35; Lazonick, "Innovative Enterprise and Shareholder Value".

[187] William Lazonick, "The Explosion of Executive Pay and the Erosion of American Prosperity," *Entreprises et Histoire*, 57, 2009: 141-164.

has argued, the only logical explanation for the open-market repurchases that account for the vast majority of buybacks is that top executives have a strong personal incentive to do them.[188]

As a result of the rationalization, marketization, and globalization of employment relations, the paucity of well-paid and stable employment opportunities in the U.S. economy is largely structural. The structural problem is not, as some economists have argued, a labor-market mismatch between the skills that prospective employers want and the skills that potential workers have.[189] As we discussed in Section 2, if major employers need and want a match, they can train, and then through pay incentives retain, employees. That, in fact, was the primary reason why U.S. business corporations adopted the norm of a career with one company under OEBM and why from the 1940s to the 1970s the real incomes of corporate employees, both blue-collar and white-collar, kept pace with productivity growth. For innovative companies, the match between what employers demand and what employees can supply is made in the workplace, not on the labor market.

Nor is the problem automation, a common refrain of economists who view SBTC as the most plausible explanation for the disappearance of good jobs for members of the U.S. labor force who have only a high-school education.[190] As we have seen, SBTC focuses on labor-market supply and demand to determine employment outcomes. But, especially where the adoption of new technologies is involved, employment outcomes in terms of pay and promotion are determined within the employing organizations, not on labor markets. And as the Japanese have shown, the development and utilization of automated technology requires a corporate commitment to employment stability. In the United States the roots of the employment problem are systemic changes in corporate employment relations related to rationalization, marketization, and globalization that have undermined CCCs.

The concomitant financialization of the resource-allocation decisions of U.S. business corporations has deepened the career-destroying impacts of rationalization, marketization, and globalization. It may well be that in an age of open innovation, emerging markets, and global competition, it is no longer possible for even the largest, most profitable corporations to offer the types of careers with one company that were the norm under OEBM. It must also be recognized that in the postwar decades "The Organization Man", to use William H. Whyte's incisive book title, was almost invariably a white male, so that the contribution of CCCs to the trend toward income equality was race-biased, ethnicity-biased, and gender-biased. Insofar as cultural homogeneity provided glue to the career-with-one-company norm, that type of social cohesion would certainly not be desirable, even if it were possible, in a society that values diversity.

Nevertheless, large corporations still dominate the U.S. economy, and if these companies do not make substantial contributions to the provision of CCCs, then we cannot expect smaller enterprises, government agencies, and civil society organizations to fill the employment gaps during the four decades or so over which members of the labor force require careers. On the contrary, and in the name of shareholder value, financialized corporations and the people who

[188] Lazonick, "Profits Without Prosperity".

[189] See, e.g., Narayana Kocherlakota, "Back Inside the FOMC," President's speeches, Federal Reserve Bank of Minnesota, 2010; Marcello Estevão and Evridiki Tsounta, "Has the Great Recession Raised U.S. Structural Unemployment?" IMF Working Paper No. 11/105, 2011 at http://www.imf.org/external/pubs/ft/wp/2011/wp11105.pdf.

[190] Daron Acemoglu, "Technical Change, Inequality, and the Labor Market," *Journal of Economic Literature*, 40, 1, 2002: 7-72: Autor, Katz, and Kearney, "The Polarization of the U.S. Labor Market"; Goldin and Katz, *The Race between Education and Technology*; Brynjolfsson and McAfee, *The Second Machine Age.*

control them actively avoid taxes, making it even more difficult for these other entities that depend directly or indirectly on tax revenues to sustain CCCs.[191]

In our view, therefore, the growing gap between productivity and wages displayed in Figure 15b is largely the result of a shift of corporate resource allocation from the "retain-and-reinvest" regime that prevailed in the postwar decades to a "downsize-and-distribute" regime in which corporate executives look for opportunities to downsize the labor force and distribute earnings to shareholders. Had corporate executives made different allocation decisions, a portion of the earnings that were paid out to shareholders could have been invested in, among other things, the productive capabilities of the people thrown out of work. In a high-wage "knowledge" economy, the accumulation of those productive capabilities depends on corporate investment in CCCs.

Instead, under NEBM and in the name of shareholder value, the U.S. corporate economy has continued its shift from a focus on *value creation* to a focus on *value extraction*. Downsize-and-distribute is a resource-allocation regime that supports value extraction at the business level that may enrich financial interests at the expense of employees who contributed to the process of value creation that generated those earnings in the first place. With trillions of dollars flowing out of the industrial enterprises that are at the heart of the U.S. productive economy, top executives, hedge-fund mangers, and Wall Street bankers are enriching themselves by reaping returns on stock-market speculation and manipulation at the expense of taxpayers and workers who have invested in innovation.[192] In the process, they are in effect eating the seed corn for the next round of innovative enterprise, thereby diminishing the possibilities for even the best educated members of the U.S. labor force to accumulate innovative capabilities through collective and cumulative careers.

The adverse impacts of a downsize-and-distribute allocation regime are already manifest in employment instability and income inequality. Our company-level research supports the hypothesis that, as a result of the financialization of the U.S. corporation, the future of innovation, and hence economic growth, in the U.S. economy is being undermined.[193] To test this hypothesis one has to delve deeply inside the "black box" of the business corporations that are central to high-tech industry to find out what investments in innovative capabilities are, and are not, being made. As Hopkins and Lazonick have argued, investment in innovative capabilities cannot be inferred from data on R&D expenditures.[194] Just like any other investment (including investment in education), there is no reason to believe that a certain amount of R&D spending automatically generates a certain level of productivity. The knowledge that makes possible higher quality

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[191] These issues of society-wide investment in CCCs are raised in Hopkins and Lazonick, "Who Invest in the High-Tech Knowledge Base?".

[192] William Lazonick, "Creating and Extracting Value: Corporate Investment Behavior and American Economic Performance," in Michael Bernstein and David Adler, eds., *Understanding American Economic Decline*, Cambridge University Press, 1994: 79-113; William Lazonick, "Corporate Restructuring," in Stephen Ackroyd, Rose Batt, Paul Thompson, and Pamela Tolbert, eds., *The Oxford Handbook of Work and Organization*, Oxford University Press, 2004: 577-601; William Lazonick and Mariana Mazzucato, "The Risk-Reward Nexus in the Innovation-Inequality Relationship," *Industrial and Corporate Change*, 22, 4, 2013: 1093-1128.

[193] See, for example, Lazonick and March, "Rise and Demise of Lucent Technologies"; Lazonick and Tulum, "U.S. Biopharmaceutical Finance"; William Lazonick, Mariana Mazzucato, and Öner Tulum, "Apple's Changing Business Model: What Should the World's Richest Company Do With All Those Profits?" *Accounting Forum*, 37, 4, 2013: 249-267; Bob Bell, Marie Carpenter, Henrik Glimstedt, and William Lazonick, "Cisco's Evolving Business Model: Do Massive Stock Buybacks Affect Corporate Performance?" paper presented to the Edith Penrose Centenary Conference, SOAS, University of London, November 15, 2014.

[194] Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?".

products and processes depends on the *productivity of R&D*, which in turn depends on organizational learning. And the social foundation for organizational learning is CCCs.

b) Researching CCCs

With the spread of globalization and open-systems technologies, it may be difficult, if not impossible, for most corporations to hold out the promise of a career with one company. But that fact does not make CCCs any less important to the prosperity of the economy, sustained by a strong and growing middle class. The CCC hypothesis contends that, for any individual, productivity-enhancing skill development derives from on-the-job experience, given the educational attainment required to access the job. The organizations that provide CCCs may be business enterprises (BEs), government agencies (GAs), or civil-society organizations (COs, including institutions of higher education). For an individual to maintain a good standard of living, he or she must maintain a CCC over 30 to 40 years.

There are, however, many different ways to structure CCCs. Over the course of his or her career, an individual may develop skill through a series of jobs in different organizations, and in the age of the Internet it may be possible for an individual to pursue a CCC through participation in an internetworked organization of BEs, GAs, and/or COs. In addition, a CCC may be followed across national borders, often with employment by one multinational organization.

Employment in BEs is central to the structure of CCCs because BEs generate the productivity that, directly or indirectly, supports remuneration and employment in CCCs in GAs and COs. In the United States BEs provide over 80% of all employment. The study of how skill development can translate into equitable and stable economic growth must begin with the structure of CCCs in BEs, but must also analyze the roles of GAs and COs in structuring the ecology of CCCs.

If, in a world of rapidly changing technologies, new emerging markets, and intense global competition, there are limited possibilities for the re-emergence of the norm of a career with one company, it is also clear that large business corporations, and particularly large high-tech corporations, must play central roles in the emergence of transorganizational CCCs. To what extent have major U.S. high-tech business corporations been playing this role? Given what we know about the rationalization, marketization, and globalization of employment relations as well as the financialization of corporate resource allocation among major U.S. high-tech corporations, our hypothesis is that their investment in CCCs is deficient relative to the investments in productive capabilities required to sustain well-paid, stable, and creative employment opportunities, even for the best-educated members of the U.S. labor force.

The only way to determine the extent to which U.S. high-tech corporations are supporting CCCs as well as the extent to which they should be supporting them for the United States to remain at the forefront of global innovation is to study the employment practices of the companies concerned. Table 5 provides a list of the 75 companies in the 2013 Fortune 500 list of the largest U.S. publicly-listed companies by revenue that are in industries that are considered to be high-tech, with data (for fiscal year 2012) on number of employees, R&D as a percent of sales, and distributions to shareholders in the forms of both dividends and repurchases, both absolutely and relative to net income, for the decade 2004-2013. Table 5 also shows the ratio of stock repurchases to R&D expenditures, not because there is an inherent relation between the two (R&D spending varies dramatically across industries, and even in this list of high-tech *industries*, many individuals companies do no R&D), but simply to provide an indicator of the relative sizes of these two forms of expenditures.

Table 5. Companies in 11 High-Tech Industries in the 2013 Fortune 500 , Employees, R&D, and Distributions to Shareholders

	2013			2004-2013					
Company Name	**Fortune Rank**	**Employees (000)**	**R&D/Sales (%)**	**RP $b**	**DV $b**	**RP/NI (%)**	**DV/NI (%)**	**(RP+DV)/ NI(%)**	**RP/ R&D**
Aerospace and defense									
Boeing	30	168.4	5.4	*13.9*	*11.2*	*45.6*	*36.9*	*82.5*	*0.4*
United Technologies	50	212.4	3.4	*16.1*	*12.8*	*36.4*	*29.1*	*65.5*	*0.9*
Lockheed Martin	59	115.0	1.6	*18.6*	*8.6*	*72.0*	*33.3*	*105.3*	*2.7*
Honeywell International	78	131.0	4.4	*11.7*	*9.2*	*50.5*	*39.8*	*90.3*	*0.8*
General Dynamics	98	96.0	1.2	*6.7*	*5.3*	*36.1*	*28.8*	*64.9*	*2.0*
Northrop Grumman	120	65.3	1.8	*13.8*	*4.8*	*96.5*	*33.8*	*130.3*	*2.5*
Raytheon	124	63.0	2.4	*9.9*	*5.0*	*63.2*	*31.9*	*95.1*	*1.8*
L-3 Communications	197	48.0	1.6	*5.3*	*1.4*	*70.0*	*18.5*	*88.5*	*2.5*
Textron	225	32.0	4.0	*2.9*	*1.2*	*69.1*	*27.9*	*97.0*	*0.6*
Precision Castparts	355	29.0	0.2	*0.6*	*0.2*	*6.0*	*1.7*	*7.7*	*5.5*
Huntington Ingalls Industries	380	38.0	0.3	*0.1*	*1.5*	*21.0*	*255.1*	*276.0*	*1.1*
Exelis[a]	453	17.0	1.7	*0*	*0.2*	*0.8*	*8.9*	*9.7*	*0*
Computer peripherals									
EMC Corp/Ma	133	63.9	11.4	*14.8*	*0.4*	*84.0*	*2.3*	*86.3*	*0.9*
Western Digital Corp	222	85.8	7.6	*1.8*	*0.2*	*24.2*	*2.5*	*26.7*	*0.3*
Netapp Inc	408	12.5	13.6	*5.9*	*0.2*	*146.4*	*5.0*	*151.5*	*1.0*
Computer software									
Microsoft Corp	35	99.0	14.4	*113.3*	*77.3*	*70.8*	*48.3*	*119.1*	*1.4*
Oracle Corp	80	122.0	12.7	*42.2*	*7.1*	*61.9*	*10.5*	*72.3*	*1.3*
Symantec Corp	379	20.8	15.4	*12.5*	*0.0*	*-1219.8*	*0.0*	*-1219.8*	*1.4*
CA	499	12.7	13.2	*5.0*	*1.7*	*84.5*	*28.2*	*112.8*	*0.9*
Computers, office equipment									
Apple	6	84.4	2.7	*23.2*	*13.1*	*17.0*	*9.6*	*26.6*	*1.4*
Hewlett-Packard	15	317.5	3.1	*64.6*	*8.9*	*147.9*	*20.5*	*168.4*	*1.9*
Dell[b]	51	111.3	1.1	*27.6*	*0.3*	*101.5*	*1.0*	*102.5*	*4.4*
Pitney Bowes	441	16.1	3.0	*1.8*	*2.8*	*42.3*	*66.5*	*108.8*	*1.1*
NCR	489	29.3	3.5	*1.8*	*0.0*	*73.2*	*0.0*	*73.2*	*0.9*
Information technology services									
Intl Business Machines	20	431.2	5.8	*116.2*	*26.2*	*92.3*	*20.8*	*113.1*	*2.0*
Xerox	131	143.1	3.9	*5.5*	*1.5*	*59.9*	*16.6*	*76.5*	*0.8*
Computer Sciences	176	79.0	0.0	*3.1*	*0.4*	*147.0*	*20.9*	*168.0*	*nm*
SAIC[c]	240	13.0	0.5	*5.0*	*2.6*	*108.4*	*56.4*	*164.8*	*11*
CDW	267	7.0	0.0	*0.6*	*0.1*	*-51.2*	*-10.1*	*-61.3*	*nm*
Cognizant Tech Solutions	352	171.4	0.0	*1.3*	*0.0*	*22.4*	*0.0*	*22.4*	*nm*
Booz Allen Hamilton Holding	436	22.7	0.0	*0.0*	*2.1*	*1.3*	*261.1*	*262.4*	*nm*
Internet services and retailing									
Amazon.com	49	117.3	6.7	*1.8*	*0.0*	*35.7*	*0.0*	*35.7*	*0.1*
Google	55	47.8	10.1	*0.8*	*0.0*	*1.3*	*0.0*	*1.3*	*0.0*
eBay	196	33.5	6.0	*10.8*	*0.0*	*67.9*	*0.0*	*67.9*	*2.0*
Liberty Interactive	270	23.1	0.0	*2.3*	*0.0*	*64.7*	*0.0*	*64.7*	*nm*
Priceline.Com	473	9.5	0.3	*1.3*	*0.1*	*13.7*	*1.1*	*14.8*	*14.7*
Facebook[d]	482	7.2	17.9	*0*	*0*	*0*	*0*	*0*	*0*
Yahoo	494	12.2	6.7	*14.0*	*0.0*	*109.2*	*0.0*	*109.2*	*1.5*
Medical products and equipment									
Medtronic	172	49.2	10.5	*14.9*	*7.8*	*53.2*	*28.1*	*81.4*	*1.0*
Baxter International	193	61.0	6.9	*11.2*	*6.2*	*67.4*	*37.1*	*104.4*	*1.3*
Stryker	305	25.0	5.8	*2.5*	*1.8*	*24.4*	*18.2*	*42.6*	*0.6*
Becton Dickinson	332	30.0	5.8	*7.1*	*2.8*	*68.7*	*27.5*	*96.2*	*1.8*

Boston Scientific	357	23.0	12.8	*2.7*	*0.0*	*-26.2*	*0.0*	*-26.2*	*0.3*
St Jude Medical	457	16.0	12.9	*6.2*	*0.8*	*99.1*	*12.3*	*111.4*	*1.1*
Network and other communications equipment									
Cisco Systems	60	75.0	13.3	*72.0*	*5.5*	*102.7*	*7.8*	*110.5*	*1.5*
Qualcomm	149	31.0	20.5	*15.0*	*10.6*	*43.6*	*31.0*	*74.6*	*0.6*
Motorola Solutions	304	21.0	11.6	*13.1*	*2.9*	*144.7*	*32.3*	*177.0*	*0.5*
Corning	326	30.4	8.6	*3.9*	*2.5*	*19.7*	*12.6*	*32.3*	*0.7*
Harris	429	14.0	5.1	*2.1*	*0.9*	*75.5*	*31.7*	*107.2*	*0.9*
Avaya[e]	477	17.0	8.3	*0*	*0*	*0*	*0*	*0*	*0*
Pharmaceuticals									
Johnson & Johnson	41	128.1	12.4	*33.1*	*52.2*	*29.2*	*46.1*	*75.4*	*0.4*
Pfizer	48	77.7	15.5	*62.4*	*65.1*	*66.9*	*69.7*	*136.7*	*0.7*
Merck	58	76.0	19.2	*19.8*	*39.5*	*34.6*	*69.1*	*103.6*	*0.3*
Abbott Laboratories	70	69.0	9.6	*10.4*	*21.4*	*25.8*	*52.9*	*78.7*	*0.4*
Lilly (Eli)	130	37.9	21.0	*2.9*	*19.7*	*9.8*	*66.0*	*75.8*	*0.1*
Bristol-Myers Squibb	158	28.0	18.0	*4.6*	*22.8*	*12.1*	*59.2*	*71.3*	*0.1*
Amgen	162	20.0	22.1	*38.9*	*3.0*	*101.5*	*7.9*	*109.4*	*1.2*
Gilead Sciences	280	6.1	19.5	*11.7*	*0.0*	*66.1*	*0.0*	*66.1*	*1.0*
Mylan	374	20.0	9.4	*3.6*	*0.6*	*217.8*	*35.3*	*253.2*	*0.9*
Actavis	432	19.2	8.4	*0.5*	*0.0*	*216.7*	*0.0*	*216.7*	*0.2*
Allergan	440	11.4	18.1	*3.3*	*0.6*	*61.2*	*10.8*	*72.0*	*0.4*
Biogen Idec	454	6.9	25.9	*9.8*	*0.0*	*118.1*	*0.0*	*118.1*	*0.9*
Celgene	456	5.1	32.9	*7.4*	*0.0*	*156.0*	*0.0*	*156.0*	*0.8*
Scientific, photographic, and control equipment									
Danaher	152	66.0	5.8	*1.1*	*0.4*	*7.0*	*2.7*	*9.7*	*0.2*
Thermo Fisher Scientific	220	50.0	3.0	*5.6*	*0.4*	*72.2*	*4.6*	*76.8*	*2.2*
Agilent Technologies	371	20.6	11.9	*9.6*	*0.3*	*108.5*	*2.9*	*111.4*	*1.4*
Semiconductors and other electronic components									
Intel	54	107.6	16.2	*58.1*	*30.6*	*70.1*	*36.9*	*107.0*	*0.8*
Jabil Circuit	163	177.0	0.2	*0.6*	*0.5*	*65.1*	*49.6*	*114.6*	*2.2*
Texas Instruments	218	32.2		*27.3*	*5.3*	*122.6*	*23.8*	*146.4*	*1.5*
Applied Materials	302	13.7	13.3	*11.8*	*2.9*	*122.2*	*30.3*	*152.5*	*1.1*
Micron Technology	318	30.9	11.3	*0.2*	*0.0*	*-29.5*	*-0.1*	*-29.6*	*0.0*
Broadcom Corp A	327	12.6	29.6	*4.9*	*0.6*	*104.3*	*13.8*	*118.1*	*0.3*
Sanmina-SCI	420	48.7	0.3	*0.0*	*0.0*	*-1.2*	*0.0*	*-1.2*	*0.1*
Advanced Micro Devices	464	10.7	25.3	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
SanDisk	487	5.5	10.5	*2.1*	*0.1*	*66.9*	*3.2*	*70.0*	*0.5*

Note: These data from the Fortune 500 list for 2013 are for fiscal year 2012.
a: Exelis (2009-2013)
b: Dell (2008-2013)
c: SAIC (2004-2013)
d: Facebook (2007-2013)
e: Avaya (2004-2013)
Source: Fortune 500 list for 2013, at http://fortune.com/fortune500/2013/

Combined these 75 companies represent $1.8 trillion in revenues, $217 billion in profits, and 4.6 million worldwide employees. Over the decade 2004-2013 these 75 companies expended $1,052 billion in stock repurchases and another $511 billion in cash dividends. The employment practices of these 75 companies, or even a subset of, say, one-third of them, are very important to the operation and performance of the economy. Yet we know very little about their actual employment practices. For those who are interested in the potential of the economy to achieve equitable and stable economic growth, the study of the career paths of STEM workers at companies such as these should be a top priority.

The analytical framework for doing these studies is provided by the theory of innovative enterprise (TIE).[195] The theory focuses on three social conditions of innovative enterprise: 1) strategic control: what are the abilities and incentives of these who have the power to make resource-allocation decisions? 2) organizational integration: what is the structure of organizational learning within the hierarchical and functional division of labor? 3) financial commitment: what are the sources of funds that sustain the development and utilization of productive resources until the enterprise can generate financial returns?

Lazonick and his colleagues have done a number of company-level studies that use the TIE framework.[196] None of these studies was done for its own sake but rather to address larger questions about the operation and performance of the economy. The empirical approach, based on our accumulated experience in doing these studies, relies on a combination of public information, most of it available via the Internet, and non-public information from a variety of industry sources, including in some cases direct access to the company concerned.

CCCs are integral to the innovation process, and hence are company-specific. Also, industrial activities differ in the types of CCCs that are needed to transform technologies and access markets. Given that we are hypothesizing an erosion of CCCs in U.S. high-tech industry, we would not expect that the characteristics of the prevailing CCCs that we discover through our research are ones that will deliver competitive (i.e., high quality, low cost) products. It is therefore necessary to do studies of changes in CCCs in particular companies over time as well as comparisons across companies, especially direct competitors that are based in different national environments. Given constraints of time and funding, we also have to choose our case studies strategically (although even the accumulation of 20-30 well-researched case studies of major high-tech companies in the U.S. economy using our approach would represent a quantum leap in our knowledge of how CCCs function and perform). U.S. companies on which our research is currently focused include, in ICT, Apple, Cisco, Google, HP, Intel, IBM, and Microsoft, with international comparisons of Alcatel-Lucent, Ericsson, Huawei Technologies, Nokia, and Samsung; in pharmaceuticals, Merck, Pfizer, and Amgen, and foreign rivals such as Novartis, Novo Nordisk, and Takeda; and the two aerospace giants Boeing and EADS (Airbus).

Through our research on investment in CCCs or lack thereof, we have identified three industry forces, related to the transformation of employment through rationalization, marketization, and globalization, that have eroded CCCs: a) global competition from foreign companies that developed more innovative CCCs than U.S. companies; b) the rise of the "New Economy business model" in the ICT and biotech industries, in which "New Economy" companies have used stock options to

[195] William Lazonick, "The Innovative Firm," in Jan Fagerberg, David Mowery, and Richard Nelson, eds., *The Oxford Handbook of Innovation*, Oxford University Press, 2005: 29-55. Lazonick, "The Chandlerian Corporation"; Lazonick, "Innovative Business Models"; Lazonick, "Innovative Enterprise and Shareholder Value"; Lazonick, "The Theory of Innovative Enterprise".

[196] Qiwen Lu, *China's Leap into the Information Age: Innovation and Organization in the Computer Industry*, Oxford University Press, 2000; Qiwen Lu and William Lazonick, "The Organization of Innovation in a Transitional Economy: Business and Government in Chinese Electronic Publishing," *Research Policy*, 30, 1, 2001: 35-54; Marie Carpenter, William Lazonick, and Mary O'Sullivan "The Stock Market and Innovative Capability in the New Economy: The Optical Networking Industry," *Industrial and Corporate Change*, 12, 5, 2003: 963-1034; William Lazonick and Andrea Prencipe, "Dynamic Capabilities and Sustained Innovation: Strategic Control and Financial Commitment at Rolls-Royce plc," *Industrial and Corporate Change*, 14, 3, 2005: 1-42; Henrik Glimstedt, William Lazonick, and Hao Xie "Evolution and Allocation of Stock Options: Adapting US-Style Compensation to the Swedish Business Model," *European Management Review*, 3, 3, 2006: 1-21; Marie Carpenter, *Le Bataille des Télecoms: Vers une France Numérique*, Economica, 2011; Lazonick and March, "Rise and Demise of Lucent Technologies"; Lazonick et al, "Apple's Changing Business Model".

lure "talent" from established "Old Economy" companies; and c) financialization of the industrial corporation characterized by a massive and systematic distribution of corporate cash flow to shareholders, incentivized by the stock-based compensation of top executives.[197] Associated with rationalization, the most significant foreign competition has been from Japanese companies that, with CCCs that integrated the skill development of blue-collar and white-collar employees, attacked the vulnerability of U.S. mass-producers for their lack of organizational learning on the shop floor.[198]

Associated with marketization, the competition for high-tech personnel from New Economy companies undermined the integrity of career-with-one-company CCCs, and have played a role in the decline since the late 1980s of corporate research labs that relied heavily on CCCs.[199] Associated with globalization, the incentive and ability of many U.S. companies to do massive buybacks using domestic profits, and more recently low-cost debt issues, appear to be related to the profits made abroad from the employment of highly educated and increasingly experienced high-tech workers in places like India and China. These foreign employees have been beneficiaries of U.S. multinationals' investments in CCCs while these companies' investments in US-based CCCs have declined. Add *financialization* "pure and simple" (as measured by distributions to shareholders and stock-based executive pay) to rationalization, marketization, and globalization, and we have the foundations of a plausibly robust model of the erosion of CCCs that can be subjected to further case-study and statistical research.

5. Economic Prosperity Depends on Collective and Cumulative Careers

We have argued that collective and cumulative careers through which individuals both develop and utilize their skills are essential foundations for a prosperous economy with a broad-based middle class. SBTC ignores work experience as a determinant of productivity and pay, assuming instead that the distribution of income is determined in labor markets for different types of skill, and that to acquire more skill an individual must acquire more education. The TIE perspective recognizes that the quality and quantity of education that an individual attains is an important determinant of the types of jobs to which that individual has access, and that labor markets are central economic institutions for giving an individual access to one or more jobs over the course of his or her career. But unless the labor service that the individual is selling on the labor market is a commodity that is readily interchangeable with the labor services that can be supplied by other individuals, the labor market will not determine either that individual's actual on-the-job productivity or the earnings that the individual will receive. Rather both the worker's productivity and the earnings that he or she receives will be determined in the labor process where, to a greater or lesser extent depending on the complexity of work involved, the worker's productivity is enhanced through a process of collective and cumulative learning.

The importance of organizational learning in the determination of productivity and earnings is not a "market failure". On the contrary, organizational learning is vital to the wealth of the modern nation. The innovative enterprises within which this collective and cumulative learning takes place constitute the foundations of a prosperous economy that can generate higher standards of living for a broad-based middle class. In long-run historical perspective, well-developed markets are outcomes, not causes, of investments in organizational learning. Indeed, when labor-market

[197] Lazonick, "Taking Stock".
[198] Lazonick, "Innovative Business Models."
[199] Hopkins and Lazonick, "Who Invests in the High-Tech Knowledge Base?"

mobility becomes too active it can undermine organizational learning, even as particular individuals may improve their own economic positions by moving from one employer to another.

A recent case in point is the much-publicized Silicon Valley "anti-poaching" case in which between 2005 and 2009, CEOs at Adobe, Apple, Google, Intel, Intuit, Lucasfilms, and Pixar entered into agreements, evidenced in emails, that they would not try to entice technical personnel to leave one company for another.[200] In 2009-2010 the Antitrust Division of the U.S. Department of Justice investigated these practices, and concluded that the anti-poaching agreements "disrupted the normal pricesetting mechanisms that apply in the labor setting."[201] Seeking $9 billion in damages, the plaintiffs, representing 64,000 current and former employees of these companies, filed a class-action lawsuit, alleging that the defendant's anti-poaching agreements suppressed their wages. In May 2014, the plaintiffs agreed to an offer from Adobe, Apple, Google, and Intel to pay $325 million to settle the case, a gross payment of about $5,000 per employee in the class-action claim.[202] In September 2014, the judge in the case rejected the deal on the grounds that the amount of payment was too low, and that the defendants should "pay their fair share."[203] The fact that the plaintiffs settled for $5,000 per employee suggests that suppressed wages may not have been the main reason for the anti-poaching agreements. The court proceedings have never actually revealed the earnings of the employees concerned or estimates of earnings suppressed as a result of reduced labor mobility.

As indicated in Section 3 of this paper, with their stock-based pay, large numbers of these high-tech employees were making very substantial incomes. For example, Lazonick's estimates of the gains from exercising stock options at Apple are (not including the CEO and four other highest-paid executives) $93,000 across 16,300 employees in 2005; $67,700 across 19,700 employees in 2006; $65,500 across 26,800 employees in 2007; and $67,600 across 33,1000 employees in 2008. This amount then fell to $20,200 across 40,400 employees in 2009, not because of collusive restrictions on labor mobility but rather because of the sharp decline of Apple's stock price in the Great Recession.[204] Given that the largest amounts of these gains from exercising stock options would have accrued to Apple's Silicon Valley high-tech personnel involved in the class-action lawsuit, as distinct from, for example, Apple Store employees whose numbers increased from 11.700 (33% of all Apple employees) at the end of fiscal 2004 to 34,300 employees (48% of all Apple employees) at the end of fiscal 2009, it is safe to say that the vast majority of the Apple employees whose potential labor-market mobility spurred Steve Jobs to make anti-poaching pacts were already very highly remunerated, with the stock market providing them with the lion's share of their incomes. It is, therefore, unlikely that Jobs and the other CEOs sought to suppress the labor-mobility of their employees because of a desire to hold down wages *per se*.

Rather as statements throughout the court documents make clear, these high-tech CEOs did not

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[200] Mark Ames, "The Techtopus: How Silicon Valley's most celebrated CEOs conspired to drive down 100,000 tech engineers' wages," *Pandodaily*, January 23, 2014; Mark Ames, "Steve Jobs threatened Palm CEO, plainly and directly, court documents reveal," *Pandodaily*, February 19, 2014; Mark Ames, "Breaking: Judge strikes down Techtopus wage theft settlement," *Pandodaily*, August 8, 2014.

[201] United States District Court, Northern District if California, San Jose Division, in Re: High-Tech Employees Antitrust Litigation, Master Docket No. 11-CV-2509-LHK, Consolidated Amended Complaint, p.1 at www.hightechemployeelawsuit.com

[202] Jonathan Stempel, "Apple, Google, Adobe, Intel to pay $325 million to settle hiring lawsuit," Reuters, May 23, 2014 at http://www.reuters.com/article/2014/05/23/us-apple-google-settlement-idUSBREA4M0MY20140523

[203] Dan Levine, "Apple, Google appeal rejection of $325 million hiring settlement," *Reuters*, September 5, 2014, at http://www.reuters.com/article/2014/09/05/us-apple-google-lawsuit-idUSKBN0H00AZ20140905

[204] Apple's stock price declined from a then-record high of $196 on December 28, 2007 to as low as $79 on November 20, 2008.

want to lose people who were central to *product development*, and they did not want to disrupt the *pay structures* within their firms.[205] These pay structures were in turn central to creating a cooperative environment of organizational learning in these companies, which is in turn the essence of innovation. The defendants in this case could have argued that their anti-poaching collusion was for the sake of innovation because high levels of labor-market mobility of high-tech personnel would undermine product development. To what extent they in fact made this argument in the private negotiations that yielded the $325 million settlement offer, we do not know. But it is safe to say that the lawyers for the 64,000 aggrieved employees in the class-action lawsuit would have found it difficult to approach the DOJ Antitrust Division and the courts with the argument that their high-tech employers were restricting their labor mobility for the sake of Silicon Valley innovation.

This case illustrates the argument made in Section 3 of this paper that generating productivity from investments in organizational learning is not automatic. Even when strategic control and financial commitment are in place as conditions of innovative enterprise, there remains the need for organizational integration to generate the collective and cumulative learning that is the essence of the innovation process. Nor is the equitable distribution of the gains from innovative enterprise to those who have contributed to generating competitive products automatic. In the financialized business corporation, if and when the gains from innovative enterprise accrue to the firm, the collective and cumulative characteristics of the learning process create opportunities for financial interests – corporate executives, Wall Street bankers, fund managers – to invoke the ideology of "maximizing shareholder value" to reap where they have not sown.[206]

The SBTC perspective cannot even begin to address these complex issues of the dynamic relation between organizations and markets in determining economic outcomes because it ignores the role of organizational learning in particular and employment relations in general as determinants of labor productivity and employee earnings. Yet, as mentioned earlier, the SBTC neglect of the role of "on-the-job experience" cannot be laid at the door of the neoclassical labor economics in which the proponents of SBTC were trained. In the same year that Mincer's 1962 "on-the-job training" article (cited in Section 2) appeared, Gary Becker published his article "Investment in Human Capital: A Theoretical Analysis", in which investments in and returns to on-the-job training and the related distinction between general and specific training held center stage.[207] As Becker put it:

> If a firm had paid for the specific training of a worker who quit to take another job, its capital expenditure would be partly wasted, for no further return could be collected. Likewise, a worker fired after he had paid for specific training would be unable to collect any further return and would also suffer a capital loss. The willingness of workers or firms to pay for specific training should, therefore, closely depend on the likelihood of labor turnover.[208]

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[205] See e.g., Consolidated Amended Complaint, pp. 8- 9: "...a company searching for a new hire is eager to save costs and avoid risks by poaching that employee from a rival company. Through poaching, a company is able to take advantage of the efforts its rival has expended in soliciting, interviewing, and training skilled labor, while simultaneously inflicting a cost on the rival by removing an employee on whom the rival may depend."; and "Defendants carefully monitor and manage their internal compensation levels to achieve certain goals, including: a. maintaining approximate compensation parity among employees within the same employment categories (for example, among junior software engineers); b. maintaining certain compensation relationships among employees across different employment categories (for example, among junior software engineers relative to senior software engineers); c. maintaining high employee morale and productivity; d. retaining employees; and e. attracting new and talented employees."

[206] Lazonick, "Creating and Extracting Value"; Lazonick and Mazzucato, "The Risk-Reward Nexus".

[207] Gary S. Becker, "Investment in Human Capital: A Theoretical Analysis," *Journal of Political Economy*, 70, 5, 1962: 9-49.

[208] Ibid., p. 19.

Becker then went on to highlight the importance of labor turnover in the presence of specific training.

> To bring in turnover at this point may seem like a *deus ex machine* since it is almost always ignored in traditional theory. In the usual analysis of competitive firms, wages equal marginal product, and since wages and marginal product are assumed to be the same in many firms, no one suffers from turnover. It would not matter whether a firm's labor force always contained the same persons or a rapidly changing group. Any person leaving one firm could do equally well in other firms, and his employer could replace him without any change in profits. In other words, turnover is ignored in traditional theory because it plays no important role within the framework of the theory.[209]

This is not the place to enter into an extended discussion of Beckerian theory except to say that the Chicago economist spent his whole career seeking to analyze every manner of economic and social phenomena, including marriage, race relations, and time management, invoking the "traditional" neoclassical theory of the market economy to provide the answers. But if we recognize that so-called investments in "specific training" may actually be investments in collective and cumulative learning that enable the firm to be more productive than its rivals, then the way in which the firm can reduce labor turnover is by sharing the productivity gains with its employees in the forms of stable employment, higher pay, enhanced learning, and superior benefits.

As Edith Penrose showed in her 1959 book *The Theory of the Growth of the Firm*, higher labor costs based on higher productivity do not place the learning organization at a competitive disadvantage but on the contrary can provide an accumulation of "firm-specific" productive capabilities, or what Penrose called "unused labor services" of career employees, that enable the firm to innovate in new product markets. From the perspective of the theory of innovative enterprise, if labor markets create a potential problem of labor turnover, then investment in CCCs can potentially solve that problem to the benefit of the participants in the innovation process.

Covering the same subject matter and time period as Penrose, Alfred Chandler's book, *Strategy and Structure*, published in 1962, documented that the theory of the growth of the firm that Penrose described was in fact the type of industrial corporation that had driven the growth of the U.S. economy from the 1920s through the 1950s (notwithstanding the disaster of the Great Depression).[210] Penrose and Chandler analyzed organizational reality, and laid the foundations for a theory of innovative enterprise. In "on-the-job training", Mincer and Becker glimpsed a slice of that organizational reality, and then tried to make it consistent with the myth of the market economy.

For the proponents of SBTC even that slice of organizational reality – the on-the-job learning through which people enhance their productive capabilities over the course of their careers – is irrelevant for understanding issues of productivity and pay. A prime example of this neglect is the Goldin and Katz tome, *The Race between Education and Technology*. Their book is about economic growth and income distribution in the United States over the course of the twentieth century, dubbed "The Human Capital Century." Yet no industrial corporations, never mind corporate research labs or corporate careers, appear in their book. In the opening chapter in a section with the subtitle, "Why Was America Different?", they make it clear that "[f]ormal school-based

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209 Ibid.

210 Penrose, *Theory of the Growth of the Firm*; Alfred D. Chandler, Jr., *Strategy and Structure: Chapters in the History of the Industrial Enterprise*, MIT Press, 1962.

education enabled American youths to change occupations over their lifetimes, to garner skills different from those of their parents, and to respond rapidly to technological change."[211] They continue:

> Apprenticeships and highly specific training were more cost effective for individuals who expected to spend their lives in the same place and in the same industry and occupation, but apprenticeships were not as valuable for other and clearly not for their employers.[212] Stanley Lebergott noted: "incessant mobility [of Americans] made it thoroughly unwise for any employer to invest much in training his employees" (1984, p. 372)"[213]

Goldin and Katz have succinctly summed up the SBTC view of American history. From a TIE perspective, however, SBTC is an approach that ignores both the microeconomic sources of productivity growth and their macroeconomic implications for income distribution. If America's twentieth century was "The Human Capital Century," it was because major industrial corporations invested in CCCs. And if America's twenty-first century is one of employment instability, income inequity, and a decline of innovative capability, it is in significant part because the old system of CCCs has declined, and a new system has yet to be put in place.

[211] Goldin and Katz, *The Race between Education and Technology*, p. 29

[212] Here Goldin and Katz cite Bernard Elbaum, "Why Apprenticeship Persisted in Britain but Not in the United States," *Journal of Economic History*, 49, 2, 1989: 337-349, stating that he "argues that the growth of formal education in the United Sayers led to the breakdown of apprenticeships; that is, the causation runs from increased education to the cessation of apprenticeships. Although possible, the greater geographic mobility in a country with enormous land availability was more consistent with formal education than with apprenticeships." Yet the end of apprenticeships in the United States was integrally linked to the rise of mass-production corporations, with organizational learning residing in the management structure rather than on the shop floor. Indeed, in a well-known volume that Elbaum co-edited with Lazonick, they argued that Britain's failure to make the transition to "managerial capitalism" in the first decades of the 20th century was a prime reason for that nation's relative economic decline. Bernard Elbaum and William Lazonick, eds. *The Decline of the British Economy*, Oxford University Press, 1986. For the comparative implications of the U.S. managerial revolution for skill development within the managerial structure, see William Lazonick, "Strategy, Structure, and Management Development in the United States and Britain," in K. Kobayashi and H. Morikawa, eds., *Development of Managerial Enterprise*, University of Tokyo Press, 1986: 101-146. For the integration of U.S. higher education with the personnel needs of U.S, managerial capitalism, see Ferleger and Lazonick, "Higher Education for an Innovative Economy".

[213] Goldin and Katz, *The Race between Education and Technology*, p. 29. The reference is to Stanley Lebergott, *The Americans: An Economic Record*, W. W. Norton, 1984.