

Fractures in the education–economy relationship: the end of the skill bias technological change research programme?

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Abstract: This paper undertakes a critical theoretical and empirical analysis of the traditional approach to analysing the education–economy relationship: skill bias technological change theory. It argues that while leading skill bias theorists have sought to address some of the anomalies that the theory confronts, there remain key data patterns that the theory cannot address. We suggest an alternative account that takes a broader political economy perspective.

Keywords: education–economy, skill bias theory, political economy, global labour markets

JEL classification: J40, B50, I125, P16

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I. Introduction

Skill bias technological change theory (SBTC) is a dominant account of the relationship between technological development and education that has widespread influence in policy debates (e.g. OECD, 2013; 2014). Its core proposition is that technology determines skill, wages, and employment change. That is, there is a relationship between technology-driven demand for skills, and the reward for skills on the basis of the productive potential of those appropriately skilled. However, SBTC is confronted by significant empirical anomalies that

limits its ability to comprehend recent labour market developments. At the core of the research programme are two assumptions, both of which are contested. These are that new technology is raising the demand for skills and that wages closely relate to the productive capacity of skill. We note that SBTC has undergone a series of challenges that have progressed the research programme. In its initial period it conjectured that the demand for skills would be raised by technology. This phase of the research programme was refined in a range of ways we document. More recently, the focus has remained on skill bias, but in the light of technological change has qualified the particular skills that are in demand.

Recent years have seen a number of attempts to address the challenges faced by SBTC theory. Here, we argue for an approach that takes into account the political economy of global capitalism. In short, it is an invitation to policy-makers and orthodox economists to, as Kuhn (1970) put it, switch worlds. To develop our argument, section II outlines the key assumptions underpinning SBTC and section III lays out the existing critiques to the traditional SBTC approach and how the literature has responded. We then move to a novel analysis of US data to highlight a further set of trends that cannot be rationalized within the core SBTC approach. In section IV, we raise questions about the fundamental theoretical and methodological assumptions of SBTC; these include the theory of wages and marginal productivity, which in turn raises issues about the connection between technology and skill bias; in particular, the explanatory resources used in understanding skill bias lead to a misguided view of the role of technology: given a richer set of explanatory resources it is possible to hypothesize that rather than seeing continuity between technology and skill bias, what we are witnessing is fundamental discontinuity. Our account presupposes both institutions and a global labour market for some forms of skill, and opens the way for work on an alternative account of human capital that can explain the changes in the labour market we are witnessing.

II. What is skill biased technical change theory?

SBTC posits that technological development has raised the demand for more highly educated workers, establishing this hypothesis by an historical analysis of this relationship (Goldin and Katz, 2008a). In this respect, technology is biased towards raising the demand for high skills rather than replacing them. It is recognized that this has not always been the case for particular workers, at any given time, but that in general, proponents argue, the claim to skill bias holds true.

These insights were first formalized by Tinbergen (1974) who presented the proposition that technology is skill biased and that there is a race between education and technology. It follows that if technology is skill biased there will be increasing inequality of incomes unless there is parallel investment in human capital to meet the demand created by technology. SBTC theorists have thus sought to explain the rising polarization of incomes in these terms (e.g. Goldin and Katz, 2008a).

(i)The theoretical and methodological approach of SBTC

In order to understand the problems that now confront SBTC we first discuss its theoretical and methodological foundations. SBTC theorists assume that there is a causal connection between technology, education, productivity, and wages. Technology raises the demand for productive workers, which can be met through investments in skills via education. Wages are determined by the contribution that education and skills make to an individual's productivity.¹ In early

¹ SBTC is closely related to human capital theory (HCT) and, while the former does not focus so closely on productivity, its assumptions align with it. In contrast to HCT, SBTC doesn't always assume that productivity and returns are closely related since it relaxes the assumptions of perfect competition. However, one of the problems

accounts, education and skill were typically conceived as uni-dimensional. Further, the treatment of technology in the core theory is notably abstract and divorced from the economic and social context in which it is applied.

A key assumption in this set of causal connections is that worker compensation reflects marginal productivity. Reder (1982) in his account of the development of human capital theory notes that: ‘In applications of human capital theory, one does not usually measure the marginal productivity of labour directly but assumes it to be equal to the relevant wage rate’ (p.13, note 20).

While it is assumed that there is an almost tautological relationship between productivity and income, there are two accounts of causation by which the particular linkages between technology, education, productivity, and income are interpreted. The first understands the link through an equilibrium demand and supply model: where there is an undersupply of educated labour we can predict a polarization of income between educated and less educated labour. It is precisely this assumption that underlies Goldin and Katz’s (2008a) classic work in the SBTC tradition. By the same token, where there is an oversupply of educated labour we can expect their relative wages to fall.

For our purposes, the key here lies in the possibility that the relative wages of educated labour might fall as its supply increases; this goes against the prevailing assumption of the second account of causality. This account effectively adopts a version of Say’s Law in which the

with SBTC is that there is no account of its methodology. The assumption made here is that, unless otherwise stated by its protagonists, its theoretical commitments are closely related to HCT.

supply of educated labour elicits the demand.² Implicit in the Say's Law version of causality, is the view that employers being rational, will see that as more educated workers enter the labour market they will upgrade the quality of their jobs. As more capable workers come into the labour market, so a new equilibrium will be established, whereby these workers will receive higher returns for their productive potential. In essence, this account rests on the idea of a constant upward adjustment of equilibria as employers reap the benefits of greater productivity and reward their educated workers accordingly. It is not surprising that policy-makers have embraced this account: arguably it has led to the development of mass higher education.

When we look at the development of the SBTC research programme, we find both accounts of causation. Acemoglu (2002) notes that:

New technologies have become more skill-biased throughout most of the twentieth century because the supply of skilled workers has grown steadily. This perspective also suggests that a faster increase in the supply of skills can lead to an acceleration in the demand for skills . . . so the timing of the increases in supply and demand is not a coincidence—instead it reflects technology responding to the supply of skills.

(p.12)

It is on this basis that Acemoglu (2002) argues for an endogenous account of the role of technology; a version of Say's Law. More recently, Acemoglu and Autor (2012) have opted for an account that appears to view technology as exogenous in a way consistent with the first account of causation: 'Technological progress raises the demand for skill, and human capital

² This view can be inferred from Schultz's (1961) explanation for the rise in productivity in the USA and in developing countries. Ever since his address, it has been assumed that the more productive potential of 4-year college graduates will, over time, be more highly rewarded in the labour market than that of non-college graduates.

investments slake that demand. When demand moves faster than does the supply of human capital, inequality rises and vice-versa when supply outpaces demand' (p. 2).

As we shall show, both of these accounts of causality run into difficulties when confronted with the fragmentation of the labour market.

III. Critiques of SBTC

While SBTC is prized for its parsimony, in its traditional form, the theory struggles to account for key trends that are observed in modern day labour markets.³ Empirical results initially thought favourable to the traditional SBTC approach have been critiqued and their conclusions revised over the years. For example, a key early study by Kreuger (1993) found that there was a premium paid to those working with computers and that the chances of using a computer rose with education. The numbers using computers rose between 1984 and 1989 in the United States, while the premium paid to those working with computers remained. Further research by Berman *et al.* (1994) found that the use of more educated labour was related to greater investment in computer technology. All facts which, taken at face value, can be rationalized within the SBTC paradigm.

However, comparing German and US data, DiNardo and Pischke (1997) found that the use of pencils, calculators, and telephones—as well as sitting while working—were associated with similar wage differentials to the use of computers! Thus, the correlation between computers and educated labour does not necessarily provide support for SBTC. DiNardo and Pischke (1997) conclude that for those attracting a premium, there must be unobserved skills at work. Acemoglu (2002) also hypothesizes that the combination of new technology and rapid organizational change requires multiple skills, many of which are unobserved. These skills did not relate directly to educational qualifications but to ‘soft skills’; those concerning

³ In discussing the issue of parsimony or simplicity in Friedman’s (1953) celebrated reflections on the economic method, Maki (2003) notes that on one reading of Friedman (1953): ‘Theory construction is a matter of theoretical isolation whereby economists “abstract essential features of complex reality”’ (p. 7). This is a widely endorsed idea in economics as elsewhere; ‘the real world is complex, therefore we need to build simple models that theoretically isolate causally significant aspects of the world’ (p. 502). However, it is how these abstractions are made that is at issue; as Einstein is reputed to have said ‘everything should be made as simple as possible but not simpler’: the problem is that the framework of assumptions and inferences that SBTC makes are too simple

interpersonal relationships, which at that time could only be hypothesized, rather than identified.

Another finding of Kreuger (1993) was that the highest wage premium was associated with those using e-mail: an interesting observation which raises questions about the relationship between skill, income, and the use of computers, since, as Moss (2002) has noted, the use of e-mail does not require great skill. SBTC does not take into account power relationships unless understood in market terms. Moss hypothesizes that there are more salient unobserved characteristics, such as rank and status within an organization, to explain the apparent links between computer use and income, arguing that what was being observed is the return to power and not skill related to technology.

Labour market polarization has also challenged the basic SBTC framework (Goos and Manning, 2007). Acemoglu and Autor (2012) disaggregate data to examine the fate of workers at different levels of income. They, therefore, distinguish between high-, middle-, and low-skill workers but, consistent with human capital theory, assume wages reflect skill. Their analysis leads them to the view that there are changes in the labour market that do not conform to the previous expectations of human capital and SBTC theory. They note that, ‘starting in the past two decades, earnings growth has become increasingly non-monotone in skill and wage levels’ (p. 15). Of particular substantive note is their finding that technology can be skill replacing for some workers, although for them these tend to be middle- and lower-skilled workers.

Finally, there is little theoretical precision in the way SBTC locates institutions, whether it be the education system (Goldin and Katz, 2008a) or trade unions (Acemoglu, 2002). Given this wide range of references to ‘institutions’, it is perhaps not surprising that SBTC found difficulty

in not being able to theoretically incorporate institutions into its analysis.⁴ That said, there have been clear examples of how institutions can be incorporated into theories which are sympathetic to SBTC; David Baker's (2014) work is one example. We raise this point because institutions, particularly transnational companies (TNCs) and nation states are central to an adequate explanatory account of the demand and rewards for skills as we discuss in section IV.

(i) Treatment of unobserved tasks and skills

In response to these challenges, SBTC theory has come to recognize that skill is multi-dimensional, with some components of skill unobserved. SBTC theorists have traditionally simply used educational credentials as a proxy for (one-dimensional) productive potential. Liu and Grusky (2013) have castigated the SBTC literature for being imprecise as to how skills relate to technology. Even in Goldin and Katz (2008*a*), credentials are used as a proxy for skills.

The issues relating to the use of credentials and skills is complex and requires discussion. More fine-grained data bases have thrown light on one aspect of the references to unobserved skills. It is now possible to identify particular 'soft' skills that attract a premium, as a result of the development of data bases such as O*NET in the United States and the OECD's Programme for the Assessment of Adult Competencies (PIAAC, 2013). A prominent recent example is Deming (2015) who has highlighted the importance of interpersonal skills in high-wage jobs.

⁴ While Acemoglu has done much to signal the need for such a theory which he has not applied to SBT, he has developed a theoretical account of institutions with Acemoglu and Robinson (2012). Goldin and Katz (2008*a*) do refer to the US education system and this is central to their argument, but it is arguable that it has been integrated into their theory.

The use of more fine-grained data has partially refined the approach taken by SBTC theorists. What we observe is an interest in skills that finesses the question of the credential. However, whether the notion of skills is any more precise in unlocking an understanding of the processes of recruitment is an open question, since skills have now taken on an elasticity and opacity to rival that of the notion of the credential (Brown *et al.*, 2018). Nevertheless, for many in this area of research, the notion of skill appears closer to an account of the relationship between education and the economy than that of the credential. Certainly, these new databases have enabled SBTC theorists to operationalize elements of the unobserved skills that they have been seeking.

While these developments revise elements of SBTC, in that the links between technology, productivity, and income are more tightly specified, the policy prescriptions remain in place. Acemoglu and Autor (2012) argue:

As new technologies continue to replace tasks performed by medium and low skill labour, the gap between economic growth and equitable growth may widen—unless a larger share of US workers is prepared to perform work that is made particularly valuable as the competencies of contemporary technologies continue to improve. (p. 33)

These remarks emphasize theoretical continuity with the past in terms of policy because workers require more education to fill the demand for high-skilled jobs. While technology may not be skill biased for all, it remains so for the more highly educated. Education remains the key to an equitable economy and the solution to the diminishing employment of middle-income jobs is for workers to redouble their educational efforts to take advantage of the opportunities at the top end of the job market. What is surprising about this quotation is that the authors also acknowledge that there has been little employment growth in high-paying jobs since 2000. The

policy recommendation will not solve the problem of how well-educated graduates will get good-quality jobs; rather it will merely increase the positional competition for these jobs. While there is a recognition that factors such as offshoring may alter job tasks, technology remains abstracted from the influence of institutions and the wider political economy in structuring the labour market.⁵

However, they also consider that part of the issue concerning the non-monotone nature of earnings growth may be to do with the way skills have been understood and measured by human capital and SBTC theorists. Educational credentials may not be a good proxy for the kinds of skills demanded and rewarded. In order to understand the returns to wages, skill utilization, rather than credentials, needs to be examined. Here they take the view that the assumed relationship between education, skills, and income may not be realized because credentials do not adequately reflect productivity. They argue that, ‘many of the shortcomings of the canonical model can . . . be overcome by relaxing the implicit equivalence between workers’ skills and their job tasks’ (p. 17). They do so because they appreciate that the canonical model and early debate within SBTC was inadequate for understanding the complexities of change within the labour market. In particular, that between technology and skills required for jobs. In contrast they emphasize task-based approaches:

The distinction between skills and tasks is irrelevant if workers of a given skill always perform the same set of tasks. The distinction becomes important, however, when the assignment of skills to tasks is evolving with time, either because shifts

⁵ There is something of an irony here because in this paper they give due credence to the importance of political economy: ‘A seemingly central factor that receives less attention than it deserves is political economy or, more crudely, politics. The unique educational institutions that are indigenous to the United States may have resulted not from optimal or even intentional design, but from a conflict in which the masses, the non-elite elements of society, were particularly successful in resisting elite designs.’ (p. 4)

in market prices mandate reallocation of skills to tasks or because the set of tasks demanded in the economy is altered by technological developments, trade or offshoring. (pp.17–18)

These are significant developments within the theory. In the history of the theory that we have sketched and, in particular, the early work, we noted that the notion of technology used within the theory was so abstract that it created considerable debate but little purchase on how precisely technology relates to wages.⁶ Here they argue for a new approach that focuses on the tasks required and the returns to those tasks which is a reflection of the way jobs are now structured, when compared to the Fordist and bureaucratic ways work was designed into set routines. This is clearly an advance in understanding the way some jobs are bundled into various tasks: the focus on the demand side is to be welcomed. However, the policy prescriptions remain with the supply side. It appears that the demand side cannot be changed, yet the data we present suggest that the focus should be on the jobs competition (Thurow, 1975) for good-quality jobs. In the past, and including Goldin and Katz (2008a), it was, as with canonical human capital theory, the supply side that was prominent. For Goldin and Katz, inequalities in America were due to a decline in the supply of educated labour. But when it is job tasks that are being analysed, questions as to how the demand side is being structured become the research focus. For example, Levy and Murnane (2013) identify the kind of skills that can be robotized and list the foundational skills that humans will need because they are beyond the competence of robots. But they present data which show that the demand for two of the key foundational skills, ‘working with new information’ and ‘solving unstructured problems’, have flatlined since 2000. Equally, Beaudry *et al.* (2014), as we discuss below, have

⁶ Bell (1973) warned of using technology as a catch-all for the best methods, techniques, and organizational practices that contribute to productivity (pp. 343–4).

shown that there is a decline in the demand for the highest skills among new entrants to the labour market. This task-based approach, often referred to as the ALM model, raises questions as to whether it is part of the SBTC research programme or constitutes a new theory. Given the empirical evidence, this new approach to SBTC may represent a narrowing of the earlier, arresting, conjecture that technology is, in general, skill biased.⁷

While these developments revise elements of SBTC, in that the links between technology, productivity, and income are more tightly specified, all the remaining substantive theoretical and methodological commitments remain in place. For example, part of the motivation for taking a new approach to the links between skills and tasks is that it will provide a more accurate account of the links between skill and income, where it is assumed that the concept of marginal productivity can still be applied to wages in the way described by Reder (1982).

(ii) Defending the marginal productivity of labour theory

Autor (2014) recognizes that the standard assumption concerning the relationship of marginal productivity to wages may require some revision, acknowledging that factors of political economy may impinge on the theory, for the income of the top 1 per cent. He has made significant interventions in debates over education and the labour market and this paper, published in the prestigious journal, *Science*, has been widely referenced. Here he seeks to come to terms with the widely accepted proposition that a disproportionate share of national income now accrues to the top 1 per cent of earners. Moreover, in the light of Piketty's (2014)

⁷ The Autor, Levy, and Murnane (ALM) model identifies the way the reduction in the price of computers has changed the skill sets needed. Research programmes progress through internal criticism. In this case ALM, or the task-based approach, can be seen as critical of previous SBTC theories. Arguably, such criticism does not lead to a new research programme since the core focus and methodology remains: skill bias technological change.

devastating critique of the theory of marginal productivity as an explanation for these high earners, there is an implicit question that if this theory cannot be applied to the top 1 per cent then does it have application to the remaining 99 per cent?⁸ When stated in this way, it is clear that Autor's paper is an attempt to rescue one of the key theoretical propositions of SBTC, for what he seeks to show is that there remains a strong relationship between education and earnings for the 'other 99 per cent'. There are three problems with the paper, which suggest that his defence is at least questionable. The first is that, as is the convention in this research programme, he seeks to show that the college/high school earnings gap has remained between 1979 and 2012 by comparing the median high-school and 4-year-college wages. The problem here is that the claim only holds if data on the returns to education are not disaggregated. As soon as they are, the picture is far more complex. Using median income as a measure is unhelpful because it obscures the fragmentation of the labour market. However, it also raises the more fundamental question about the adequacy of the theory of marginal productivity of labour Autor is trying to defend.⁹ Third, he sees issues of de-unionization, international trade,

⁸ Autor does not specifically refer to the theory of marginal productivity since he is publishing in a non-specialist journal. He does note that, 'Workers' earnings in a market economy depend fundamentally (some economists would say entirely) on their productivity' (p. 845). It is the 1 per cent that deters him from aligning with the 'entirely' camp.

⁹ There are alternative approaches to this issue developed by New Keynesian microfoundation theory (see, for example, Carlin and Soskice (2006)). Here wages may be related to but do not equal the marginal productivity of labour (MPL) because (i) monopoly power in the goods market reduces the wage relative to the MPL; (ii) monopoly power in the labour market increases the wage relative to the marginal product. So the wage can change if the monopoly power of firms in the goods market changes and/or the monopoly power of workers in the labour market changes. Under these conditions, more education may have increased the MPL but this has not resulted in higher wages because firms have gained more monopoly power in the goods market and/or workers have lost power in the labour market. The problem here is that the notion of changes in monopolies cannot be explained

and technology as skill replacing as only affecting the non-4-year college educated; that is, the lower skilled. But the changes we are witnessing affect 4-year college graduates as well as those without a college education.

(iii) Unmet challenges to skill bias technological change theory

The challenges to SBTC are both empirical and theoretical. All centre on the connections at the heart of the theory relating to the key variables of education, productivity, and income and their relationship to technology. Turning to the empirical, if we examine each of the key terms in the theory, education, productivity, and income, we find all raise significant anomalies.

Education

Since the turn of this century we have witnessed a doubling of educated labour in the world (Brown *et al.*, 2011). In response to the new technological revolution (Freeman and Louca, 2001), many countries have increased the numbers attending higher education. We now have more highly educated labour than has ever been the case. Two predictions follow from this: that productivity should increase significantly and incomes for the more highly educated should rise.

Productivity

The record on productivity, which should have risen, as the proportion of educated labour has increased, has been at best mixed. In the USA, Gordon (2015) shows, between 1950 and 2014, a decline in the rate of total factor productivity. In the UK, the flatlining of productivity has been a major concern expressed by Barnett *et al.* (2014). Crafts (2018, this issue) considers a

without a political economy analysis. The notion of monopoly is a formal place holder for more detailed analyses.

Our thanks to Chris Martin for drawing our attention to this point.

range of possibilities to explain what he describes as a paradox. His conclusion is that there may well be a time lag between the advent of new technology and a rise in productivity. There is certainly historical support for such a view. Perez (2002) has argued that financial bubbles succeed technological revolutions and it is only subsequently that productivity gains can be made. Focusing on skills, Bessen (2015) has studied the relationship between industrial revolutions and skills and argues that there is a time lag between inventions, the technology that arises from them, and the impact it has on working practices, wages, and, by implication, productivity. Given that we are in the middle of a technological revolution such views should be given credence.

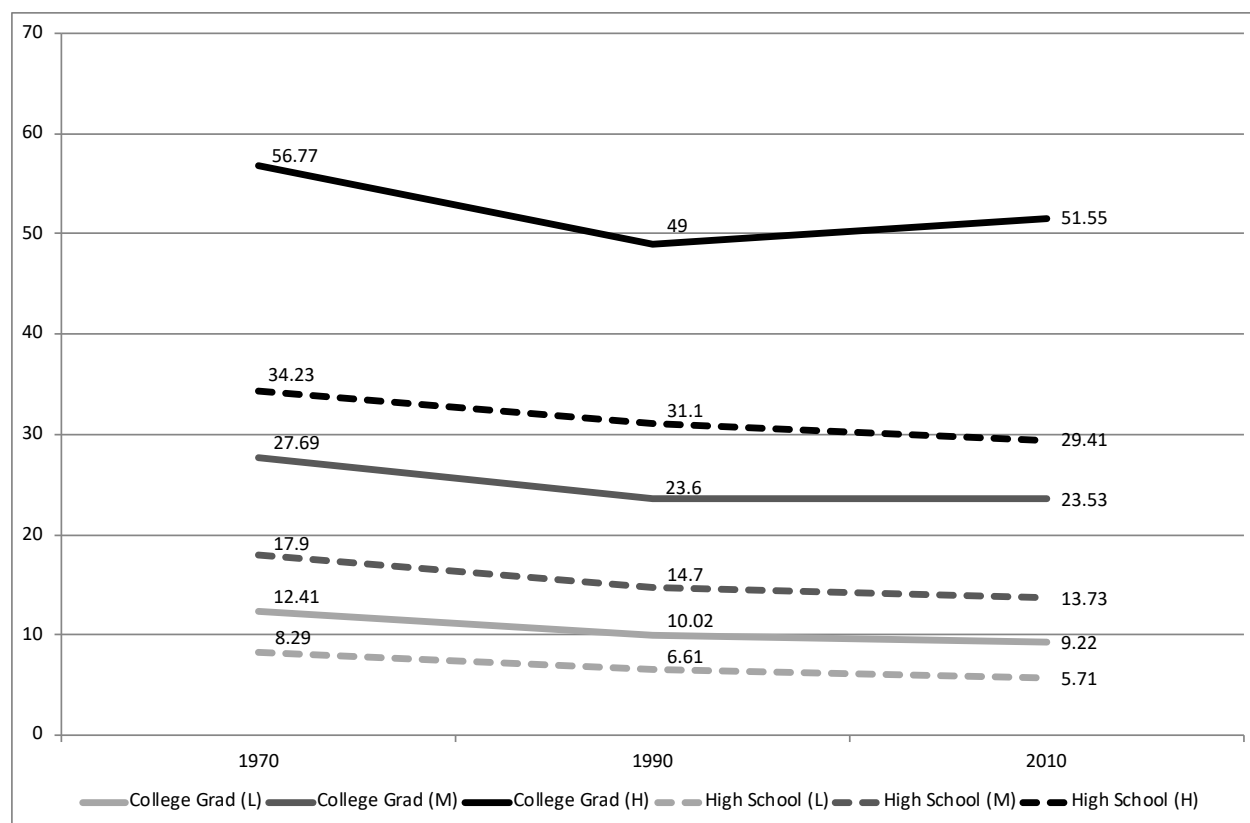
However, there are more immediate explanations that might be considered. One would be that if wages are so low that employers prefer cheap labour to technology, then we might expect the kinds of problems with productivity growth that we are witnessing. A further related explanation is that major non-bank corporations have adopted the strategies of financialization to raise share prices rather than investing in productive capacity (Foroohar, 2016). This is consistent with Galbraith's (2008) account of predatory capitalism which may explain the divergence between workers' productivity and wages (Cooper and Mishel, 2015), because the revenue accruing to increased productivity has been appropriated by executives and senior managers.

It is the case that productivity is a difficult concept to operationalize, once we move away from an economy based on Fordist forms of manufacturing. For example, globalization (Houseman *et al.*, 2010), the internet (Mason, 2015), and the service economy (Kupfer, 2014; Brown *et al.*, 2018) all raise questions about its measurement. Nevertheless, we might have expected some indication of an increase when, in the UK and USA, we have had a significant decline in productivity which has predated the Great Recession.

Incomes

We should start by examining data for the United States where the defence of SBTC has been mounted. In Figure 1 we show the returns to education in the United States between 1970 and 2010.¹⁰ We start with 1970 because it can be claimed that it is the beginning of the new information revolution (Freeman and Louca, 2001). Using the US Census and American Community Survey data over four decades at three time points, 1970, 1990, and 2010, we compare college graduates' wages to those of high school graduates. Instead of using the overall median or mean income, we present the top and bottom end of the income distribution: the bottom and top deciles as well as median earners over time. In contrast to Autor (2014), when we disaggregate the returns to education, measured as real wages, several points follow.

Figure 1: US hourly earnings high school and 4-year college graduates 1970-2010



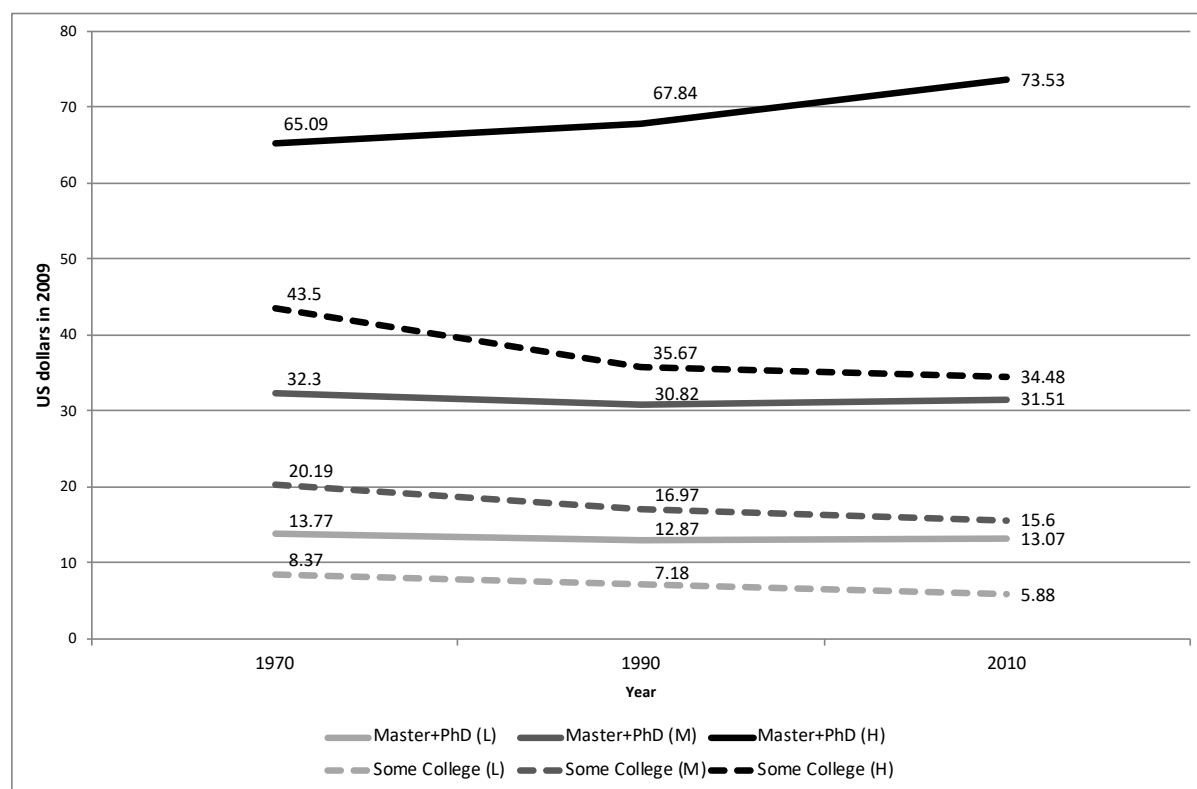
¹⁰ Income in US dollars in 2009 and is inflation adjusted using the consumer price index inflator provided by IPUMS-USA <https://cps.ipums.org/cps/cpi99.shtml>.

The first and most striking point is that with the exception of those in the top decile there has been a decline in all other wages over time. Given the assumptions made by SBTC theorists that technology would raise the demand for most skilled labour and raise income, then this figure is problematic. Here, we need to distinguish between jobs and income, so it may well be that technology has raised the demand for jobs but, given the supply of educated labour, it has depressed incomes, as Goldin and Katz (2008a) predicted. But it also refutes their assumption that an increased supply of educated workers would reduce the polarization of income; when we look at top decile earners, this is not the case.¹¹ It also confounds both SBTC and the canonical theory because high-school top-decile students have higher wages than 4-year college median students. It could be argued that the returns to the top decile simply reflect the demand for their highly specialized skills because they are in short supply, while for median graduates there is an oversupply of their skills. In the light of these data, the task-based approach may be able to provide a better explanation than the earlier SBTC account, but it has yet to be forthcoming. However, an explanation of this kind is provided by Murphy (Murphy and Saez, 2015) in his canonical account of the returns to skill. However, as we have seen from the critique of the super managers developed by Piketty, this is a questionable view. When we also consider Rivera's (2015) account of recruitment to elite positions it would appear that class as much as skill enters the frame. However, an alternative account of how the labour market and returns to skill are constructed, which we present below, would consider the inequalities in power, not only with respect to class but also gender and ethnicity in determining returns.

¹¹ For human capital theorists it challenges the assumption of an almost tautological relationship between productivity and wages.

Given the emphasis on the importance of knowledge and innovation, it is perhaps at the post-graduate level that we can find support for SBTC. In Figure 2 below we show the hourly earnings of graduates with higher degrees and graduates with some college study.¹²

Figure 2: Hourly earnings of graduates with higher degrees and graduates with some college



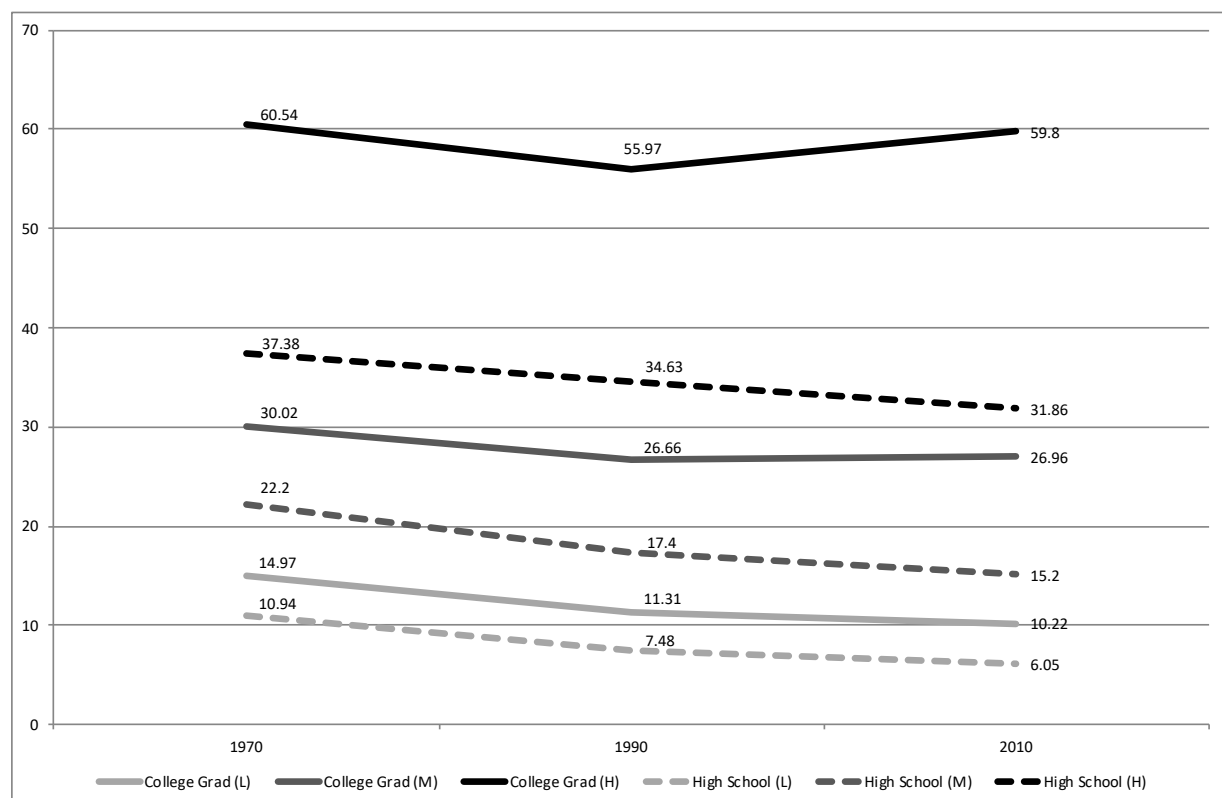
Here we see a similar pattern to that shown above. The top-decile PhD, and Masters' students have an increase in their wages over this time; for the rest there is a decline. This suggests that if the new technological revolution is having an impact on wages, then it is only for relatively few. Again, we should note that the highest decile with some college study earn higher wages

¹² In 1970 masters and PhD degrees were defined as 5 or more years of college education. About 4 per cent of the sample achieved this level of qualification in 1970 and this has risen to 10 per cent in 2010. See IPUMS-USA for details: https://usa.ipums.org/usa-action/variables/EDUC#codes_section

than median Masters and PhD students. This suggests a quite different account of returns in the labour market than that suggested by SBTC.

Turning to the question of gender and labour market returns, we find that the penalties women suffer have remained over time.

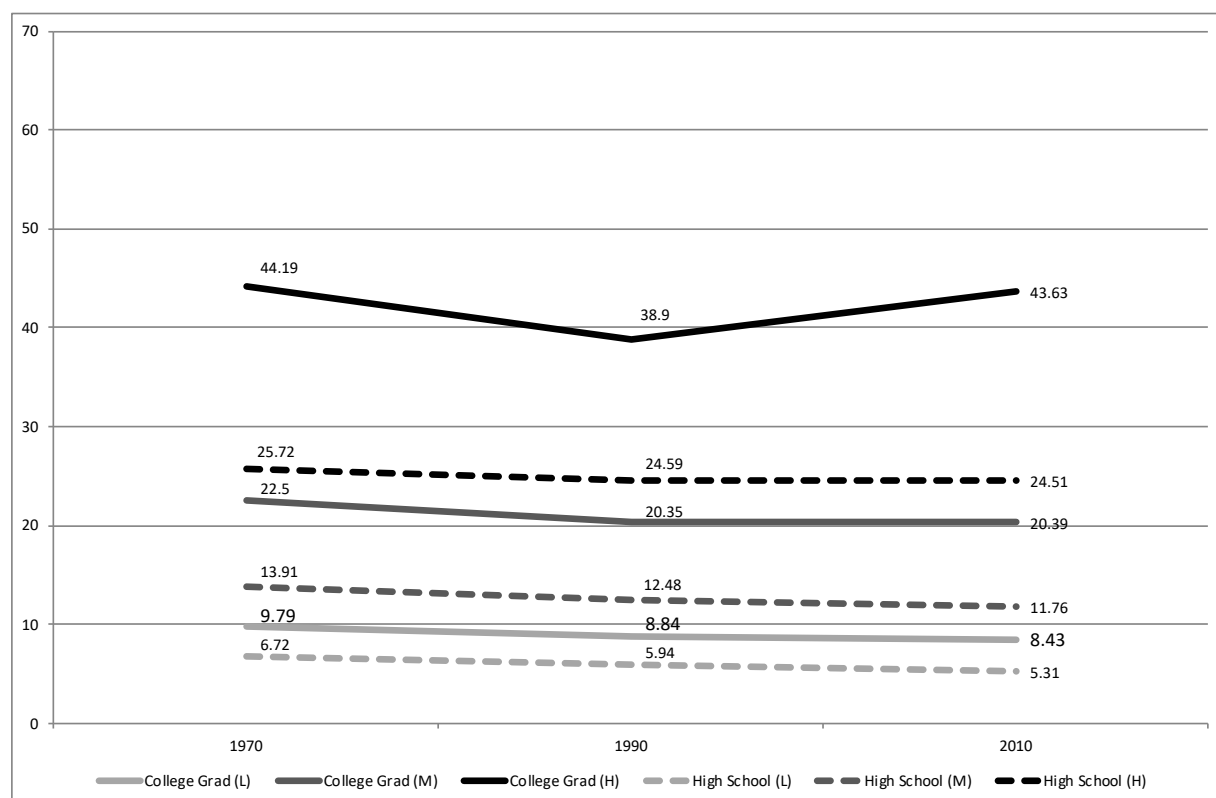
Figure 3: US male hourly earnings high school and 4-year college graduates 1970-2010



These figures show that there is wide variance in the returns to education for both men and women. However, women earn far less than men for all deciles shown. Women's wages have, up to 2010, not closed the gap on men's wages; like men they have experienced a decline in real wages with the exception of those in the top decile, when they hold the same educational qualifications. This is consistent with similar research on educational qualifications and returns by gender (Evertsson *et al.*, 2009; Davis and Gould, 2015). The recent Institute for Fiscal Studies report (Britton *et al.*, 2016), which also disaggregates the data on education and

income, shows that the returns to education are determined by class, gender, subject taken, and institution attended, where there is a close relationship between social class and institution attended.

Figure 4: Hourly female earnings, high school and 4-year college graduates 1970-2010



Our data suggest that for the highest-skilled jobs there is a premium for top-decile wages. However, when we look at the demand for the highest-skilled jobs they appear to be stagnating in the United States (Beaudry *et al.*, 2013, 2014) and Britain (Holmes and Mayhew, 2015).¹³ However, strikingly, Beaudry *et al.* (2014) show that the demand for highest-skilled jobs is in decline for new entrants to the labour market. It is, therefore, not surprising that in the United States and Britain, approximately 50 per cent of college graduates are underemployed (Vedder *et al.*, 2013; ONS, 2013; Holmes and Mayhew, 2015; Abel and Deitz, 2016). What is

¹³ The only recent paper which takes a different view is that by Green and Henseke (2016).

significant about these data is that they predate 2008, suggesting much longer-term labour market trends than the changes caused by the Great Recession.

When faced with these challenges, SBTC theorists have responded in two ways. Either they have advocated that workers should be educated for the higher-skilled work available, which in effect simply intensifies the positional competition or, as in the case of Autor (2015), argues that what we are seeing is a temporary halt in the upward growth of higher-paying, skilled jobs.¹⁴ Autor's paper is significant because it represents what may be a key moment in the history of the research programme in that it can be read as a rallying defence of the theory in the face of the demand for labour being replaced by robots (Levy and Murnane, 2013). He restates its basic propositions: 'The primary system of income distribution in market economies is rooted in labor scarcity; citizens possess (or acquire) a bundle of valuable "human capital" that, due to its scarcity, generates a flow of income over the career path' (p. 28). He understands the stakes are high for:

If machines were in fact to make human labor superfluous, we would have vast aggregate wealth but a serious challenge in determining who owns it and how to share it. . . . Are we actually on the verge of throwing off the yoke of scarcity so that our primary economic challenge soon becomes one of distribution?' (p. 28)

¹⁴ Placed in an historical context, this may be a plausible response. See, for example, Perez (2002) but she is taking a very long view of the impact of technological change. Alternatively, we need to consider seriously the possibility that we are seeing what Marx identified: a rupture between the forces and relations of production (Cohen, 1978). It is an argument that has recently been sketched by Mason (2015) with respect to the IT revolution, and while he does not focus on the prospects for human capital, it is clear that elements of such a rupture would have the kind of profound implications outlined by Autor (2015).

He thinks not and while the threat he poses to human capital and SBTC theory may be considered a little extreme at present, we already have the routinization of much knowledge work through digital Taylorism (Brown *et al.*, 2011); enough has changed to challenge his restatement of the canonical theory.¹⁵

IV. Towards an alternative research programme

In the following we sketch the conditions for a more adequate approach to understanding the role of technology and the demand for high-skilled labour. Here, we raise questions about the fundamental theoretical and methodological assumptions of SBTC; these include the theory of wages and marginal productivity, which in turn raises issues about the connection between technology and skill bias; in particular, the explanatory resources used in understanding skill bias lead to a misguided view of the role of technology: given a richer set of explanatory resources, it is possible to hypothesize that rather than seeing continuity between technology and skill bias, what we are witnessing is fundamental discontinuity. Such an account presupposes both institutions and a global labour market for some forms of skill. Finally, we address the fragmentation of the labour market. This critique then clears the way for work on an alternative account of human capital that can explain the changes in the labour market we are witnessing.

(i) Wages and marginal productivity theory

¹⁵ However, as Lakatos (1971) a leading theorist of the development of research programmes has noted, even when they seem to be down and out, they can be revived with sufficient ingenuity.

Lars Pålsson Syall (2014) has noted that marginal productivity theory has been much debated in mainstream economics and that this was particularly the case by Cambridge economists, by Sraffa in the 1920s and more recently in the 1960s and 1970s. He cites Sen (1982) who raises clear objections to the theory:

The personal production view is difficult to sustain in cases of interdependent production . . . i.e. in almost all the usual cases. . . . A common method of attribution is according to ‘marginal product’. . . . This method of accounting is internally consistent only under some special assumptions, and the actual earning rates of resource owners will equal the corresponding ‘marginal products’ only under some further special assumptions. But even when all these assumptions have been made . . . it does not ‘show’ which resource has ‘produced’ how much. . . . The alleged fact is, thus, a fiction, and while it might appear to be a convenient fiction, it is more convenient for some than for others. (p. 40)

If we return to Autor (2014), his defence of the theory of marginal productivity looks even more tenuous, once we disaggregate data on education and earnings. The problems with the theory extend far beyond the 1 per cent. Kupfer (2014) in her feminist analysis of human capital theory makes two points. First, that there is a clear lapse in the accounting procedures of the theory as regards women, for human capital calculations do not take into account the costs of reproduction. It is a point that Kuznets (1941) made long ago and the reasons for the omission can be understood as part of a patriarchal world-view linked to the neo-classical programme in which only the costs to the individual and capital are taken into account. The second point is that:

productivity is highly culturally conceptualised . . . as well as its remuneration; we just need to think of the ‘gender’ of occupations . . . one only needs to visualise

wages for midwives, an occupation at the foundation of productivity, to doubt empirical basis for this presumption. (p. 116)

Kupfer's point is that when we look at many women's occupations, we find that they are poorly paid, as in the case of carers; we also know that these occupations, certainly in Denmark, have elements of high skill (Wegener, 2014). This point raises the possibility that productivity may be determined and/or limited by job design. It is a question of enabling skills to be exercised and appropriately rewarded. However, SBTC theorists struggle with an inadequate explanatory framework, because the marginal productivity of labour assumes that if certain groups are paid less when they have the same qualifications, it must be because they are less productive. Recent work on this issue within this theoretical framework has not improved such individualist explanatory accounts (see, for example, Deming, 2015).¹⁶ When we turn to social class and ethnic penalties in the labour market, similar points can be made (Cheung and Heath, 2007; Rivera, 2015; Britton *et al.*, 2016).

The marginal productivity of labour obscures the search for explanations for the structural inequalities in the labour market; a symptom of the problem is the difficulty in measuring the returns to occupations such as caring or counselling, far less management, as Kupfer, predating Piketty has noted. But the cultural and political basis for wages extends further. When we consider the issue of credential inflation we can see that there are cases where there has been

¹⁶ Deming sees women as having greater interpersonal abilities: 'Sex differences in sociability and social perceptiveness have been shown to have biological origins, with differences appearing in infancy and higher levels of fetal testosterone associated with lower scores on tests of social intelligence' (p. 34). An alternative hypothesis might be that women may be more alert to the emotions and signals that are given out, especially in relation to men, because they are oppressed and need to read signals and emotions to survive. The general point here is that explanatory resources Deming refers to simply do not take into account social structures such as that of patriarchy.

credential upgrading, which has had a clear effect on income, but the question first raised by Collins (1979) remains as to whether and to what extent the skills have been upgraded.

If we consider, that in contrast to SBTC, the fundamental problem is not one of skill shortages or mismatches but of good quality jobs, then, as we have noted, encouraging more educated workers to apply for fewer good-quality jobs, simply intensifies the positional competition for credentials. In turn, positional competition theory (Hirsch, 1977; Brown, 2000), which has rejected the simple relationship between the supply and demand for skills, is central to explaining why some win and many lose in the jobs competition, although it cannot address the question of the distribution of wages.

Part of the problem with this longstanding debate is that it has failed to take into account the more precise connections between productivity and income. Moreover, the nature of the modern division of labour is such that there are many areas where the connection between productivity and reward appears tenuous.¹⁷ A step in the right direction has been made by Sorensen (2000), who sought to identify the many ways in which rent-seeking was possible in the labour market. The problem with his elegant account is that it was based on a neo-classical understanding of the labour market, which meant that questions of productivity were assumed not interrogated. Until we can look at productivity more closely, we will not be able to unravel the rewards of rent-seeking from productive work. It may be that, as Mason (2015) has suggested, we need to revisit the labour theory of surplus value. Certainly, there are theoretical resources that can be used.

¹⁷ See, for example, Alvesson (2001) who has noted there is considerable ambiguity in the qualities that are required for knowledge work and, given the impression management that often accompanies knowledge work, it is difficult to assess an individual's productivity.

(ii) Technology and skill bias: institutions and the global economy

One of the fundamental problems with skill-biased explanations is that they fail to consider the wider employment, organization, and political context that determine the way technology is used and rewarded in the workplace. It is a case where unwarranted parsimony can produce misleading analyses. Consider first of all the relationship between organization, technology, and skill under Fordism. Here the Fordist production line was specifically developed to use low-skilled workers (Brown and Lauder, 2001). On this foundation, bureaucratic corporations, described so well by Chandler (1990), arose. What is interesting about this example is that, while the introduction of new technology (the Fordist production line) was skill replacing (Braverman, 1974), it was the development of the corporate superstructure that led to a rise in the demand for more skilled workers, not the technology *per se*. Moreover, without the creation of mass markets, large corporate bureaucracies would not have emerged. In turn, these conditions obtained because of a Keynesian settlement between capital, organized labour, and the state (Brown and Lauder, 2001). As the white-collar sector grew, so did the demand for educated labour.

Three points follow from this account. First, the demand for skill was largely a secondary effect of the Fordist production line and dependent on a range of other social, political, and economic factors. The hypothesis, then, that there is a direct, endogenous connection between technology and the supply of skilled labour is clearly tenuous. Second, whereas skill-biased theorists see an essential continuity in the rising demand for skill over the past century, and assume that it will continue for more highly educated workers, the kind of analysis sketched above points to the possibility of discontinuity. The conditions that comprised the Keynesian settlement no longer obtain.

Third, and perhaps most significantly, the idea that we need to see the demand for skills within the context of wider social and political formations leads to a fundamental challenge to skill-bias theory. One of the clearest indications of discontinuity lies in the fragmentation of the labour market.

(iii) The fragmentation of the labour market

In referring to the fragmentation of the labour market we are contrasting the period of the 1950s and 1960s, when there was a direct relationship between a degree awarded and entry to professional and managerial occupations, and the situation now where 4-year graduates will typically qualify for entry to elite occupations if they attend elite universities, and in which all graduates require a CV which recounts their extra curricula activities to demonstrate a rounded character (Brown *et al.*, 2011; Rivera, 2015; Britton *et al.*, 2016).

The consequence of the globalization of key elements of the labour market provides a basis for an explanation for the variance in returns to graduates. Here we have argued that the emergence of the ideology of talent has made a significant difference to the recruitment of students from elite universities to elite transnational corporate jobs (Brown *et al.*, 2011).¹⁸ In turn, it is the

¹⁸ See, for example, Goldin and Katz (2008b) on the returns to Harvard graduates, Rivera (2015) on the recruitment from elite universities to elite jobs, and Britton *et al.* (2016) for data on class, elite universities, and returns to education in the UK.

‘talented’ that receive a similar order of compensation as leading executives. At the same time, global processes have not only contributed to the recruitment of elites but to the variation of wages within occupations. The strategy employed by corporations such as Apple provide a good example. While they will have core workers in engineering and design on the west coast of the USA, receiving high incomes, they will have offshored many professional jobs at a far lower price.

If we ask why high-skill jobs are now stagnating and appear to be in decline for younger workers, in the UK and USA, we need to take into account the global auction for high-skilled work and the rise of digital-Taylorism (Brown *et al.*, 2011). Many high-skilled jobs can now be undertaken in low-cost countries for a fraction of the price of university graduates in the United States or Europe. At the same time, digital-Taylorism can help to explain why the fruits of technological innovation may not lead to high-skilled, high-waged employment for university graduates. Digital-Taylorism is not simply creating a polarization between high- and low-skilled workers, but the segmentation of knowledge work and of middle-class occupations, where the benefits of productive growth are concentrated in the hands of executives and senior personnel, especially when combined with a shareholder approach to corporate governance. The irony is that without the introduction of new information technologies the global auction for high-skilled, low-wage work would have been impossible. These are some of the factors that have led to the fragmentation of the labour market and they cannot be explained in terms of skills and skill shortages but require a much broader understanding of the political economy of the changes underlying the labour market. Such an approach raises the question of whether, as some SBTC theorists have argued, skill can be seen as the key determinant of income: here we have already pointed to some of the issues that need to be addressed. It is noteworthy, in this respect, that Hacker and Pierson (2011) in their analysis of why there is increasing economic inequality point to the influence of the rich and powerful in Washington to change

labour market and tax regulations in their favour. In describing these political machinations, they note that the explanation for these inequalities provided by SBTC ‘is at most a modest accomplice’ (p. 41); a similar point has been made by Lafer (2017).

In this context, policy-makers have given too much weight to the view that technology will be skill biased. Education by itself cannot be seen as the antidote to the fragmentation of the labour market and the march of new technology, despite the recommendations of some SBTC theorists. What we are witnessing is an age of intensified positional competition as the solution to problems of competitiveness and the challenge of technology. While the best education that we can offer coming generations is central to social cohesion, it cannot be framed in terms of a continued striving for jobs that only a few can attain.

V. Conclusion

In developing a critique of skill-biased technical change theory, we have referred to structural inequalities in power within the global labour market and the key role that transnational companies play in the demand and allocation of skilled labour and the distribution of wages. Our analysis suggests a radically different theoretical and methodological approach to understanding the nature and rewards of the labour market. Such an approach would also need to consider the wider political economy context in which, as Piketty (2014) has argued, the returns to owners of capital can far outstrip the returns to labour. In turn, these changes in the nature of capitalism undermine what may be described as the opportunity bargain, that social advantage is offered to individuals if they are prepared to gain a good education based on fair competition (Brown, 2003). This is the broader context in which the idea that we can gain a good job and income by investing in education is being fundamentally challenged.

It appears that we are now on the cusp of a new form of capitalism in relation to the labour market. Employers will have the choice of the exploitation of low-wage insecure labour (OECD, 2015) or investment in skill-replacing technology, while the proportion of high-skill, high-wage jobs stagnates or declines. The theorists that we have discussed understand the threats that are presented to SBTC but believe that there will continue to be an increasing demand for high-skill high-wage work, which has been the central assumption of the theory. The evidence suggests this is doubtful. The optimism which accompanies SBTC has come face to face with new forms of predatory capitalism. In this emerging form of capitalism, the role of education is wholly uncertain, since the rationale for education under neo-liberalism has been that it is an economic investment in which the relationship between education and wages is relatively straightforward. The case for education will now have to be re-stated in very different terms since, for many, the promised returns to education will not materialize: the relationship between education and economic returns will be far more complex. In the light of these problems for SBTC, it can be argued that trying to rescue the theory will not advance our understanding of how rewards are created in the labour market and why.

Figure 1: US hourly earnings high school and 4-year college graduates, 1970–2010

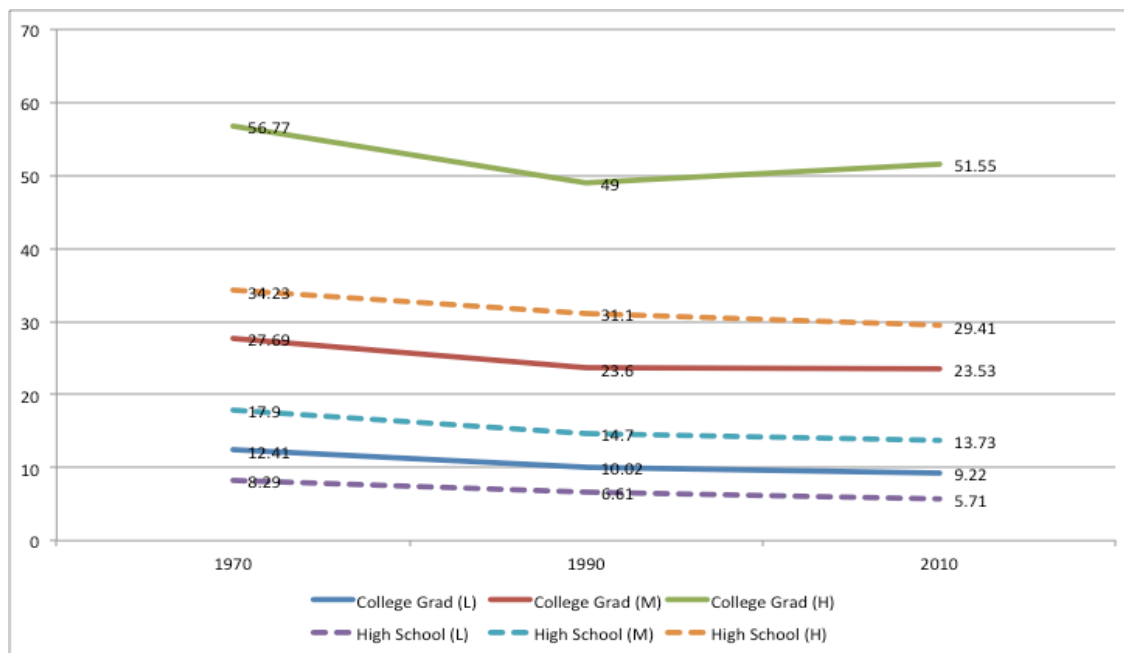


Figure 2: Hourly earnings of graduates with higher degrees and graduates with some college

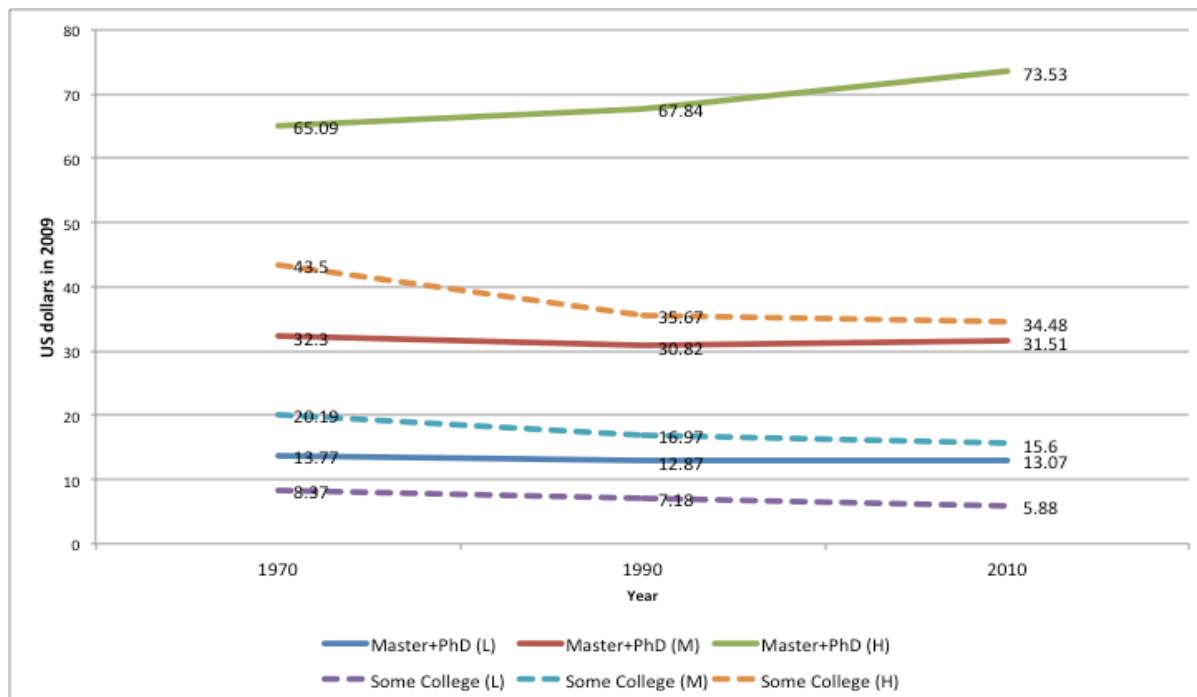


Figure 3: US male hourly earnings high school and 4-year college graduates, 1970–2010

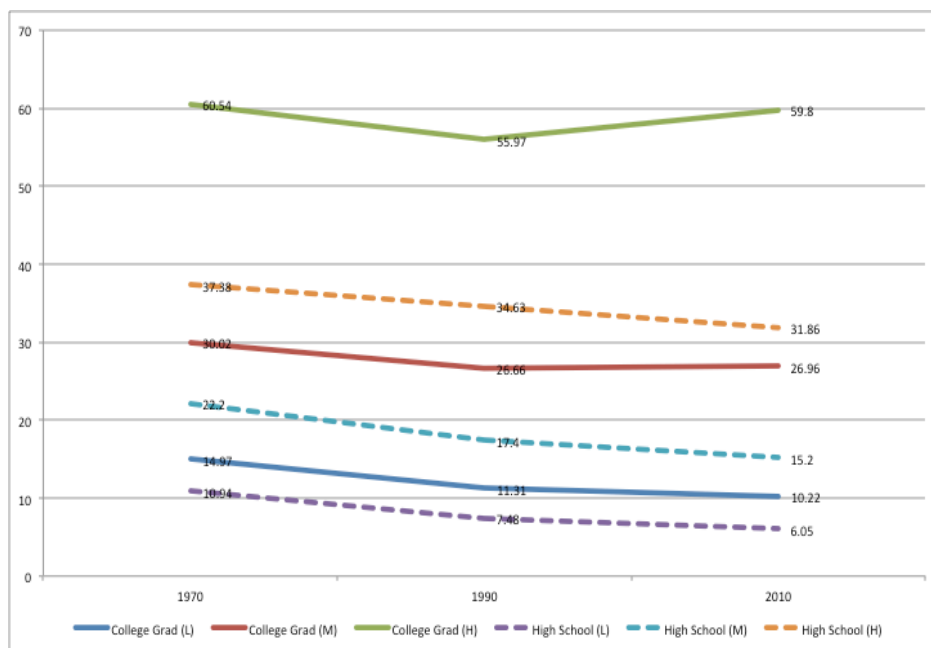
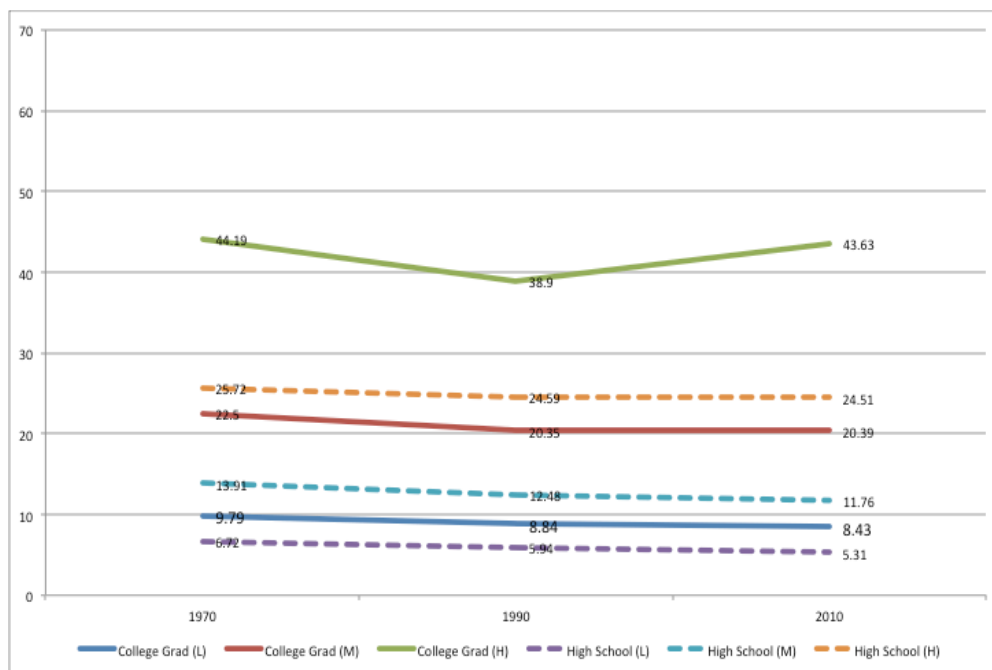


Figure 4: Hourly female earnings, high school and 4-year college graduates, 1970–2010



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