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Technology, power and the political economy of inequality

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Abstract

Technology can affect the distribution of income directly via its influence on both the bargaining power of different parties and the marginal product of different factors of production. This paper focuses mainly on the first route. The role of power is transparent in the case of medieval choke points but modern network technologies have similar features. There is also substantial evidence -- from truckers and retail clerks to CEOs -- that power affects the determination of wages. But power relations inevitably have institutional dimensions; regulatory frameworks influence industry structures and the market power of large companies as well as the parameters that determine the earnings of different groups of workers. The institutional framework is arrived at through complex social and political processes; technology, however, may exert some influence on the course of those processes.

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1. Introduction

Changes in the distribution of income or wealth can be attributed to political choice and institutional change, to technological change and its effects on market outcomes, or to a combination of the two. Some economists emphasize the political/institutional story, others the technology/market one.

In most developed countries, the inequality of income fell markedly sometime around 1940: this was the 'Great Compression'. Inequality began to rise again around 1980: we can call this the neoliberal period. Both the onset of the Great Compression, and its end in the neoliberal period, are marked by institutional sea changes, roughly contemporaneous – though by no means uniform - across developed capitalist countries. Levy and Temin (2007), focusing on the US case, point to a combination of collective bargaining institutions, progressive taxation, and a high minimum wage in the postwar era, followed by reversals in all of these areas at the onset of the neoliberal period. Alvaredo et al (2013) offer a similar list of institutional changes to explain the same pattern across a range of countries: the reduction in top income tax rates; the reduced influence of trade unions and other bargaining institutions in the labor market.³ Others have noted the contribution of financial regulation and deregulation, or the monopolies afforded by intellectual property rights.

Other theories attribute changes in distribution primarily to technological, rather than institutional, change. The theory of skill-biased technological change (SBTC) views increasing inequality as a reflection of changes in demand for, and supply of, skills (e.g. Goldin and Katz 2008 and Autor et al. 2008). Technology and market forces are at the centre of this story; institutional elements enter mainly insofar as they affect supply or demand. We have argued that a more plausible link between technology and lasting changes in the distribution of income is found in the many ways in which technology can affect the relative bargaining power of different parties – we call this *power biased technological change* (Guy and Skott 2008)

These institutional and technological explanations for changes in (in)equality should not be seen as mutually exclusive. Moreover, they should not be seen as independent: 'technological' effects on outcomes, in both labour markets and product markets, are politically and institutionally contingent; institutions and the politics of institutional change are, in turn, influenced by changes in technology. Our purpose here is to outline important technological and political/institutional explanations of distributional outcomes, and to show how they interact.

³ To this they add the growth in the share of capital income relative to earned (labour) income and, in the case of the United States, an unexplained strengthening of the correlation between the earned and capital income of individuals. These last changes are not themselves institutional changes, but they may be driven to a large extent by the combination of reduced effective tax rates on both high incomes and inherited wealth, and the reduced bargaining power of workers.

2. Technology and power

2.1 Choke points and rent

We begin with a simple example. Historically, the trade route between the Baltic region, including the lands that we know now as Poland, Latvia and Lithuania, and the growing economies of Europe's Atlantic seaboard went through the narrow straits of Øresund (The Sound). Between 1429 and 1857, the Danish crown earned its living by exacting tolls – 'Sound Dues' -- from ships carrying cargoes through the strait (Gøbel 2010). The collection was enforced from a fortress located at Helsingør (Hamlet's Elsinore) at the narrowest point of Øresund. By the time the practice was ended - in return for an indemnity from other trading nations, a deal secured under threat of action by Britain's Royal Navy - new technologies and investments had already undermined the grip of the Danish crown on the trade in grain and other raw commodities: steamships and railways combined to lower the cost of getting grain from the American interior to Europe; soon railways and the capture by Germany in 1864 of the Eiderkanal, a canal route that previously had been controlled by Denmark, also offered alternative routes between Baltic and Atlantic.

That the action of Denmark's kings affected income distribution should be obvious: their own income was increased, and this came at the expense of both producers and consumers. The kings' ability to exact this payment reflects a strong bargaining position, though that may seem an anodyne term for the choice offered to passing ships by the guns of the fortress. But the bargaining power was determined not just by guns. The technological options of the period made shipment from the Baltic via Øresund (or alternative routes also controlled by Denmark) decisively the lowest cost means of getting grain, timber and other commodities to the Atlantic coast of Europe. Without this cost advantage, control of the straits would not have benefited the Danish kings. Similar stories can be told about tolls on Europe's rivers, including the Rhine. Indeed, the term robber baron – now used in relation to late 19th century industrialists (Josephson 1934) – originally denoted noblemen who used their control of a choke point to charge excessive tolls.

A robber baron's choke point allows the appropriation of *rent*, which we define as follows. A good or service is produced using factors of production – labour, capital, and natural resources. Some minimum aggregate factor payment (combined wages, profits and interest, and payments to the owners of the natural resource) is necessary to bring the factors to market and thus to produce the good or service (the product). There is a rent if the income that results from the sale of the product

is greater than the minimum aggregate payment to all factors; the rent, or surplus, will be divided up in some way between the various factors.⁴

2.2 Technology and monopoly

A robber baron's control of a choke point is also an example of *monopoly*. Calling it a monopoly carries no implication that the monopolist's power is absolute: using the Øresund example, there were alternatives to using the straits, but they were more costly and the cost difference gave the king power to extract rent. In this spirit, we use the term monopoly power interchangeably with market power, where the degree of an agent's market power is seen in its ability to choose the price it can charge. The increase in prices raises the monopolist's share of income and reduces the real incomes – incomes stated in terms of purchasing power - of the monopolist's customers.

In general the presence of market power and rents makes the distribution of income less equal; Commanor and Smiley (1975) find this to be the case for changes in market power and the distribution of wealth in the US. We will see below, however, that a similar analysis of choke points and rent appropriation sometimes applies not to robber barons or monopoly capitalists, but to workers, in which case it can produce a distribution of income which is more, not less, equal.

Sunk costs and increasing returns

The economic analysis of monopoly sees many instances as technologically determined: barriers to entry and the ability of a monopoly to withstand competitive assaults depend on the *sunk costs*⁵ required to enter the market and produce at a competitive level (Baumol and Willig 1981; Sutton 1991). Products which require a large up-front investment and then have relatively low marginal production costs exhibit increasing returns, internal to the firm. Simple models of perfect competition cannot describe these markets; scale economies like this do not usually produce pure monopolies in large economies, but they often produce oligopolistic market structures in which a few large companies enjoy pricing power for products which are close substitutes.

Many things are cheaper to produce in quantity. In some cases, this is a matter of physics: large steam engines are more efficient than small steam engines, and for this and other reasons large factories can be more efficient than small ones. More often, it is a question not of physics but of organization, codification or network technologies.

⁴ This usage of the term *rent* comes from Ricardo (1817) who regarded payments for the rights to a natural resource (e.g., for the use of farmland) as rents, on the assumption that the idle land has no value to anyone, and so could be brought to market for even a trivial payment. Thus, the term used to describe payments for the use of land has been appropriated by economists.

⁵ Sunk costs are those incurred in entering a market, which are not recoverable on exit.

Mass production employs organizational methods which facilitate the coordination of an elaborate intra-organizational division of labour. These methods provide ways both to make the parts of complex machines so near identical that they become interchangeable, and to use semi-skilled (and thus inexpensive) labour in production (Best 1990; Hounshell 1984). We associate these methods in particular with automobile assembly lines, but they apply to many situations involving the production of large quantities of standardized products, from aircraft to hamburgers.

Codification describes a process of making tacit knowledge explicit by putting it into a standard form (a code, or *codified* knowledge). Codification is an element in mass production: it lies behind the creation of technical specifications, standards, and procedures, and the embedding of many of these specifications and procedures physically into machines. The codification itself is costly but once completed, many copies of the same product can be produced at low average cost – codification, in other words, is part of the sunk cost required to become a mass producer. Over recent centuries, the proportion of production information that is codified – programmed, pre-loaded – has risen, while the marginal cost of production has fallen for most goods: compared with fifty or one hundred years ago, more engineering and design, and less labour and steel, are needed to make a car today. We have also seen large markets develop for products consisting almost entirely of code - pure information products, such as digitized music, general purpose computer software, and genetically modified organisms. With pure information products, virtually all costs are sunk costs, marginal costs approach zero, and increasing returns are extreme.

Network technologies

Some of the most powerful increasing returns, and most powerful monopolies, are based in network technologies. These are increasingly important in modern economies, but we will start with an ancient example. In climates where large irrigation systems offer decisive cost advantages in food production, a long tradition of scholarship (Marx 1859; Weber 1976; Bentzen, Kaarsen, and Wingender 2012; Wittfogel 1957) tells us that the result is what Wittfogel called a “hydraulic civilization”: the institutional structure will be shaped by the critical importance of irrigation works and the power afforded by the central management of those works. A hydraulic civilization produces a skewed distribution of wealth and power – hence the ability of royal and priestly classes to extract vast resources for temples, tombs, luxury consumption, and armies, while leaving the majority poor. In contrast, a climate where crops are watered by rainfall can be conducive to independent smallholdings and a relatively flat distribution of income.

In the hydraulic state, the control of the irrigation works is an exact analog of a baron’s control of some straits, but extended to the central production system of an agrarian society. Notice, too, that

the technology is not simply physical, but also organizational – it encompasses not only the dams, aqueducts and pumps, but also the *systems* of coordination and control, incentive and sanction, required to build, operate, and maintain the works: the earliest known written records and accounts – the first information technologies of which we are aware - come from hydraulic states.

The rulers of a hydraulic state have the power to appropriate rents because the lowest cost irrigation technologies typically display increasing returns; the average cost of delivering water falls as more water is delivered. These increasing returns are at least in part due to *network externalities*: the cost of delivering to a particular user is lower if that user is in close proximity to other users – there is less plumbing to install and maintain when the marginal farm is the farm next door.

General definitions of network technologies are somewhat more complicated than this, allowing also for (i) situations where proximity to other users brings greater *benefit* to the user, with or without lower costs, and (ii) situations where ‘proximity’ is not spatial, but takes the form of some kind of connection or affinity, as in a social network. Network technologies have become increasingly important over the past two centuries, and constitute many of the basic building blocks of modern economies, among them railways, electricity grids, urban water and sewage systems, natural gas pipelines, air transport networks, postal systems, and telecommunications, whether for voice or data, wired or by satellite. For most of those services, we could draw some kind of map or diagram of the network, but for many products with powerful network characteristics drawing a diagram would be daunting: software products such as Microsoft Windows or Word, owe much of the value they have to me, to the fact that so many other people use them; the value of software such as Adobe Acrobat, or social network products such as Facebook and Twitter, grows *entirely* from the product’s network characteristics (imagine solitaire Twitter).⁶

2.3 Technology, chokepoints, and the power of workers

The presence of workers’ power is transparent when strong labour unions call a strike or negotiate collective agreements. But workers have power in other contexts too. As an example, consider a labour discipline model.⁷

⁶ The sunk costs required for competitive entry of a network product may lie in a costly physical network, or in the development of a *user* network, or both.

⁷ A range of efficiency wage theories have been developed; they all imply that wages systematically exceed the typical worker’s fallback option (the income the worker would get if she were to lose her job). This holds whether the wage determination is understood as reflecting a gift exchange (Akerlof 1982), fairness norms (Akerlof and Yellen 1990), a desire to reduce costly labour turnover (Salop and Salop 1976) or – as in the labour discipline model -- the inability of employers to monitor self-interested workers’ effort on the job (Bowles 1985; Gintis and Ishikawa 1987; Shapiro and Stiglitz 1984).

The model assumes an adversarial relationship between self-interested rational agents; employers want high work effort, workers want low effort. But workers' behaviour cannot be monitored perfectly and instantaneously by their employer, and for workers this is a source of power: it gives them an ability to affect outcomes for the employer.⁸ How much power they gain depends on both the sensitivity of employer outcomes to the worker's actions - is the worker able to affect a large operation or a costly piece of equipment, or is her work independent and without much capital? - and on the employer's ability to constrain the worker's actions through monitoring and intervention. High costs of monitoring individual workers, or the employer's ignorance of the state of nature in which they operate, leads, *ceteris paribus*, to greater worker power and, as a result, to higher wages. An investment banker who can make or lose millions for the employer in a single bet can have a lot of power in this way, while a dishwasher has very little.

As in the case of choke points and robber barons, the power associated with a particular job depends on the prevailing technology. Consider the case of truck drivers. Since the 1980s, new technology has increased the ability of the owner of the truck to monitor the driver. The driver's performance – speed, acceleration, throttle position, etc., even the interior sound level – can be monitored in real time. To quote the website of a manufacturer of these monitoring devices, "it is like being able to sit next to every one of your drivers every second they drive"

(<http://www.roadsafety.com/fleet.php>).

This technology marks a shift in the relationship between truck drivers and owners. Formerly, a late arrival at a destination could be blamed on mechanical problems, bad weather or heavy traffic. And if the truck were to break down, it was difficult for the owner to tell whether the breakdown had been caused by driver negligence. With the new technology, this has all changed (Guy and Skott 2008; Skott and Guy 2007). Truck driver's wages went down (Burks and Guy 2012), while the pay of trucking executives went up (Burks, Guy, and Maxwell 2004).

Truck drivers are not unique. In the retail sector the introduction of bar codes and networked computing since the late 1970s has created a substantial barrier to clerk-customer collusion and, as in the case of trucks, the new technology gives managers the ability to monitor each individual clerk's productivity, second by second.⁹

⁸ The imperfect observability of effort creates an 'agency problem': it becomes impossible to write a complete, enforceable contract between the principal (the firm) and the agent (the worker).

⁹ Business Week (11 September 2006, pp. 48-50) (Business Week 2006) described one of the uses of information technology in retailing:

"No part of a store churns up more data than cash registers. This is also where employee theft is most likely to pop up. ... With the press of a button, managers can highlight irregular register transactions

The choke-points just described affect the power of individual workers. Of greater political consequence are choke-points that can bring to a halt a large, highly interdependent production system. Such systems are widespread in modern economies with their elaborate division of labour. Some choke points can be exploited by workers who act in concert. Two important cases of this are assembly lines and the supply systems that fed them, in the era of mass production; and pre-digital telecommunications networks. Mass production systems in the early-mid twentieth century had scale economies and were often associated with market power for the owners. At the same time, they typically depended on a single dedicated flow of inputs: stop the auto assembly line, or the manufacture of engine blocks destined for the assembly line, and a vast system employing hundreds of thousands could grind to a halt. While assembly lines and mass production generally have features that serve to keep workers under tight control and to reduce their bargaining power, organized workers were able to exploit this feature of the production technology to bargain for substantial improvements in wages and working conditions. In 1937 workers at General Motors were able to bring a large part of the operations of the company and many of its suppliers to a halt by sitting down in a few factories; long distance telephone operators -- who instead of sitting down went on strike by standing up, at the same time, across the country -- were able to exploit analogous choke points in telephone networks.

These choke points have largely vanished in the digital age. At the same time that truck drivers and retail clerks came under improved surveillance, improvements to both information and transportation technology have created multiple alternative paths down which both auto parts and telephone calls can pass, severely restricting the bargaining power of workers and enhancing the power of managers and owners (Skott and Guy 2013).

3. Institutions and power

Technology, then, can have profound effects on the distribution of income, whether by establishing conditions which favour monopoly or by allowing, or preventing, workers' uses of choke points in the production process. Yet none of these effects happens in a political vacuum. The technological effects are mediated by particular institutional frameworks, which are the outcome of political processes; different institutional frameworks can – and often do – produce different distributions of income from the same technological endowment.

on their computers and pull up corresponding video. This could enable them to catch cashiers who cut deals for their friends or pocket cash refunds themselves.”

The worker's ability to make use of the choke-points afforded by assembly lines and pre-digital telephone networks depended on firm- and industry-level mobilization of workers, and the formation of trade unions (Kelly 1998); it also depended on political mobilization and coalition formation, to establish a legal environment favourable to unionization and collective bargaining. The same coalition supported high marginal tax rates for individuals and corporations; regulation or public ownership of certain – network industries in particular; social insurance in various forms; and other measures. Together these brought the Great Compression of income and wealth during the 'Fordist era' (Guy and Skott 2008), known also as the Golden Age of Capitalism (Marglin and Schor 1990).¹⁰

Similar considerations apply to the technological foundations of monopoly. Certain institutional conditions must be met in order for the extreme increasing returns of information products to produce monopoly (Guy 2007). In recent decades, intellectual property rights have been extended through legislation, court decisions, and treaties (Sell and May 2001): new categories have become patentable (genetic code, software); broader patent claims are allowed, making it harder for competitors to 'invent around' a patent (Freeman 1995); pharmaceutical companies are permitted to leverage their patent rights with a variety of legal protections both from international trade and from sensible public procurement; the copyright doctrine of fair use is undermined by the rental model for digital media; internationally, the TRIPS treaty makes intellectual property protections more uniform and enforceable; IPR rights are commonly extended beyond the TRIPs provisions by bilateral agreements between the US or EU and their smaller trading partners. Increasing returns are technological properties, but whether those returns are privately appropriable are institutional ones (Boldrin and Levine 2008).

The same goes for network technologies. Microsoft's domination of personal computer operating systems and standard productivity applications has a technological face, but also a regulatory one: Microsoft's position has been hard fought with courts and regulators in many countries for many years, and rests not on the substance of its products, but on the slender reed of being allowed to control certain application program interfaces (APIs), such as document formats. In an alternate regulatory regime where such interfaces are public property, software markets would have very low entry barriers, and could function largely as markets for customization and service (Stallman 1985;

¹⁰ In recognition both of Ford's five dollar day and of the emblematic consumer good of the period, the package of institutions and technologies that characterized advanced economies from the 1930s to the 1970s is often known as Fordism (Aglietta 2001; Marglin and Schor 1990; Kotz, McDonough, and Reich 1994), a deal sealed at the "treaty of Detroit" (Levy and Temin 2007).

Raymond 1998). Winner-take-all markets with private increasing returns depend on a regulatory regime that makes the technical standard proprietary.

The institutional contingency of technologically facilitated network monopolies is also apparent in one that has not happened: despite persistent lobbying by internet service providers (ISPs) for the right to prioritize content as they choose, in the case of the Internet (unlike, say, the case of cable TV, which often goes down the same wires) 'net neutrality' has been largely maintained in the US. This represents the continuation -- and adaptation to a new technology -- of the common carrier principle, a legacy of earlier generations of network regulation.

4. Technology and skill: skill-biased technological change

The analysis so far has focused on power. Technology also influences the demand for different factors of production, including labour with different types or levels of skill. A classic example comes from the devastation brought upon the skilled textiles workers whose livelihood was threatened by the introduction of automated looms in the early nineteenth century (and whose response was seen in the Luddite movement). More generally, technological change can either increase or reduce the demand for skill. Standardization and codification can substitute for skill, by making the skilled portion of labour endlessly replicable; Braverman (1974) took this position. Adam Smith, by contrast, saw the machinery associated with new techniques as a substitute for muscle power and routine operations. Since the 1980s the most widely held view has been that, on the whole, new technology complements skill: high-skilled workers benefit from technological change, while the demand for low-skilled workers declines.¹¹

Skill-biased technological change is a demand-side phenomenon, and can be thought of as reflecting simple market relationships. The supply side of skill, however, is governed not simply by the individual worker's response to labour market demand, but by the structure and funding of the public education system. Goldin and Katz (1998, 2008) treat income distribution as the outcome of a perpetual race between the demand and supply of skill. In the US, the successive extension of mass access to primary education, then high schools, then universities, kept the supply of educated workers (high skill) growing along with technologically-driven demand from the late 19th century until the 1970s. The expansion of investment in education then stalled, and the gap grew between the earnings of the highly educated and less educated.

¹¹ The simple monotonic relation -- workers benefiting more from technological change the higher their skill level -- has been challenged in favour of a more complicated story (Autor, Katz, and Kearney 2008). The focus, however, is still on skills and the effects for different skill categories of biases in technological change.

Institutional differences in the way skill is supplied help us explain not only changes in the US income distribution, but contemporaneous differences between countries. Investment of skills can be risky, because the future demand for skills (particularly those useful only in industries making internationally tradeable goods, or only with particular technologies) is uncertain. Among rich industrial countries, those with either social welfare systems or job security provisions which insure individuals against the costs of a skill becoming obsolete (Estevez-Abe, Iversen, and Soskice 2001) are also those with less income inequality – Japan, Germany, and Denmark, for instance, as against more the liberal (and unequal) economies of the English-speaking world. Cusack et al (2007) locate the origins of these differences in social insurance and job security in national electoral systems, and locate the difference in electoral systems in national efforts at economic (and technological) catch-up in the 1920s.

The institutional contingency of the supply of skill is important. But perhaps a more striking implication of the SBTC analysis is the severely limited role of institutions: this approach rejects or at least discounts the importance of institutional changes that may seem obvious to a casual observer. During the Great Compression between 1942 and 1980 the dispersion of wages and the income shares of the top 1 or 0.1% both were low compared with the periods before and since. Federal legislation in the late 1930s strengthened labour unions, extensions of social insurance improved workers' bargaining position, and there were important changes with respect to workplace health and safety, minimum wages, and statutory overtime pay. These changes, it seems, must have contributed to the Great Compression. Analogously, it is easy to see how changes in policies and institutions since the late 1970s may have put downward pressure on low-skill wages; federal labour relations law weakened, unions declined, industries were deregulated, and the minimum wage was allowed to fall.¹² Indeed, the institutional influence on power relations and distributional outcomes was central to the argument in section 3. But institutional accounts of rising wage inequality face a challenge.

A decrease in the relative wage of low-skill workers leads to a rise in the demand for low-skill workers in a standard model of the labour market. Contrary to this prediction, low-skill workers have lost ground in terms of both wages and employment since the 1970s: relative wages and relative employment have moved in the same direction. In a standard competitive model, however, a profit maximizing firm will not choose to employ an increasing proportion of those workers who have

¹² Studies by DiNardo et al. (1996) and Lee (1999) find that de-unionization and the falling minimum wage can account for a substantial share of the rise in wage inequality between 1970 and 1988.

become relatively expensive unless there has been a skill-biased shift in technology (e.g. Acemoglu 2002; Autor, Katz, and Kearney 2008).¹³

This analysis produces a TINA argument for SBTC ("There Is No Alternative", as Margaret Thatcher used to tell her critics): the observed patterns of employment *and* wages, it is suggested, imply that there must have been SBTC. Moreover, the analysis implies that institutional changes like the fall in the minimum wage cannot be blamed for increasing inequality: the SBTC approach suggests that attempts to prevent the increase -- by maintaining or raising the real value of minimum wage -- would have resulted in unemployment for low-skill workers.¹⁴ Thus, institutional changes like the fall in the minimum wage must be seen as endogenous reactions to a weakening of the demand for low-skill workers and a slow-down in the educational upgrading of the labour force. Looking ahead, the SBTC hypothesis suggests that only changes in the skill composition of the labour force -- education and training programs -- can ensure a lasting reduction of inequality without causing unemployment.

The TINA argument for SBTC has seemed convincing to many economists. The SBTC story has important empirical weaknesses, however,¹⁵ and at a theoretical level the TINA argument is false. Skott and Guy (2007) show that PBTC can account for a simultaneous rise in the relative wage and the relative employment of high-skill workers. In other words, PBTC can explain the particular employment-inequality pattern that has been regarded as a key piece of evidence for the SBTC hypothesis. Unlike the SBTC hypothesis, moreover, PBTC explains an increased intensity of work effort, evidence for which is reviewed by Green (2004).

The TINA argument falls, also without PBTC. It is well known that a rise in the minimum wage, within a certain range, can raise employment in markets with monopsony; Manning (2003) shows that monopsonistic features can appear more generally in labour markets that have some kind of friction.¹⁶ Empirically, a positive correlation between changes in minimum wages and employment has been found in a number of studies, including Card and Krueger (1994), Dube et al. (2010).

¹³ A shift in the sectoral composition of demand could have similar effects in a disaggregate framework; international trade, in turn, is a possible source of sectoral shifts in the demand for domestically produced goods.

¹⁴ This was a standard argument for high unemployment in Europe in the 1980 and 1990s; see Howell et al. (2007) for a critical examination of the evidence.

¹⁵ E.g. Howell (1999), Card and Dinardo (2002), Mishel et al (2013).

¹⁶ Efficiency wage models -- the same basic framework that we used to analyse PBTC -- can explain why many workers fail to get jobs that make use of their qualifications (Skott 2006). Endogenously generated mismatch of this kind, in turn, implies that low-wage workers can gain from a rise in the minimum wage, both in terms of wages and employment (Slonimczyk and Skott 2012). The SBTC argument is usually cast in the context of a one-sector model; in a multi-sector model, aggregation problems can also invalidate the conclusions (Skott 2011).

5. Technology and institutions

A rejection of the TINA argument and of the claim that neoliberal policies simply mask underlying market forces does not imply that institutions evolve independently of technology. The technologies available shape the set of feasible institutional options and affect the power of different political actors; technology (or what Marx called the forces of production) can have an important influence on institutions.

The technologies of the Fordist era facilitated the political coalition behind the institutional package of the Great Compression (Guy and Skott 2008). The information and communication technologies (ICTs) of the era -- the likes of the telephone and the tabulating machine -- made it feasible to coordinate an elaborate, planned division of labour involving hundreds of thousands of employees in big corporations, but the limitations of the information systems necessitated a relatively rigid, single-path flow of materials and information. This rigidity gave small groups of workers the ability to disrupt production and strengthened their bargaining power. As a result, industrial conflict threatened the productivity gains of large-scale production and, in some cases, the larger social order. Labour unions and government regulation can be viewed as a way to alleviate these threats and promote orderly industrial relations. Thus, the limitations of ICT may have been essential to the institutional changes that contributed to the Great Compression.¹⁷

This technological explanation for the onset of the Great Compression can help explain the fact that something similar seems to have occurred at about the same time in many different countries -- within antagonists on both sides of World War II (the US, UK, France, Japan) and in neutral countries, both fascist and social democratic (Spain, Sweden) (Piketty and Saez 2007). Yet, these collapses in the income share of the top 1% are so close together in time that it is not really plausible to see them as independent national responses to technological changes: even if such responses were entirely mechanistic (which surely, they are not), the countries in question were at different levels of development. Whatever assistance there may have been from the technological quarter, we must also be looking at some sort of policy contagion.

Just as the Great Compression had a technological foundation, technological change undermined it, creating the political opening for neo-liberalism. Improved information, communication and

¹⁷ Freeman and Medoff (1984) suggest another role for labour unions. If limited coordination technology forces a firm to rely on relatively inflexible rules, the firm can be brought to a standstill by its employees 'working to rule'. In this situation, doing a good job will sometimes require working beyond - and perhaps even in violation of - the rules, and employees therefore expose themselves to arbitrary retaliation from supervisors simply by doing a good job. In these cases unions may help ensure fair treatment, and as a result, unionized companies may gain productivity benefits.

transport technologies enhanced the flexibility of firms and their ability to coordinate complex production networks. This reduced the ability of low-level employees to disrupt production, and improvements in the monitoring technology led to further reductions in the power of low-level workers. By eliminating choke points that workers could exploit, the technologies of flexibility also undermined the power of labour unions, and thus a key pillar of the political coalition which sustained the Great Compression. The new technologies, however, can do little to monitor the more complex actions and options of executives; instead, the increased flexibility gave them a wider range of decisions to make and a more volatile environment to make those decisions in, leading to a growth in the level and performance-contingency of their pay - where performance is an outcome, not an action (Lemieux, MacLeod, and Parent 2007). From this perspective, the very large changes in the top end of the earnings distribution are not surprising (Skott and Guy 2013).

The regulatory solutions developed for network industries during the 1930s came to fit poorly as the network technologies themselves changed; de-regulation ensued, and the new web-based networks grew up in a time of general hostility to regulation, allowing the rapid growth of private monopoly power. Information-based products always come with strong increasing returns (the code can be replicated at near zero marginal cost); for increasing returns to produce inequality, though, it must be possible for the few to privately appropriate those returns. This has happened, facilitated both by the new tolerance of network-based monopoly, and by the extension of intellectual property rights (IPRs) (Krugman 2013; Baker 2013).

Rapid technological change and the emergence of the information economy raised the volatility of company-level financial results (Comin and Mulani 2006), necessitating pension reforms which pushed retirement savings into the stock market, bringing a change in the corporate governance regime in favour of shareholders and against employees (Gourevitch and Shinn 2005; O'Sullivan 2001).

The reduction in investment in education in the US – the reason, Goldin and Katz say, that the supply of skills in the US has failed to keep up demand – coincides with this broader neo-liberal policy revolution. Indeed, it is part of this policy revolution, and as such it is not simply a failure to keep up with technological change but is itself, in part, a consequence of those same technological changes.. Our argument is not that technological change is exclusively responsible for the institutional changes which brought the end of the Great Compression, but they contributed to shifting the ground on which the distribution of income and wealth is fought out.

6. Conclusion

Institutions and technology jointly shape the distribution of income. Technology shapes distribution partly by affecting the types of labour demanded (skill-biased technological change) and partly by affecting the relative bargaining power of different actors – workers, managers, shareholders – within the firm (power-biased technological change). But technology also affects the political power of different actors as they vie to shape the institutions which regulate competition (or monopoly), collective bargaining, tax rates, minimum wages, and so forth. Institutions, in turn, condition the effects of technology on the distribution of income: increasing returns is a technological property, but the private appropriability of rents from increasing returns is an institutional one; workers' ability to exploit technologically determined choke points depends on their legal rights in the workplace.

Clearly, there is no simple technological determinism; the diversity of international experience over the last 30 years illustrates the limits of technological explanations. Increases in inequality are widespread, but vary considerably in magnitude. Looking ahead, it is hard to say whether a grand Polanyist social response like that which produced the Great Compression, is possible with today's technological endowment and existing American institutions; eighty years ago, at the start of 1933, it was not clear, either, that the regulatory framework of the Great Compression was feasible.

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