The American Knowledge Economy

David Soskice

Working paper 51

October 2020

LSE International Inequalities Institute

The International Inequalities Institute (III) based at the London School of Economics and Political Science (LSE) aims to be the world's leading centre for interdisciplinary research on inequalities and create real impact through policy solutions that tackle the issue. The Institute provides a genuinely interdisciplinary forum unlike any other, bringing together expertise from across the School and drawing on the thinking of experts from every continent across the globe to produce high quality research and innovation in the field of inequalities.

In addition to our working papers series all these publications are available to download free from our website: www.lse.ac.uk/III

For further information on the work of the Institute, please contact the Institute Manager, Liza Ryan at e.ryan@lse.ac.uk

International Inequalities Institute

The London School of Economics and Political Science

Houghton Street

London

WC2A 2AE

Email: Inequalities.institute@lse.ac.uk

Web site: www.lse.ac.uk/III

@LSEInequalities

Editorial note and acknowledgements

I thank Torben Iversen for many of the ideas here. Paul Pierson has pushed my thinking a very great deal. I also thank Niki Lacey for getting me interested in the idiosyncracies of city politics in the US. And Michael Storper for opening up the whole field of economic geography to me.

1. The US as Driver of Radical Innovation

Perhaps the most extraordinary contribution of the US since the late C19th has been its leadership of successive waves of Schumpeterian innovation. These (three) waves are often referred to by economic historians as the Scientific Revolution (late C19th and early C20th), the Fordist Revolution (1920s), and the ICT Revolution (1980s on)[1][2]. (The first wave historically, the co-called Industrial Revolution, based on iron, steam and coal, and centred on the UK, had taken place from the late C18th through the mid C19th.)

One contribution of this paper is to explain how this dominance was possible in terms of key institutions of American advanced capitalism. It also stresses the key complementary role of the Federal government, the Supreme Court and city administrations, in the Scientific and Fordist technological revolutions.

This was also the case in the initial decades of the ICT Revolution. The core of the paper is devoted to the political economic dynamics of how the ICT Revolution put the American knowledge economy into shape. The ICT Revolution was dominated by the US with the initial active complementary engagement of the state. These dynamics are set out in Section 2.

The C21st Innovation Slowdown: the underlying federal dilemma

But in the new millennium a shift started to occur. Even if the US held the technological lead, a noted slowdown in US innovation was already developing through the 2000s, a slowdown made slower still by the long-drawn out effects of the financial crisis – the great recession to which the innovation slowdown itself contributed. Section 3 seeks to understand this process which it attributes in part to the progressive retreat of the Federal government from the innovation process, and notably from basic science. This was in part made up by the FAANG giants but only in a limited way as far as basic science was concerned.

We will argue that this Federal political retreat reflected the geographic dynamics of the ICT revolution, moving the benefits of the knowledge economy from the wide spread of cities and states and (relatively) egalitarian structures of the unionised postwar Fordist era to a small number of highly successful metro areas (the Bay Area, DC-Virginia-MD, NY, Boston, Seattle, as well as Boulder, San Diego, Austin and the Research Triangle). We will argue that politically this has caused massive problems: for it has generated a deep geographical, educational and cultural segregation which the US 'multi-venue' political system has exploited.

Successful massive technological change requires powerful governmental assistance – still currently the Federal government. A key theme of the chapter is that this problem caused to the Presidency by this segregation. For an American president needs to carry Congress to promote major initiatives. While congressional parties are disciplined over some broad policies, geographical fissure issues undermine party discipline. This poses a fundamental

[1] Germany also played a main role in the Scientific revolution, including in its scientific leadership, but it was increasingly dominated by the US.

[2] Some innovation theorists have suggested a fourth wave of technological change, referred as the 4th Industrial Revolution or the AI Revolution; here again the driving forces are American (even if China is now a competitor). We won't in this paper distinguish these two revolutions (the ICT and AI); there is no simple distinction, and there are in any case a whole range of partially associated radical innovations (eg cloud and edge computing, quantum computing, 5g, blockchains) taking place in parallel; in addition, the breakthroughs in life sciences, such as CRISPR, and the advances in immunology do not easily fit in; so we assume that they constitute together in the ICT revolution the technological basis of the Knowledge Economy.

dilemma for any Presidential policies which have sharply asymmetric benefits geographically. Thus, the Presidency can support and/or promote: the Federal highway system; the GI Bill; the military-industrial complex (including DARPA and the internet) as a response to the Cold War Soviet threat; Pell grants; the NIH in the battle against cancer; and the Morrill Act with 30,000 acres of Federal land per member of Congress. It is much harder to focus support on successful cities and the states where most research is done (starting with California, NY, Massachusetts), except by subterfuge.

We will see that the federal government's partial withdrawal in the last two decades combined with other policies, notably on fiscal policy and corporate governance, to dampen the extent of the contemporary American lead in radical innovation over China. Ironically, the conservative ideological push to an anti-statist and pro-libertarian institutional framework in the US political patchwork, may have also cut back the radical innovative capacity of the American economy. We return to this question in section 3.

The Institutions of Radical Innovation

What are (or have been) the institutions of radical innovation in the US? US dominance, we argue, reflects a particular institutional heritage going back to the (re)foundational period of advanced capitalism by the Republican Ascendancy presidents in the 1880s after the failure of Reconstruction, itself built on earlier foundations. (This history is discussed below.) The institutions which took shape were unusually propitious to radical innovation, and unique in the C20th advanced world:

(1) Highly flexible and decentralised systems of research and higher education, largely at university level and in the research diaspora of universities, and/or in the research laboratories of large corporations. This has been typically highly competitive during periods of radical innovation.

(2) Equally flexible and decentralised systems of finance, widely geographically distributed and with a wide variety of institutions, relatively little regulation, capable of high risk financing, and potentially disruptive to existing corporations.

(3) Companies capable of scalability; and a legal competition system, which both ensures reasonably competitive product markets and allows scalability. A key condition for this has been absence of protection at state, city or regional level, and of course a large market; (in the late C19th, external tariffs widened the overall domestic market for American corporations). A further element of the absence of protection (in the wider sense) at city and state level, at least apart from the 'stable' Fordist period from the late 1930s to the 1970s, has been the weakness of unions.

(4) Finally, a high-level (professional and technical) labour market, allowing easy movement across professions (via professional schools); enabling talented individuals to form spin-offs from existing (advanced) companies; and also to recover status after unsuccessful innovative projects.

There has been, of course, a very large amount of work done on the relation between particular institutions and innovation, notably in business schools, finance, economics and political science. Recent management literature, based on a large sample of companies internationally, concludes that a culture of organisations produces at least some of these characteristics as underlying innovations (Tellis, Prabhu et al. 2009). The nationally-comparative work is largely in innovation systems (Lundvall 1992), and to some extent in the literature on technology regimes and their dynamics (Freeman and Louçã 2001, Perez 2010).

But very little of it, important though it is, looks at the particular American institutions relevant to radical innovation and their embedding in the American political economy. (Indeed much of the literature was and written in the 1990s about Northern European and Asian countries to explain their success in innovation when American performance was seen as in decline.)

Varieties of Capitalism

It is tempting to see the institutions behind American radical innovation as simply those of a Liberal Market Economy, and strongly differentiated from a Coordinated Market Economy. They are certainly the latter. But equally, and more surprisingly, the radical innovation institutions differ in significant ways from those of the UK. These result from the degree of centralisation of the UK government system, focussing power on the Prime Minister with a majority in the House of Commons, geographically centred on Westminster; the Bank of England (private or nationalised) has had a high degree of de facto control on financial institutions going back to the C19th; the university system (even Oxford and Cambridge) has de facto long been influenced and standardised, as well as partially financed, by the government; from when competition legislation was initially enacted (in 1948), its concern was the market share of leading companies – there was no goal of rolling out giant companies, in part because for a long period governments were nervous of imposing 'the right to manage' on the shop floor. This does not (remotely) equate the UK to Germany; brilliant breakthroughs have come in the UK (largely from Cambridge), such as the structure of DNA, but the transformation of basic science into large-scale production systems is American.

Indeed a major distinction between the US and other advanced economies (leave aside China) is the capacity for scalability through most stages in the innovation process: there is thus a great emphasis on economies of scale, in the innovation process, in the production process and in the marketing and sales rollout. This is as true in the electro-chemical engineering processes designed for scale through-put in the Scientific revolution in the merger movement of the early C20th, as in the designs a century or more later of platform technologies. (By contrast, even in chemical production, more specialisation and quality customisation was involved in the giant German companies. The UK contrast is discussed below.)

With the sole (possible) serious comparison of China very recently, the US is the sole advanced capitalist system with these institutional characteristics. While China's analogous institutions are obviously very different from the American, a tempting suggestion is that they are functionally equivalent: Highly entrepreneurial competitive research environment, as well as flexible finance, and the capacity to scale-up giant technology companies with state encouragement.

US Dominance in Radical Innovation

Winning Nobel prizes is not equivalent to radical innovation, but it gives a (lagged) measure of breakthrough science. A rough idea of the US in the leading innovative edge of science over the past century or so, is shown in the following table and figure list affiliations of Nobel prize-winners. There are various ways of showing this to be the case, taking account of the implicit lags. Urquiola uses biographical details of Nobel prize winners to show the institutions to which they had affiliations (Urquiola 2020): (They may have been in more than one country, and thus the table is without reference to their nationalities. In addition, although the first Nobel prize was only in 1901, the list includes the prior history of the prize-winner's affiliations).

Table 1: Career Institutional Affiliations by Country

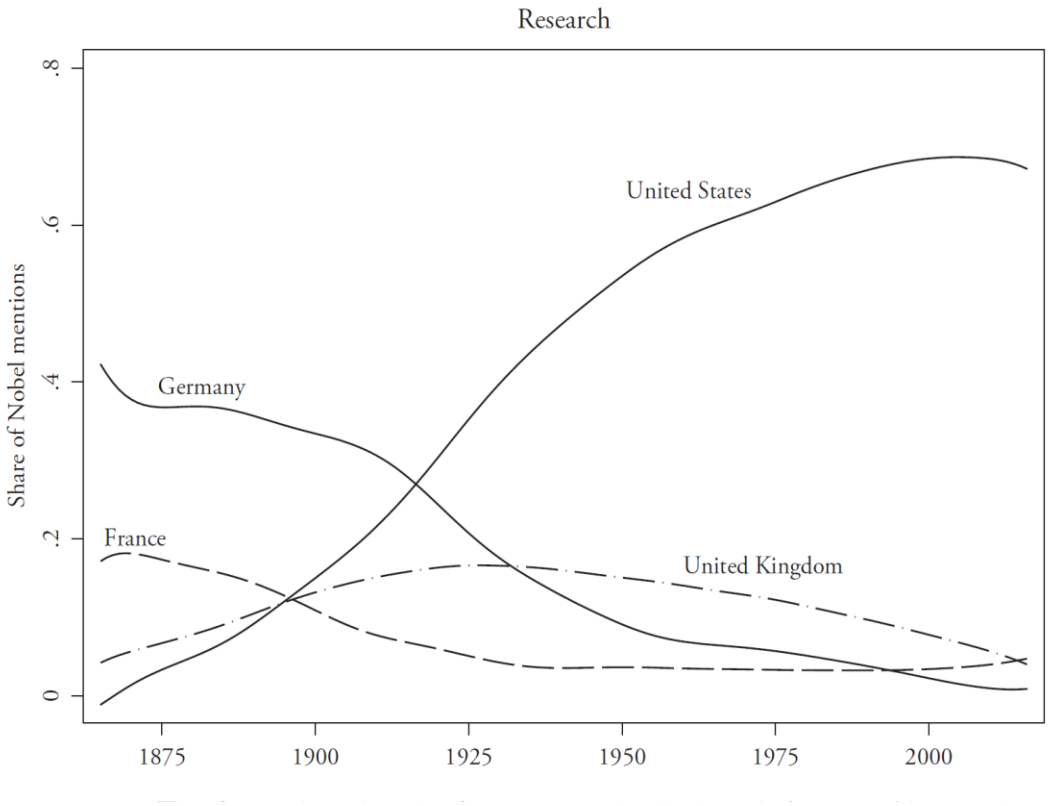
Rank	Country	Total mentions	Mentions by period 1855–1900	1901–1940	1941–1980	1981–2016
1	United States	1,548	13	298	862	375
2	United Kingdom	424	22	151	205	46
3	Germany	388	87	187	98	16
4	France	151	33	51	50	17
5	Japan	77		7	39	31
6	Switzerland	71	9	29	27	6
7	Canada	53		10	35	8
8	Sweden	50	7	20	19	4
9	Netherlands	38	10	13	10	5
10	Denmark	36	6	18	10	2
11	Austria	35	9	24	2	
12	Russia	30	5	12	9	4
13	Australia	25		7	15	3
14	Israel	24			17	7
15	Italy	23	1	13	7	2
16	Norway	17		4	7	6
17	Belgium	16	2	6	7	1
18	China	14			6	8
19	India	12		5	6	1
20	Finland	10		5	3	2

Source: Urquiola Table 1.1 (Urquiola 2020).

Notes: This shows for each academic Nobel Laureate the number of institutional (generally university) affiliations by nation in each period including the affiliation when the prize was won, but not subsequent affiliations. (It does not measure number of prizes: In the interwar period the US, Germany and the UK were level pegging in the number of Nobel prizes, in Physics, Chemistry and Medicine/Physiology with 6 each; the US had greatly more prizes winners after the 2nd World War, with most of those having American institutional affiliations before the War.)

In Figure 1 this data is reproduced on an annual basis in graphic form.

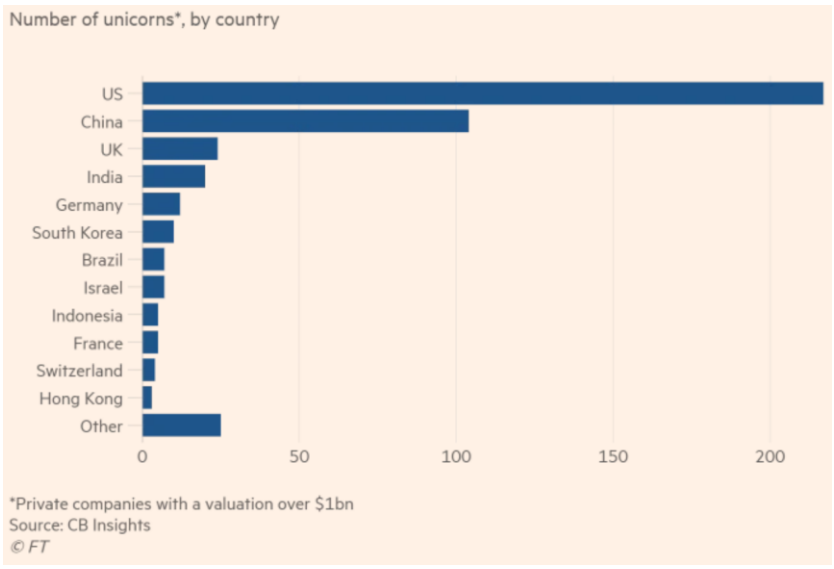
Figure 1: Nobel institutional mentions over time



Source: Table 1.2 (Urquiola 2020)

China is late in this game. So another measure of recent innovation dominance is the number of unicorns.

Figure 2: Number of Unicorns by Country



Source: Financial Times, 6th February 2020

Figure 2 shows the US as leading country in the number of unicorns in 2015. More recent data, using different sources, has China as close to or overtaking the US in the number of unicorns, thus further posing the possibility of developing US weakness. But most commentators believe that the US is currently still significantly ahead of China in most areas of sciences, even if the US may be declining in historical terms.

A Brief History

Some elements of this institutional system go back to the original colonisation of America. But following Bensel, also Gerstle, the key elements of the institutional strategy of industrialisation were developed from the late 1870s by the Republican Ascendency presidents of the last third of the C19th following the failure of Reconstruction (Bensel 2000, Gerstle 2017). Indeed the clues to understanding the multi-venue complexity of contemporary American political economy, and the power therein of big business and finance today to access political systems, lie in this (re-)foundational period; in turn that period was based on the rich pre-foundational tapestry of more strongly and more loosely regulated municipalities and counties as well as the states in which they were embedded (Novak 1996).

The Republican Ascendency presidents from 1877 on were confronted with the failure of Reconstruction on the one hand and the success of European industrialisation on the other. Close both to Northern industrialists and to financial capital, forced industrialisation was seen by them as a central goal given the evident strength of European industrialisation and military power (notably in England and Germany). But as Germany and England in the late C19th show in different ways, a great range of centralised framework institutions is needed for advanced industrialisation. Little of that then existed in Washington; and the Federal government had minimal administrative capacity. This was not a 'weak American state' (Novak 2008). But it was not a strong centralised state. Administrative capacity instead lay in the big and rapidly growing cities of this period mainly in the North East and mid-West, and in a limited number of state capitols; it lay too in the railroad companies, as well as in northern manufacturing companies (partly as a result of the Civil War). The South – where the states were more organised and powerful – was hostile to industrialisation for fear it would give employment and education to the black population; thus Republican presidents excluded the former Confederacy from their industrialisation strategy. As a model of successful corporate growth the Presidency had the example of the well-organised and highly-scaled transcontinental railroad companies (Chandler 1965); (as Clinton had 'used' Goldman-Sachs under Rubin's guidance). It critically relied on the acceptance of Supreme Court decisions and 'stuffed' the court with lawyers who had been directors of the railroad companies (Bensel 2000). While the reality was far more complex, there were two key elements:

(i) encourage giant companies along the lines of the major railroad companies, by allowing trusts and mergers; encouraging rather than regulating the uncoordinated finance sector in the process; eventually using the Presidential threat of Sherman to distinguish between Theodore Roosevelt's 'good' and 'bad' trusts – an American (and latterly Borkian) interpretation of competition policy;

(ii) rule out protection at state or city level, hence encouraging the (ultimately) transcontinental 'rollout' of the highly scaled giant corporations; this was enforced by the Supreme Court interpretation of the Interstate Commerce clause; it also encouraged cities to make conditions attractive to these corporations (bringing employment and rising property values to the city), in part by preventing or limiting unionisation of the semi-skilled workforces; thus

it had the consequence of reinforcing the organisation and control of production in large-scale industry to engineers and foremen rather than by skilled workers and their unions; the AFL unions thus organised skilled services and smaller manufacturing companies.

Important though parties were (Aldrich 2011), Congressional politicians were rooted in city and state politics, rather than in centralised disciplined parties. Both corporations and cities engaged in Congressional politics to safeguard their specific interests, thus maintaining its porousness, and hence the incentive to 'invest' in members of Congress given their individual power in political decisions. And the more laws passed by Congress and the greater the role of Federal agencies, from the late nineteenth century, the greater the incentive became to invest in politicians. Given the continuing role of state politics as well as those of the big cities, parties remained relatively undisciplined as individual politicians retained independent sources of power; Cox explains the difference with the centralising UK parties over this period (Cox 1987).

We might have expected on the lines of these arguments that financial institutions would have developed in similar ways to the giant industrial corporations. Large-scale commercial banks would have required branch banking; but the distribution of political power across municipalities and states blocked branch banking in many environments historically and the McFadden Act (1927) formally prohibited interstate branch banking. The Interstate Commerce clause was deemed not to apply. More widely and despite many attempts, there was relatively little general regulation of financial institutions until Glass-Steagall in 1933 prohibiting commercial banks from investing in companies. Even then, American financial institutions remained relatively unregulated, thus permitting very large investment banks to develop, often institutionalised as trusts. A myriad of deposit banks sent reserves to financial institutions in New York for short-term lending, and investment banks used these resources, as well as the value of their investments in large manufacturing companies, to finance the merger wave of the early twentieth century. The New York Stock Exchange could adopt rules to cover the companies quoted on it but not on the riskier Curb Market in New York. More basically, there was large amounts of money available for investments, and outside the formal commercial banking system and (to a lesser extent) the NYSE and the SEC relatively little centralized regulation. Thus the constraints on the financial system were those which municipalities and/or states imposed; that favoured risky finance (outside commercial banks, where residents money was at risk) when the risk finance came from outside (or from the wealthy) while the successful developments benefitted in part the residents.

Likewise, universities did not develop within a centralised framework for broadly similar reasons. The Federal government had only limited administrative capacity. Frameworks for higher education were largely provided at state level, with state university systems. The 1862 Morrill Act provided endowments for colleges in the form of grants of land (30,000 acres per state member of Congress) to be used to teach agriculture and engineering (mechanics). This in fact favoured the more industrialised Northeastern and Midwest states; they could be and were run in ways tailored to benefit local industry; apart from Cornell and MIT they have remained public institutions; and they played a major role in producing more engineers annually than Germany by the end of the C19th. The trustees who ran the older universities (*inter alia* Harvard, Princeton, Yale, Columbia) pushed those universities in a more industrial/scientific/engineering direction; as did the philanthropic founders of the period, mainly from the newly successful companies (*inter alia* Carnegie, Mellon, Duke, Stanford, MIT, Caltech).

For similar reasons, trustees and philanthropists, as well as state governments and city elites, and the growing corporations themselves, were concerned to develop flexible professional schools at the universities (in law, engineering and management) to staff corporations. But the concern was to use them in building organisations rather than formalised professions. So these professional schools developed high intellectual standards, but where general argument was prized. Above all they enabled mobility, geographical as well as professional, capable of working across disciplines and of management (in the broadest sense).

The Earlier Technological Revolutions

Briefly we go back from the ICT revolution to the two other main periods of radical innovation in which America acted as technology driver: In both cases, they were 'revolutionary' in developing techniques to operate at mass scale; indeed standardisation and scalability characterised these innovatory episodes as it has done in the ICT revolution. First, in the late C19th and early C20th, across a whole range of industries, Chandlerian corporations built integrated operations from basic research through to marketing, sales and distribution. This 'revolutionary' period is often referred to by economic historians as the Second Industrial Revolution. These corporations used the transcontinental railroad systems built (with 'generous' land-grants) since the civil war; they also copied the sophisticated logistical systems the railroad companies had evolved. They did this, Hamiltonian-style, behind a tariff wall, where necessary making use of European technology. They also more importantly developed a range of sophisticated but relatively standardised goods produced at great scale, with machinery and equipment designed by their engineers (electro-mechanical and electro-chemical) and scientists. These goods were mainly produced by process-manufacturing (steel, non-ferrous metals, sugar, rubber, pharmaceuticals, cement, chemicals, petroleum). A lengthy quotation from a leading interpretation of the period by Lance Davis and Larry Neal:

> Concentrated in this short time span were inventions of electric generators, dynamite, photographic film, light bulbs, electric motors, internal ternal combustion engines, steam turbines, aluminum, and prestressed concrete and all this even before the turn of the century. The pre-World World War I surge of invention culminated with airplanes, tractors, radio, plastics, neon lights, and synthetic fertilizers in the first decade of the twentieth century. ….
>
> …… similarities in patterns of innovation, speculation, currency crisis, and financial panics that occurred in both the 1890s and the 1990s.
>
> ….. the leading country in developments in both finance and technology was the United States. Why this was so at the turn of the nineteenth century, we believe, lies in major part in the particular features of the American financial system with its complementary array of financial intermediaries and capital markets (Davis and Neal 2007).

Industrial monopolies were formed across many industries with the use of trusts, in the so-called Great Merger movement of the late 1890s and early 1900s (Lamoreaux 1988). What is significant (albeit disputed) is Teddy Roosevelt's use of the 'rule of reason' in trust busting, the Sherman Act, to distinguish between 'good' and 'bad' trusts.

A similarly disruptive period occurred in the 1920s in ushering in the Fordist revolution, with spin-offs and heightened competition as Ford put together his company. A highly flexible financial system was also in evidence. A likewise a beneficent attitude by the Federal government to the rapid scaling up of giant companies.

2. The ICT Revolution

In this section, I want to explain why the ICT revolution has had such a peculiarly powerful effect on the building-up of a number of hugely powerful cities and their metropolitan areas in which the breakthroughs in radical innovation were located.

This took place in the US far earlier than elsewhere. It started from the investments in the military-industrial complex going back to the 1950s and 1960s, with an acute awareness as Eisenhower saw it in 1960 of the 'technological revolution of recent decades':

> Akin to, and largely responsible for the sweeping changes in our industrial-military posture, has been the technological revolution during recent decades.
>
> In this revolution, research has become central; it also becomes more formalized, complex, and costly. A steadily increasing share is conducted for, by, or at the direction of, the Federal government.

The Federal government (and principally the Department of Defence) both funded basic university research across a wide range of areas as well as subsidising technology companies. Via a sequence of companies and scientists (with much movement early on from Cambridge Mass to Silicon Valley), with the Engineering department at Stanford and its entrepreurial Dean, Terman, and the move of Shockley (having broken with Bell Labs and then Raytheon on the East Coast), a cascade of spinoffs took place: the 'traitorous 8' left Shockley to found Fairchild, from which Noyce and Moore then broke off to set up Intel (in 1968), all close to Stanford, where Hewlett-Packard was already established. Berkeley and UCSF, as well as a growing ecology of venture capitalists, investment banks, technology and patent lawyers, many based in San Jose and then San Francisco, thus generated a sprawling agglomeration with massive public funding and increasing private capital.

This agglomeration took place later in the Boston area because the advanced companies there were initially more established and internally hierarchical, and less porous to external interchanges (Saxenian 1994, Gertler, Oinas et al. 1995). It developed later in NY, Seattle and other major cities.

The big cities in which many have benefitted from the ICT revolution are themselves divided between very poor ethnic areas and the rest; and the rest is divided between the highly educated areas (such as in NYC Manhattan and parts of Brooklyn) and other less educated but far from poor areas; and the suburbs are divided both ethnically and on educational and economic grounds. (In his fascinating book on urban politics in Washington, Ogorzalek shows how urban politicians maintained unity despite these divisions (Ogorzalek 2018).)

What I want to do here is show why one part of the population invested heavily in university education, and how that dramatically transformed the high skill and innovative economies of key large cities.

The ICT Revolution and Returns to Analytic and Social (but not Physical) Skills and Horizontal Organisations

To understand how this has worked itself out, we have to analyse the way IT has transformed company structures and management practices. There is in fact huge variation in company performance in the United States, even within narrowly defined sectors and within different establishments of the same company (Bloom, Brynjolfson et al 2018). In this section we discuss the high value-added establishments of companies, largely employing graduates. Knowledge-based establishments of companies, with much oversimplification, are organised on a project group basis (for example developing a new product line), with relatively short lines of communication with top management. And we refer to this type of 'horizontal' or 'relational' structure in what follows.

Returns to Skills

The ICT revolution occurred over a long period of time, so in describing its effects on skills inevitable temporal compression is necessary. But there is some agreement that there have been three main effects on the return to skills:

(1) As a result of massive technical change in the workplace, the demand for physical skills has greatly declined. This has gone with a decline in the manufacturing workforce to a very low level, although manufacturing output remains high, reflecting high productivity in production facilities located in the US. This is reinforced by outsourcing and the transfer of much production to China and South East Asia and the Sub-continent, via global value chains, or trough direct import competition. Moreover, the demand for significant physical strength in the service sectors, in which most employment is now created in the US, is quite limited.

(2) For what I'll call knowledge-based sectors, the ability to access information and software via a computer console, and the payoff from being able to use that information increases the return to analytic skills. These are largely in service or technology/research sectors and account for perhaps 50% of employment of the workforce below 40. In nearly all these sectors, this requires college education or at least associate degree level in a community college. Currently around 40% of the labor force above 25 are college graduates or above; and 28% have some college or an associate degree (data for 2016, BLS).

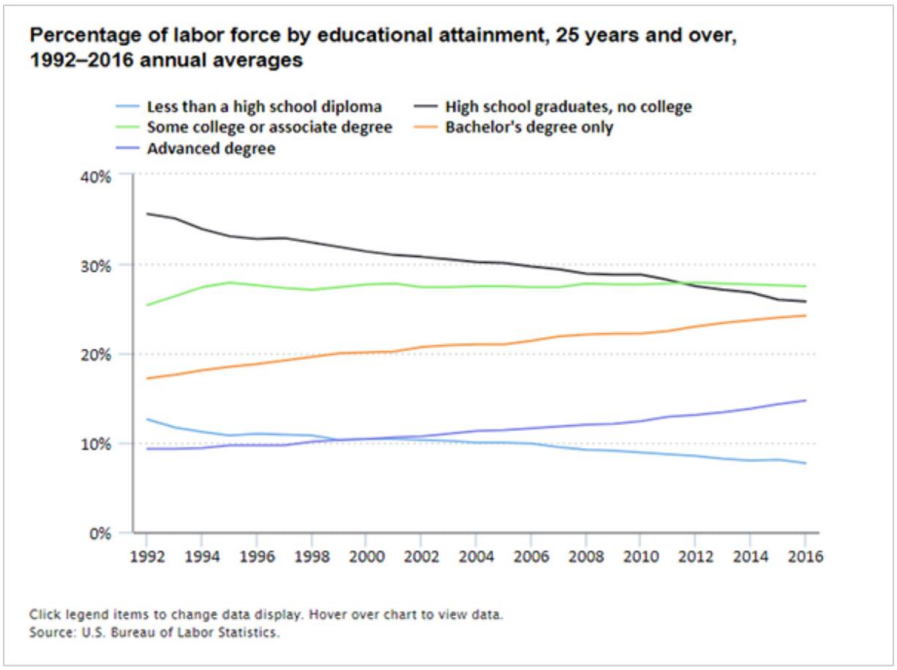
(3) In moving from a Fordist world of relatively hierarchical companies with well-defined ranges of tasks and instructions to one of project groups in knowledge-based establishments, social skills have become increasingly important. The ability to interact with others requires more than analytic abilities. Now a wide range of competences is looked for: the ability to communicate easily, negotiate, provide leadership, to possess e-skills and the ability to 'read' others, be empathetic, reliable, imaginative, likeable, capable of developing good and durable working relations, be tolerant of diversity, and so on all become desirable assets; and to exercise them in relation to those of a broadly similar educational level. Acquisition of some or all of these skills is most commonly learnt in higher education, not in lectures but through living, discussing and organising life with fellow students.

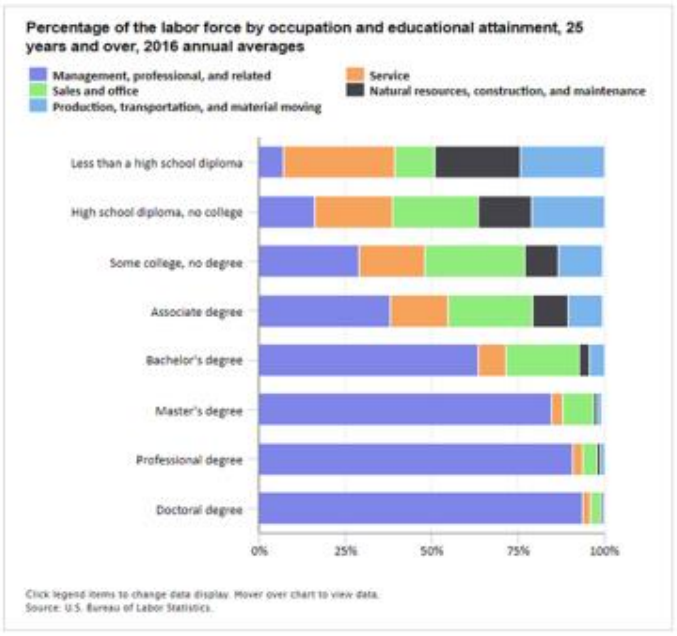
In so far as this has increased the demand by knowledge-based companies for graduates with both analytic and social skills, the return to college has increased relative to high school graduation over several decades, and there have been two consequences for investment in education. The first most evidently is that university participation has increased. In this BLS

data, the percentage of college graduates in the labor force rose 13% from 1992 to 2016; NCES data show that 36% of those aged between 18 and 24 participated were at college, implying a rate of college participation over a 4 year period of around 55% against 39% in 1991. (A point we will come back to is that participation stabilised between 2010 and 2016.)

The second implication was that there was a bigger payoff for women than for men, since physical skills were no longer so valuable. And the participation rate for women in higher education in the US is about 8 to 9% above that for men in 2017 (OECD 2018).

Figures 3,4: Percentage of Labor Force by Occupation and Education Attainment, 1992-2016





Source: US Bureau of Labor Statistics

Co-location Over Time in Companies

The central question in understanding the great inversion back to the big city is that of location: why in recent decades have smart people increasingly located close together? As is well-known the 'flat earth' which Thomas Friedman predicted as a result of the ICT revolution has not happened. Knowledge-based companies generally require their workers to work in the same physical location, to 'co-locate'. There is no agreed theory of why this is the case; but it is central (at least at the moment) to the way knowledge economies work in all advanced economies. In our view it is linked to the need of project groups for people to work together over a period of time to develop projects; this is a world of (at best) incomplete contracts tying a number of people together over uncertain lengths of time during which ideally they need to build relations of implicit obligation towards each other. My contention is that this is very difficult to do if they live and work in different places, perhaps in different countries: this is in part because it is almost impossible for other members of a project group to monitor how someone in a different geographical place is spending their time (they might be working for someone else or not working); in part it is because in most joint working systems individual effort is important but difficult to factor into rewards, so that interpersonal ties and implicit obligations become important – and interpersonal relationships develop (if they were not there beforehand) through personal interaction over time. If some quite strong interpersonal relations within a group are important for the group to function cohesively and deal with the myriad of conflicts and opportunities which arise within it, then that seems closely linked to physical proximity: a family, or a group of close friends, is an analogy, where it would be difficult to evolve close relations if people lived apart.

Skill Clusters

High skill-intensity companies work by people with different specialised but related skills working together. But companies often fail or need to downsize; and other companies are set up or need to expand. Whereas even semi-skilled jobs in Fordist plants typically had longish tenure and agreed LIFO and LOFI plans as well as temporary layoff pay agreements, many small high-skill companies cannot predict employment demand so easily. They frequently operate moreover in a high-risk market or technological environment. This leads to skill clusters where those with specialist skills say in finance will want to live in areas where they can switch jobs without having to move to a new area (causing disruption to schools, social network, spousal jobs. etc). Moreover, thought of as a two-sided location platform, it also pays companies needing to tap into the relevant skill area to locate in the same area. This is an example of a locational matching problem (Roth).

It is in fact a multi-sided matching problem, since membership of the social networks of skill clusters is (as well as doubtless pleasurable) a valuable asset for someone with the relevant skill-set. It gives access to information about upcoming positions, itself important to wage-bargaining. And friendship and such transfers of information are mutually reinforcing.

Such a skill-cluster, as Michael Storper has pointed out, becomes geographically embedded (Storper 2013). (Founded on Marshallian externalities it is only movable in unusual circumstances such as major changes in laws; and despite all the research in urban studies there are no policy recipes for growing clusters.) Indeed in the knowledge economy world, knowledge competences are geographically embedded. In some circumstances they can be codified and the codified knowledge transferred (perhaps patented). But most generally as skills becomes more sophisticated and specialised, the codified knowledge is co-specific with the tacit (ie non-codifiable) skills of the specialist; (the exceptions are in some biotechnology

therapeutics, in which knowedge of the patent is all that is necessary to produce the therapeutic product; even they are probably rarer than might be imagined; and even then tacit skills are probably necessary to move from the patent to develop related therapies). Thus the patent is at best a blocking device.

Skill clusters, typically overlapping, populate large successful cities (or as we may refer to them) urban agglomerations. The most obvious sectors are:

- High value-added services, finance, law, accounting and management consultancies, and advertising
- Culture, media, entertainment and high-end retail
- Knowledge intensive business services (kibs) and software
- Medical, research universities and professional schools, research facilities and think tanks

All these underline the urban agglomeration in the knowledge economy as providing a wide range of complex high-skill intensive products largely in the form of services from their skill clusters. It is sold within the metro area including the suburbs. Or it goes to other urban agglomerations within North America. Or it goes to other advanced economies.

In addition these skill clusters attract two sorts of major companies to locate in the urban agglomeration:

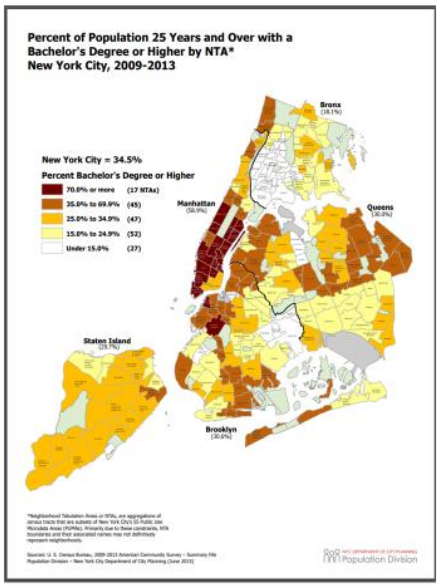
- Subsidiaries of knowledge-based multinationals, buying into relevant skill clusters often technological research-based; we discuss later the radical reconstruction of research-based MNEs since the early 1990s across the advanced world, which we explain as a result of the increasingly embedded nature of the knowledge competences they need to use in their headquarters in the development of advanced products which they brand and market across the world (Nestles and Unilever are good examples)
- Headquarters of advanced companies, able to access easily the multiple high level specialised business services available in the urban agglomeration (which in the Fordist era they would likely have produced in-house)

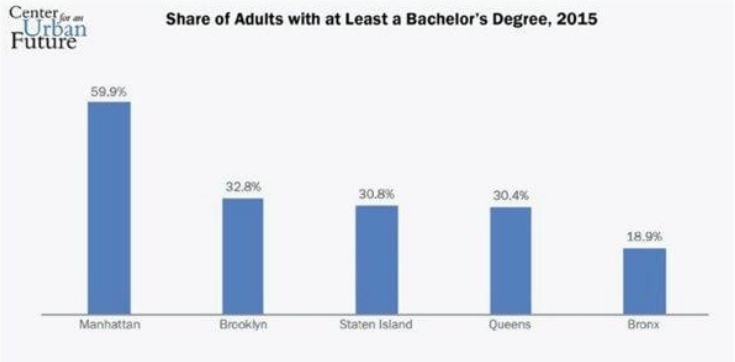
Graduate Social Networks

Skill clusters constitute one way of looking at the relations between graduates across the successful big city. But these relationships are held together by another set of interrelations; that is the even more powerful glue of social networks linking friends and partners across these skill networks, and the critical phenomenon of what will be shortly described – assortative mating. These two interwoven networks are critical to urban agglomeration.

Urban areas, even New York, are far from homogeneous. The overall proportion of graduates in NYC, 36%, in the 25-64 age group in 2009-2013, compares with the US average of 30%. But this ranges in NYC from 59% in Manhattan to 18% in the Bronx. (These figures would be higher if I took the 25-34 age group.) Here I look at the high educated areas. In fact as can be seen can be seen in relation to NYC, Manhattan south of Harlem has an extraordinarily high rate of college graduates, with 17 of its neighbourhoods having above 70% rates; and there are large chunks of both Queens and Brooklyn with high rates. But contrast this with other parts of Brooklyn, Queens and the Bronx.

Figures 5, 6: College degrees in New York Boroughs 2015 and Precincts 2009-13





Source: US Census Bureau, 2011-2015 American Community Survey 5 year estimates, Age > 25 years

Social networks across groups of friends are of great importance in the lives of most people. As a growing proportion of young people go to university, relatively durable social networks are formed there so that from an educational perspective networks have become more homogeneous. In just the way that social networks based on skill clusters benefit mutually from friendship and career advancement, the same is true of the social networks which are not directly skill related. And very likely they overlap.

Assortative Mating

One of the most marked social phenomena of recent decades is that of *assortative mating*. Young people tend to find their future partners among people of the same educational background. This is particularly true of graduates. Permanent relationships tend to start much later than was the case in earlier decades. But frequently this happens through the social networks formed during higher education, or through people met subsequently after university via a member of the network. (And online dating pays much attention to information about university background.) This process is simplified by the wide tolerance of graduate

social networks for diversity of all sorts – so long as new members are smart and have the right education (and probably the right set of views and beliefs). Indeed this goes with an advanced company world in which diversity is seen as important for innovation: thus many things tie together! (Two things are worth pointing out from an economic point of view: First, and very obviously, it makes sense if one is going to live with someone else that both partners are graduates because of their combined earning capacity, given the economies involved in sharing accommodation. Second, for graduates marriage lasts longer and first children arrive later: thus the arrangement is more secure and the joint earning continues for longer.)

Assortative mating has a major consequence for the agglomerating city. If both partners are pursuing careers in different high level occupations, they can only live in a city which has enough skill clusters to accommodate both of them. Thus assuming that partner choice is made independently of the availability of the relevant skill clusters in their existing city of residence – say on the basis of maximising joint income or even of 'true love' – then they need to live in or move to a city big enough to provide the relevant skill clusters for both of them. In that case, cities of residential choice will likely be large cities with wide ranges of skill clusters. (Note that the absence of a wide range of clusters has handicapped highly specialised manufacturing cities like Detroit or Cincinnati from becoming successful agglomerating big cities.)

This bias towards the large (or very large city) is reinforced by the incentive of preserving graduate social networks. The bigger the city the more easily can these be preserved. This is an area on which more work needs to be done; but the likelihood that the best companies in a particular sector will be in a very large city and that there will be many sectoral clusters in such a city, makes it sensible to stay in a large city if your social network is already in one and if you are smart to move to one if you are not in one. The combination of these considerations with assortative mating gives a strong upward twist to successful agglomerating cities.

Property Prices and Centripetal-Centrifugal Demographies

This is accompanied by a further dynamic. Able, clever people want to live close to other able clever people. This facilitates social networking; one's own productivity is increased around other productive people. When this is social and random, Jacobs' externalities are created (Storper and Venables 2004). The closer such people live together the more likely are such interactions. The map above of Manhattan is very suggestive of this. Better still if children go to the same school and play together; thus the value of assortative mating for such people.

The more intense the desired geographical interactions, the more costly the price of property since the demand for property close to the 'right sort of people' (as Henry James might have said) will be in high demand. Assortative mating provides extra financial resources for such property and plays a major role in raising property prices.

As is now understood a large part of the increases in wealth to which Piketty has pointed in his explanation about the increasing K/Y ratio, result not from increased investment in business capital but in house prices in the large urban agglomerations (Bonnet, Bono et al. 2014). Piketty pays little attention to technological change and the ICT revolution but much of the increase in wealth which he flags can be attributed to it in this indirect way.

To summarise where we are at: The ICT revolution has played a major part in building up skill clusters in a wide variety of areas in the urban agglomerations. This has gone with a

major residential move into these agglomerations by graduates working in these clusters. In so doing they reinforced moves into big cities by seeking to preserve social networks and relatedly by assortative mating. This whole process has added to the human capital and to its wealth by raising the price of property in the city. It has also raised the demand for less skilled non-graduate labor; though there is an argument between Moretti and Autor as to whether their wages are higher in the city (given its cost of living) than they would have earned in smaller towns (Moretti and Thulin 2013). There is a related argument about the effects of gentrification on poorer ethnic areas of the big cities.

What seems very clear is that a number of cities have become hugely more economically powerful (let alone solvent) than they were in the 1970s and 1980s as the Fordist labor system was slowly and painfully crumbling: most notably Boston, New York, Washington DC, Seattle, San Francisco, San Jose, San Diego, as well as Denver/Boulder, Minnesota, Madison, Austin, Raleigh/Durham/Chapel Hill. On balance, Chicago, Los Angeles, Philadelphia, Baltimore and Pittsburgh have benefitted. Detroit, Milwaukee, Cleveland, Cincinnati have not.

The cities which on balance have so far not succeeded were industrial cities which found it difficult to get rid of their industrial base. Part of this was their concentration on a single major industry. Much of this was politics: most notably Detroit and Michigan persisted in trying to restart the auto industry. But research universities by themselves were insufficient: Equally political in terms of corporate representation was the failure of Los Angeles, despite UCLA and USC, relative to San Francisco (Storper, Kemeny et al. 2015); perhaps this was true of basic steel in the restructuring of Pittsburgh, despite Carnegie-Mellon and the University of Pittsburgh.

The cities which have benefitted clearly are cities which started the 1990s with a wide range of service sector activities and strong research universities. These are the innovation powerhouse cities. I will argue that they are developing into political bodies capable of intervening in a wide range of policy areas. These include environmental areas and mass transport, as well as housing, education and health. Above all they are beginning to play a central role in developing city-region innovation systems.

3. C21st Problems: Radical Innovation Slowdown and Segregation

In the C21st there is growing agreement that radical innovation in the US has slowed down. This has been particularly marked in the last decade during the Great Recession after the Financial Crisis and subsequently.

There are a number of different views about why this is so. Gordon argues that the source of the great inventions of the C20th has dried up, and believed this had been happening by the end of the C20th (Gordon 2000). The most obvious reason to reject this perspective is that massive changes have come about during the ICT revolution: Most evidently the nature of communication has radically changed. We can communicate quickly and virtually costlessly via video almost anyone anywhere with minimal equipment. That has gone with transformative changes in the power, security and scope of computing (cloud, edge, mobile), in 5g and potentially quantum, in AI and robotics, in nanotechnology and new materials, as well as via these developments in the life sciences.

The question is why the pace of change has declined in the recent past. Nick Bloom and colleagues suggest this is because of the rising cost of innovations over time (Bloom, Jones et al. 2017); but this pattern has been visible for a long period, and not just over recent decades.

It is certainly wrong to suggest that the US has become incapable of radical innovation. But a lot of evidence, including that of the steady decline of productivity growth, points to this slowdown in radical innovation. While few observers see China as close to being competitive with the US currently, China has clearly been catching up and in a decade is likely to be a challenger in a number of key areas, notably AI.

The general argument of the chapter has been to explain American dominance in radical innovation as the result of two broad sets of factors: First, a unique set of institutions – highly competitive research systems; relatively unregulated financial systems; scalable companies; and professional and technological labor markets, allowing spin-offs and career switching. These institutions have not significantly changed.

Gradual Withdrawal of Federal Support for Basic Science: the geography of politics and the decline of the military-industrial complex

The other reason for the success of American dominance of radical innovation over the long-term has been – in many different ways – a supportive Presidency: this has been discussed earlier in relation to previous periods of technological change. Several elements stand out during the ICT revolution. As we saw in the last section, as the new ICT technology was developing in a world in which research is becoming increasingly expensive, the Federal government provided massive support for the initial substantial investment in the basic and applied science involved.

Large investments in basic science (in a whole range of different disciplines including new interstitial disciplines) appears key to the maintenance of radical innovation. This support has gradually declined, and a major argument in this section is the dilemma such support has increasingly posed for the Presidency. To carry Congress behind major spending initiatives the President needs to demonstrate that the benefit will be geographically widespread. Individual senators and representatives have considerable liberty; where spending is at issue they will have two concerns.

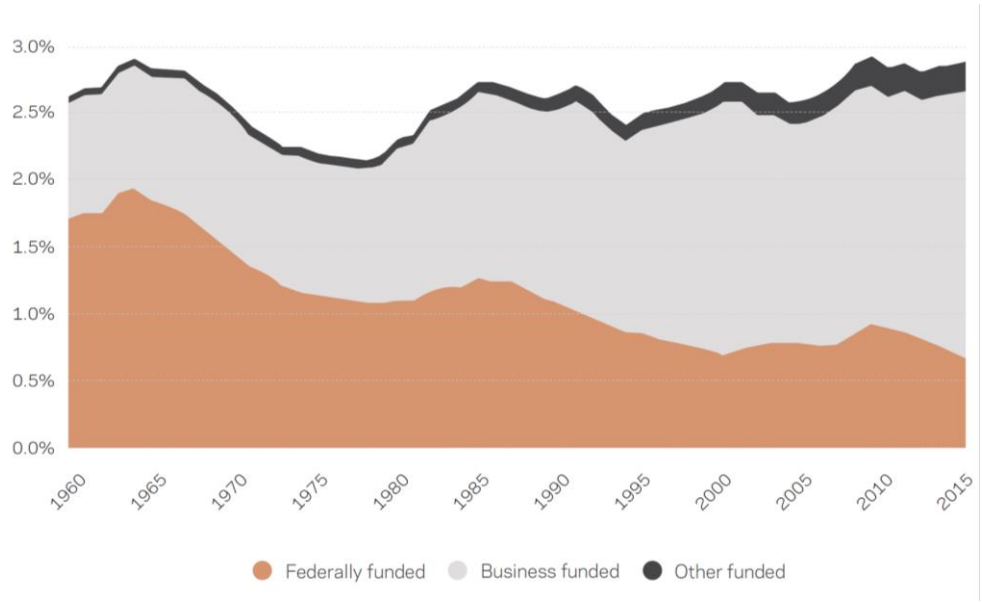
One concern is that their constituents benefit from the spending or approve of it. This can happen in two ways: the spending may directly geographically benefit their constituents; or it may be seen as benefitting the nation (or a class therein) as a whole. Much of the foundational spending on R&D by the Federal government came from the Department of Defence. Defence spending may literally benefit constituencies via companies (defence contractors) or via the service sector supplying military institutions or research establishments located there. Indirectly, during the Cold War, specialised defence expenditures in research laboratories may be seen as protecting the nation as a whole against the Soviet threat (or however that is portrayed). Eisenhower explained it thus, in leaving office in 1961 early in the build-up:

> A vital element in keeping the peace is our military establishment. Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction. …
>
> This conjunction of an immense military establishment and a large arms industry is new in the American experience. The total influence -- economic, political, even spiritual -- is felt in every city, every State house, every office of the Federal government. We recognize the imperative need for this development.

> Yet we must not fail to comprehend its grave implications. Our toil, resources and livelihood are all involved; so is the very structure of our society.
>
> Akin to, and largely responsible for the sweeping changes in our industrial-military posture, has been the technological revolution during recent decades. In this revolution, research has become central; it also becomes more formalized, complex, and costly. A steadily increasing share is conducted for, by, or at the direction of, the Federal government. Today, the solitary inventor, tinkering in his shop, has been overshadowed by task forces of scientists in laboratories and testing fields. In the same fashion, the free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research.

This (subtly) explains the 'national' benefit in the first paragraph, the localised benefits in the second, and (somewhat hidden) the acceptance that research is key and it will only take place in particular places. And, just as earlier Presidencies had idealised 'growth' models – the railroad companies in the later C19th, and Ford and GM in the early Fordist era, Eisenhower promotes the military-industrial complex.

Figure 7: R&D Funding as % of US GDP

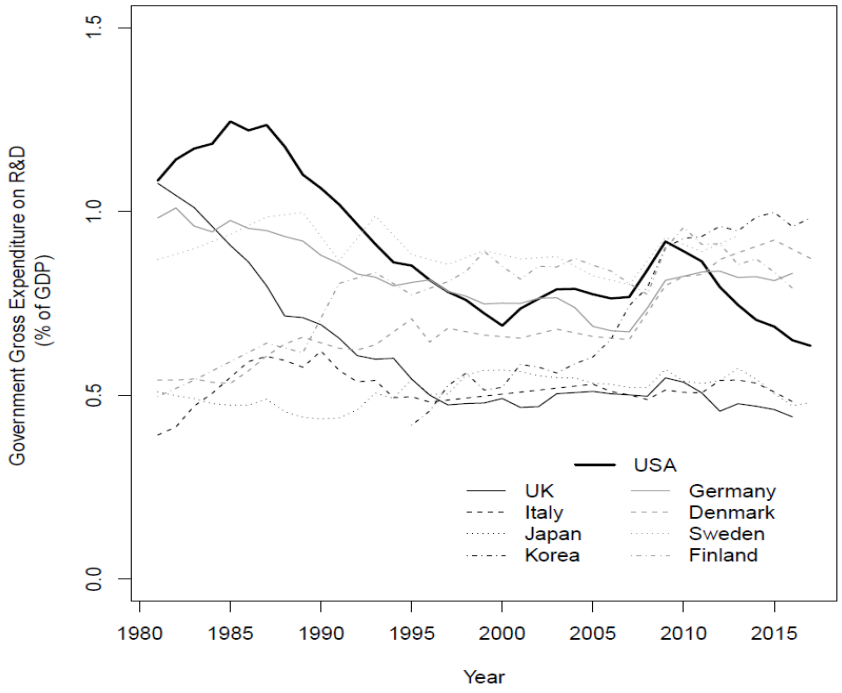


Source: Economics Innovation Group and National Science Foundation

But already by the mid-1980s, the Cold War threat was losing its sharpness as Gorbachov's position developed. As can be seen in the figure the federal funding of R&D declines from the mid-late 1980s on from over 50% to 1/3rd in the mid 1990s and then less than a quarter by 2015.

Through the 1990s indeed, as the *scientific* case for spending on basic research in IT and a range of associated sciences was increasing, the end of the Cold War and collapse of the USSR made the Federal case for support harder.

Figure 8: Comparative Government Expenditure on R&D (GERD)



Source: OECD, Main Science and Technology Indicators. Vol 1 (2019)

Decline of Basic Research and The Geography of Politics (2): research agglomerations and left-behind areas

In section 2 we showed the centrality of the Great Inversion to the ICT revolution. From the 198os on the driving areas of research (hence radical innovation) have largely been located in a relatively small number of hugely successful cities, most notably San Francisco (with San Jose and the Bay Area), Boston (and Cambridge), New York, DC (with Baltimore and parts of Maryland and Virginia), as well as Austin, Pittsburgh, Seattle, Denver/Boulder, Chicago, San Diego and the Research Triangle. These wealthy areas are in turn linked to a small number of mainly private universities. In turn a small number of states are the key beneficiaries (NY, California, Massachusetts, Washington, Colorado).

The truly massive anti-democratic bias of the American federal system as a result of the geography of electoral districts combined with the demography of groups with different interests is sharply exposed in this type of policy choice. For the result of this geographically-distributed demography effectively rules out political support in Congress for Federal funding of basic research, even given the 'Cities on the Hill' (Ogorzalek 2018). This is particularly the case in the Senate.

Nor are there major lobbies for basic research, at least outside the life sciences. First, the major companies who benefit in principle from basic research in universities (mainly the FAANG+M companies) have very large R&D budgets of their own, and it pays them to target much of their own – some relatively basic – research collaborations with universities or research institutions close to their own long-term development requirements. Second, as will

be discussed below in the context of fiscal policy, a pervasive concern among many business leaders (outside advanced research-driven sectors) is opposition to public expenditure and lobbying for tax reductions.

Thus the public sector has declined steadily over time from its leading position in financing basic research. We see this as playing a major role in the relative decline of the US as the driver of radical innovation.

Decline of Basic Research in the Private Sector

Nor has the decline of basic research in public sector funding been compensated by an increase in basic research in the private sector. The decline in the public sector knocked on directly to the private, both because of the decline in public sector training of scientists working in the relevant areas and the complementarity between research in the two sectors. (In addition the federally funding partially covered private sector activity.)

Moreover, and of greater concern, public corporations have positively retreated from science research. A detailed paper by Arora et al makes this point at length (Arora, Belenzon et al. 2018):

> 'We document a shift away from science by large corporations between 1980 and 2006. We find that publications by company scientists have declined over time in a range of industries. We also find that the value attributable to scientific research has dropped, whereas the value attributable to technical knowledge (as measured by patents) has remained stable. These trends are unlikely to be driven principally by changes in publication practices. Further science continues to be useful as an input into innovation. Our evidence points to a reduction of the private benefits of internal research. Large firms still value the golden eggs of science (as reflected in patents) but seem to be increasingly unwilling to invest in the golden goose itself (the internal scientific capabilities).'

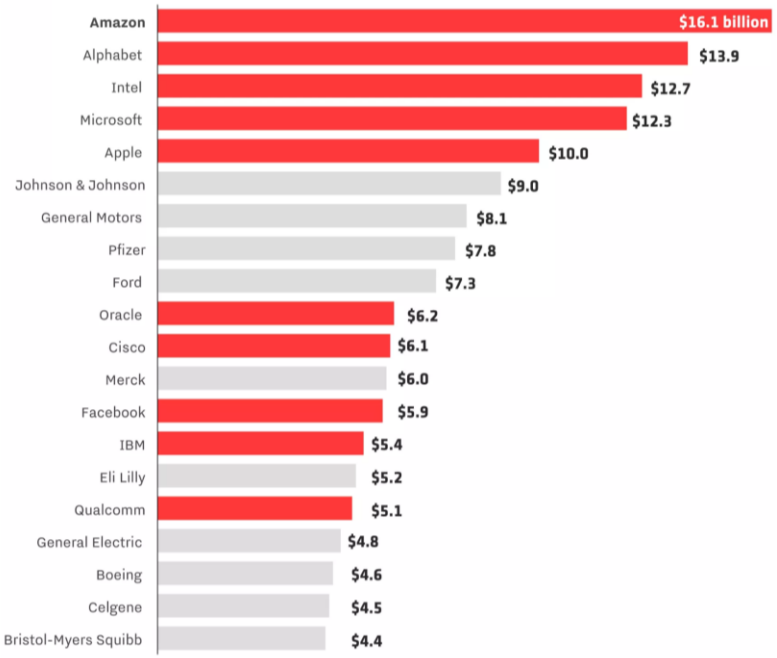
In other words, these large (quoted) American companies are engaged in knowledge-intensive markets. They value technical knowledge. But they have moved away from science. This can also be seen in the following figure (Arora, Belenzon et al. 2015):

Figure 9: Basic Research in non-Federal R&D

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Industrial Research and Development (2007)

As recently as the 1980s many of the Chandlerian conglomerate corporations had major research laboratories. 'Reconfigured' by the junk bond financed managed buy-outs, investment decisions were de facto moved from the investment committees of these companies to Wall St, as many of them were downsized (or even profitably broken up) into individually profitable units. (The junk bond was a radical innovation itself; Milken operated out of a minor but highly entrepreneurial investment bank Drexel Lambert, and the investment banking industry was only very loosely regulated.) The consequence was that most large public corporations ended by closing research laboratories and eventually moving away from research into basic (and even much applied) science.

Figure 10 : 2017 R&D Investments in Leading US Companies



Note: Includes latest fiscal year data for reporting S&P 500 companies.

Source: FactSet

The FAANG+M companies are partially exempt from this line of argument. As they grew (rapidly) their founders retained some form of ownership control. Thus the issue of management buyouts did not arise. Radical innovation in the C21st has been largely focussed on these companies; moreover, Amazon and Alphabet have at least in part acted as giant venture capitalists prepared to take very major risks in developing new areas, especially in AI and the associated technologies. Even here, they have been concerned with resources; and – depending on the definition of basic science (in relation to AI) – basic science has been left to universities. Thus again the absence of the Federal government is likely to be a major cause of the relative decline in radical innovation.

4. Conclusion

Why has the US been historically since the early C20th the global driver of radical innovation? Why, very recently, is this dominant role being partially challenged by China (with the US still remaining the driver in most areas)? And why was the UK, the initiator of the first Industrial Revolution in the C18th and earlier C19th, subsequently unsuccessful?

We argue that the first part of the answer lies in the way *four key 'market-type' institutions* work in America: a highly competitive research system, starting in the research universities and their diaspora; a relatively unregulated multiply-differentiated financial system, promoting creation and destruction; rapidly scalable companies, which if successful are protected from anti-trust rules; and a flexible high-level labor market for professionals and technologists, allowing spin-offs from established companies, career and professional switches, and multiple de facto safety-nets. The second complementary part of the answer lies in a *supportive political system at both federal (providing heavy investments in basic science) and regional/city level*.

Our claim is that China has formally different but functionally equivalent 'market' institutions and that its political system is reinforcing at national and regional levels in supporting technologies. The UK is – like the US – an LME, but its market institutions nonetheless function quite differently: this reflects the tight political control of the central government, over the university system, and over the financial system (via the tacit power of the Bank of England); there are a range of restraints against company scalability; and careers in professional and technological labor markets are more narrowly circumscribed.

And our key argument is this: The four key 'market' institutions in the US remain very much in place. But Federal support for the ICT revolution has progressively declined/collapsed in recent decades. This we attribute to the end of the Cold War, and the reduction in 'national' electoral support for Federal support; and then to the agglomeration of innovation-driven successful cities as the beneficiaries of ongoing support.

That geographical divergence (Storper's Great Inversion) opened up the whole range of less successful states to the Republican party. The latter has been hostile to fiscal expansion via public expenditure (both redistribution seen as favouring the ethnic poor, and social investment seen as favouring the cities) , but open to tax cuts. And it has been happy to be tacitly financed by the anti-statist pro-business ideologues rewriting the rules in State legislatures and courts (Hertel-Fernandez 2019).

Bibliography

Aldrich, J. H. (2011). Why Parties? A Second Look. Chicago, University of Chicago Press.

Arora, A., S. Belenzon and A. Patacconi (2015). Killing the golden goose? The decline of science in corporate R&D, National Bureau of Economic Research.

Arora, A., S. Belenzon and A. Patacconi (2018). "The decline of science in corporate R&D." Strategic Management Journal **39**(1): 3-32.

Bensel, R. F. (2000). The Political Economy of American Industrialisation, 1877-1900. New York, Cambridge University Press.

Bloom, N., C. I. Jones, J. Van Reenen and M. Webb (2017). Are ideas getting harder to find?, National Bureau of Economic Research.

Bonnet, O., P.-H. Bono, G. C. Chapelle and E. Wasmer (2014). "Capital is not back: A comment on Thomas Piketty's 'Capital in the 21st Century'." VOX CEPR's Policy Portal.

Chandler, A. D. (1965). The railroads: the Nation's first big business; sources and readings, Harcourt, Brace & World.

Cox, G. W. (1987). The Efficient Secret: The Cabinet and the Development of Parties in Victorian England. NY, Cambridge University Press.

Davis, L. E. and L. Neal (2007). Why did finance capitalism and the second industrial revolution arise in the 1890s? Financing Innovation in the United States, 1870 to the Present. N. R. Lamoreaux and K. L. Sokoloff**:** 129-161.

Freeman, C. and F. Louçã (2001). As Time Goes By: From the Industrial Revolutions to the Information Revolution, Oxford University Press.

Gerstle, G. (2017). Liberty and coercion: The paradox of American government from the founding to the present, Princeton University Press.

Gertler, M. S., P. Oinas, M. Storper and P. Scranton (1995). "Discussion of Regional advantage: culture and competition in Silicon Valley and Route 128 by AnnaLee Saxenian." Economic Geography **71**(2): 199-207.

Gordon, R. J. (2000). "Does the" new economy" measure up to the great inventions of the past?" Journal of economic perspectives **14**(4): 49-74.

Hertel-Fernandez, A. (2019). State Capture: How Conservative Activists, Big Businesses, and Wealthy Donors Reshaped the American States--and the Nation, Oxford University Press.

Lamoreaux, N. R. (1988). The great merger movement in American business, 1895-1904, Cambridge University Press.

Lundvall, B.-A. (1992). "National systems of innovation: towards a theory of innovation and interactive learning."

Moretti, E. and P. Thulin (2013). "Local multipliers and human capital in the United States and Sweden." Industrial and Corporate Change **22**(1): 339-362.

Novak, W. J. (1996). The people's welfare: law and regulation in nineteenth-century America, Univ of North Carolina Press.

Novak, W. J. (2008). "The Myth of the "Weak" American StateWilliam J. NovakThe Myth of the "Weak" American State." The American Historical Review **113**(3): 752-772.

OECD (2018). "Education at a Glance 2018." Editions OECD.

Ogorzalek, T. (2018). The Cities on the Hill: How Urban Institutions Transformed National Politics, OUP.

Perez, C. (2010). "Technological revolutions and techno-economic paradigms." Cambridge journal of economics **34**(1): 185-202.

Saxenian, A. (1994). "Regional networks: industrial adaptation in Silicon Valley and route 128."

Storper, M. (2013). Keys to the city: how economics, institutions, social interaction, and politics shape development, Princeton University Press.

Storper, M., T. Kemeny, N. Makarem and T. Osman (2015). The rise and fall of urban economies: Lessons from San Francisco and Los Angeles, Stanford University Press.

Storper, M. and A. J. Venables (2004). "Buzz: face-to-face contact and the urban economy." Journal of Economic Geography **4**(4): 351-370.

Tellis, G. J., J. C. Prabhu and R. K. Chandy (2009). "Radical innovation across nations: The preeminence of corporate culture." Journal of marketing **73**(1): 3-23.

Urquiola, M. (2020). Markets, Minds, and Money: Why America Leads the World in University Research, Harvard University Press.